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Commissioner	:	Alice Reynolds
Admin. Law Judge	:	Brandon T. Gerstle
Public Advocates	:	Otto Nichols
Project Managers	:	Lauren Schenck
	:	Christopher Hogan
Public Advocates	:	Otto Nichols
Witnesses	:	Lauren Schenck

PUBLIC ADVOCATES OFFICE

CALIFORNIA PUBLIC UTILITIES COMMISSION

Final Evaluation Reports of the Dynamic Rate Pilots Authorized by Decision (D.) 21-12-015

San Francisco, California

January 16, 2026

Final Evaluation of Southern California Edison's Dynamic Rate Pilot

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February 28, 2025

Confidential information is redacted and denoted with black highlighting: [redacted]

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EXECUTIVE SUMMARY

The California Public Utilities Commission approved two dynamic rate pilots in Decision (D.)21-12-015 (Phase 2 Decision) to be implemented during a three-year period from 2022 through 2024. The Decision required mid-term and final evaluations of each pilot. This document represents the final evaluation of Southern California Edison's (SCE's) Dynamic Rate Pricing Pilot (Pilot).[1]

The Phase 2 Decision ordered SCE to "conduct a mid-term and final evaluation of its dynamic rate pilot…to assess the costs and benefits of real-time rates, including required infrastructure, manufacturer interest, and customer impacts...The evaluations shall include the following elements:"[2]

1. An evaluation of load responsiveness.
2. The monthly bill impacts of the Pilot dynamic rate in comparison to a customer's otherwise applicable tariff (OAT).
3. An evaluation of the cost recovery to assess the impact of any under-collection of revenues associated with the Pilot.

The dynamic rate design in the Pilot employed a "two-part" pricing method, in which the customer is provided a subscription of a fixed quantity of electricity (the "subscription" load) priced at an OAT equivalent rate and based on historical customer usage from the year prior. The subscription method provides the customer with protection, flexibility, and predictability. Customers in the Pilot stayed on their current OAT and were converted to monthly calendar billing cycles to align with the subscription energy load profiles. A customer "shadow bill" was then calculated each month, reflecting the amount that would be owed or saved under the Pilot pricing method.

SCE bundled customers participated in the Pilot via Automation Service Providers (ASPs) who have installed automated technologies to manage selected electrical end uses at customer sites. SCE did not market the Pilot to customers or directly enroll them into the Pilot and participants were often customers of the ASPs prior to enrollment. This minimized SCE's recruitment costs. Multiple ASPs were engaged during the Pilot's development and deployment, but only three ASPs actively enrolled customers in the Pilot, with that customer data contributing to this report.

Southern California Edison (SCE) partnered with TeMix, Inc., a third-party market consultant and application software platform services provider, to host their software-as-a-service (SaaS) transactive platform (TeMix Platform™) for delivering the Pilot's dynamic pricing to ASPs. TeMix also provided analytical design support, application reviews, and operational services for various technical aspects of the Pilot. Their consulting services included collaborating with SCE's Rate Design Team on dynamic price designs and determining hourly price values. These values were calculated by the TeMix Platform and

[1] The other dynamic pricing pilot in the Decision relates to agricultural pumping customers served by Valley Clean Energy and Pacific Gas and Electric Company.
[2] Phase 2 Decision, Ordering Paragraph (OP) 62.

transmitted to the ASPs on a day-ahead schedule so that the ASPs could manage the end uses on behalf of their customers.

SCE contracted with another third-party consultant, GridX, to provide TeMix dynamic circuit load forecast models published daily for the SCE distribution circuits that serve the specific participants in the pilot. This information was used in the calculation of the hourly dynamic prices.

SCE directly contracted with the customer ASPs, who developed machine learning Agents to manage customer loads in response to the day-ahead dynamic prices communicated by TeMix using its protocols. The ASPs interact with the TeMix Platform to manage electric end-use technologies at customer sites, while integrating dynamic rates into the end-use technology operating schedules. TeMix and the ASPs managed the Agents to schedule the operation of devices based on the hourly dynamic prices, weather inputs, other data, and the devices' physical constraints. This schedule is then used to manage the hourly pricing transactions during each day to optimize the customer's electrical costs.

During the Pilot, participating customers continue to receive and pay their OAT bill each month on a calendar basis. Additionally, the TeMix platform calculates a "shadow bill" each month, reflecting the customer's energy costs associated with the Pilot pricing method. However, this shadow bill is not settled with the customer's OAT bill each month. Instead, at the end of a full year of Pilot participation[3], the total OAT bill over twelve months is compared to the total shadow bill over the same period for settlement. If the shadow bills are lower than the OAT bills, the customer receives an incentive payment for the difference. Conversely, if the shadow bills are higher than the OAT bills, the customer does not owe any additional payment to SCE.

There were 38 Pilot participants that participated at some point through September 2024 (one opted out in 2024). July 2023 was the first month in which a customer became eligible to receive shadow bill credits after one year of Pilot participation, though most of the customers' eligibility began later in 2023. Twenty-two of the enrolled customers had validated shadow bills available for inclusion in this report, with 4 to 15 months of available data within the July 2023 through September 2024 timeframe.

The Pilot framework is based on an innovative dynamic rate design that required the creation of new hourly pricing models with interfaces to the CAISO; GridX for circuit load forecasts; SCE for current and historical meter data, OAT billing data, and OAT-based subscription costs; and ASPs and SCE for customer enrollment information. While many of the early challenges of developing these unique and unprecedented Pilot processes are now substantially resolved, their resolution contributed to schedule delays as the Pilot evolved, resulting in the smaller data set of active customers available for this report than may have been expected when the Pilot was originally executed.

[3] Net Energy Metering customers will receive their shadow bill after the end of their relevant period.

Findings

Our study examines customer outcomes during their participation in the Pilot in the following ways:

- Comparisons of peak-period energy usage shares before and during the Pilot.
- A comparison of usage and prices on high-price days and comparison days.
- Statistical estimates of the effect of changes in the dynamic hourly price ratios (peak to off-peak) on the share of peak-period usage.
- Comparisons of shadow bills and OAT bills.
- Feedback from the three active ASPs and TeMix.
- Feedback from SCE.

The key takeaways we have from the Pilot are described below.

- The evaluation of load responsiveness found the following:
    - The ASPs in the Pilot reported the ability to successfully respond to the hourly dynamic price signals from TeMix. ASPs were able to integrate technologies (primarily smart thermostats) in the Pilot that responded to the ASP Agent schedules based on the day-ahead price signals without customer intervention.
    - The analysis did not find evidence of consistent and/or large changes in hourly energy usage due to customer price response. Possible explanations for this finding include:
        - Extended time required to set up and implement Pilot activities, including time for the ASPs to refine their response algorithms, time to acclimate customers to the Pilot (e.g., ensure they understand the kinds of changes they can expect to experience as their AC units respond to prices), and time to produce information that provides ASPs and customers with feedback to understand the value of their participation and evaluate how they can improve performance.
        - The shadow bill credit methodology gives customers an incentive to simultaneously pay attention to OAT rates and dynamic prices. It is possible that the ASPs prioritized reducing costs from the OAT during the Pilot period as those were more visible monthly to customers (shadow bills were not). Because of the "dual incentives" issue, the Pilot was not designed to obtain statistically valid estimates of customer response to dynamic prices.

  - Hourly price differences from the dynamic rates may not have been high enough to induce significant price responses. At a given time, ASPs and customers may have prioritized maintaining comfort over the possible shadow bill savings available from shifting air conditioning loads.

- The monthly bill impacts of the Pilot dynamic rate (shadow bill) in comparison to a customer's OAT showed 41% (9 of the 22) of the customers evaluated in this report saved money on the Pilot. At the time of this evaluation:[4]

  - 4 of 13 residential customers were on track to receive a credit averaging 2.1% of their OAT bill.

  - 9 of 13 residential customers had shadow bills that were, in aggregate, 6.1% higher than their OAT bills.

  - 5 of 9 commercial customers were on track to receive a credit averaging 4.7% of their OAT bill.

  - 4 of 9 commercial customers had shadow bills that were, in aggregate, 8.3% higher than their OAT bills.

- The evaluation of cost recovery concluded that the customer's subscription load profiles were the most important factor in determining whether a customer was due a shadow bill credit. The optimal method of subscription pricing (e.g., whether/how to update quantities over time, how to deal with NEM and electric vehicle adoption) is a topic worthy of in-depth research that is beyond the scope of this study.

- The ASPs reported that they did not receive timely information on shadow bills and credits as expected for customer communications. The Pilot experienced significant delays in providing information to ASPs due to implementation issues and a largely manual infrastructure (e.g., customer-specific shadow bill spreadsheets).

- ASPs suggested that customer engagement could be improved by providing closer to real-time feedback and the ability to set preferences (e.g., desired temperature ranges) in a smartphone application (or something similar).

[4] Note that the Pilot credit summaries presented here in the evaluation are based on all available months for each customer. For the actual shadow billing, the shadow bill credit calculation for customers was conducted at the end of their relevant period for NEM customers and at the end of the 12 months of participation for non-NEM customers, with the months in the following period being included in a subsequent shadow bill credit calculation. This change in the timing of the calculation may affect whether a customer received a credit, as the calculation is cumulative over the shadow bill period.

- ASPs report that intra-day price variation needs to be higher to provide sufficient incentives to shift loads. It appears that the existing TOU rates in the customer OATs often provided higher incentives to shift.[5]

- Consider implementing a formal testing algorithm (i.e., the randomized treatment days used by one of the ASPs) on a more widespread basis to assist in evaluating the efficacy of the Pilot tariff in shifting loads enrolled in the program from peak to off-peak periods, compared to non-participant loads.

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[5] Even if one assumes that the Pilot provides the "correct" incentive to shift loads and the TOU rates provide bill reductions that are larger than the avoided costs, a customer will be likely to choose the TOU rate if it provides a higher reward for their usage changes.

1. INTRODUCTION AND PURPOSE OF THE STUDY

1.1 Regulatory Background

On November 19, 2020, the California Public Utilities Commission (Commission) initiated Phase 1 of Rulemaking (R.)20-11-003 (Reliability OIR) to establish policies, processes, and rules to ensure reliable electric service in California in the event of an extreme weather event in 2021. This rulemaking was designed to identify the near-term actions the Commission proposes to prepare for a possible extended heat storm, setting forth the process for obtaining stakeholder and respondent input on the proposed actions, and establishing a schedule that would allow it to adopt relevant changes to its processes, programs and rules in advance of the summer of 2021.

On March 25, 2021, the Commission issued D.21-03-056, directing the three California electric investor-owned utilities (IOUs) to take specific actions to decrease peak and net peak demand and increase peak and net peak supply to avert the potential need for rotating outages during the summers of 2021 and 2022, similar to what occurred in summer 2020. The actions included increased media outreach, modifications to existing demand response programs, the creation of new demand response pilots, and other guidance.[6]

On May 25, 2021, the Energy Division (ED) staff held a public workshop entitled, "Forward Looking Vision: Advanced Distributed Energy Resources (DERs) & Demand Flexibility Management."[7] During the workshop, ED outlined a six-step roadmap to establish a unified, universal, dynamic economic signal (UNIDE) to help meet similar goals as defined in the OIR but through enhanced customer demand flexibility response to market-based dynamic pricing. The UNIDE roadmap presentation by ED staff was not part of an official proceeding but rather it requested voluntary industry input on how to best use flexible devices and decentralized DERs to assist in meeting goals highlighted in the Reliability OIR and other proceedings.

On July 30, 2021, Governor Newsom signed an emergency proclamation to "free up energy supply to meet demand during extreme heat events and wildfires that are becoming more intense and to expedite deployment of clean energy resources this year and next year."[8] In response to the Governor's emergency proclamation, on August 2, 2021, the assigned Administrative Law Judge initiated Phase 2 of the Reliability OIR. On December 6, 2021, the Commission issued D.21-12-015 (Phase 2 Decision), which directed the IOUs to take additional actions to prepare for potential extreme weather in the summers of 2022 and 2023.

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[6] D.21-03-025: https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M372/K335/372335522.PDF

[7] Presentation available at: https://www.dret-ca.com/wp-content/uploads/2022/02/UNIDE-Presentation-5-2021.pdf

[8] See Press Release from the Office of Governor Gavin Newsom available at: https://www.gov.ca.gov/2021/07/30/governor-newsom-signs-emergency-proclamation-to-expedite-clean-energy-projects-and-relieve-demand-on-the-electrical-grid-during-extreme-weather-events-this-summer-as-climate-crisis-threatens-western-s/

The Phase 2 Decision authorized SCE to conduct a demonstration pilot of the TeMix "RATES" platform (or the TeMix proposed "Pilot UNIDE Program") for a three-year period (2022 to 2024) and approved SCE's requested $2.5 million budget for the Pilot.[9] The CPUC authorized the Pilot so SCE could "conduct comprehensive studies that fully assess the costs and benefits of real-time rates, including required infrastructure, manufacturer interest, and customer impacts."[10] The Pilot was to be administered under SCE's Demand Response (DR) Emerging Markets and Technologies program authorized in D.17-12-003.[11]

Ordering Paragraph (OP) 63 of the Phase 2 Decision directed SCE to submit a Tier 2 advice letter (AL) within 30 days of the issuance of the Decision that included, but was not limited to, the following elements: (1) Pilot scope, (2) Pilot partners, (3) shadow bill implementation, (4) Pilot dates, and (5) Pilot tariff design. SCE submitted ALs 4684-E and 4684-E-A (Pilot ALs) to meet the requirements of OP 63, which were approved on April 29, 2022.[12] The Pilot officially started on May 1, 2022.

On June 22, 2022, ED issued the white paper and staff proposal entitled "Advanced Strategies for Demand Flexibility Management and Customer DER Compensation", that elaborated on a comprehensive policy roadmap generally referred to as the California Flexible Unified Signal for Energy (CalFUSE) framework.[13] On July 14, 2022, the CPUC initiated R.22-07-005 "Order Instituting Rulemaking to Advance Demand Flexibility Through Electric Rates" (Demand Flexibility OIR or DFOIR) to, among other things, "advance demand flexibility pursuant to strategies identified in the Demand Flexibility Whitepaper or by a working group."[14]

Since initiating the Pilot in May 2022, SCE has been moving forward in accordance with the Pilot scope as outlined in its Pilot ALs. SCE has engaged Pilot partners who have been enrolling customers and has also been developing internal processes for streamlining how the ASPs and their enrolled customers interconnect with the TeMix dynamic pricing platform. In addition, SCE and TeMix also developed the dynamic price parameters and subscription functions, implemented the process to provide shadow bills for customers enrolled in the Pilot, and calculate the bill credits as the Pilot progresses.

1.2 Purpose of the Evaluation

As directed by the Phase 2 Decision, SCE was required to submit a mid-term evaluation report no later than December 31, 2023 that presented a mid-term review of the Pilot, which assessed the "costs and benefits of real-time rates, including required

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9 Phase 2 Decision, p. 96, OPs 59 and 60

10 TeMix UNIDE proposal: temix-opening-testimony-phase-2.pdf (ca.gov)

11 Phase 2 Decision, p. 96

12 SCE Advice Letters 4684-E and 4684-E-A are provided as an appendix to this report.

13 CalFUSE white paper available at: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/demand-response/demand-response-workshops/advanced-der---demand-flexibility-management/ed-white-paper---advanced-strategies-for-demand-flexibility-management.pdf

14 Demand Flexibility OIR, p. 7

infrastructure, manufacturer interest, and customer impacts."[15] The final evaluation report is to be released no later than March 1, 2025. This study covers pilot activities through September 30, 2024.

Specifically, the Phase 2 Decision requires the evaluation to include:[16]

1. An evaluation of load responsiveness. SCE should evaluate the efficacy of the Pilot tariff in shifting loads enrolled in the program from peak to off-peak periods and should be compared to non-participant loads.
2. The monthly bill impacts of the Pilot dynamic rate in comparison to a customer's OAT.
3. An evaluation of the cost recovery which assess(es) the impact of any under-collection of revenues associated with the Pilot, similar to the evaluation required of the Valley Clean Energy dynamic rate pilot.

SCE bundled customers participated in the Pilot via ASPs who have installed automated technologies to manage selected electric end uses at the customer's site. SCE did not market the Pilot to customers or directly enroll them into the Pilot, and participants were often customers of the ASP prior to enrollment. This minimized SCE's recruitment costs. Multiple ASPs were engaged during the Pilot's development and deployment, but only three ASPs actively enrolled customers in the Pilot, with that customer data contributing to this report.

Southern California Edison (SCE) partnered with TeMix Inc., a third-party market consultant and application software platform services provider, to host their software-as-a-service (SaaS) transactive platform (TeMix Platform™) for delivering the Pilot's dynamic pricing to ASPs. TeMix, Inc., also provided analytical design support, application reviews, and operational services for various technical aspects of the Pilot. Their consulting services included collaborating with SCE's Rate Design Team on dynamic price designs and determining hourly price values. These values were calculated by the TeMix Platform and transmitted to the ASPs on a day-ahead schedule so that the ASPs could manage the end uses on behalf of their customers.

SCE contracted with another third-party consultant, GridX, to provide TeMix dynamic circuit load forecast models published daily for the SCE distribution circuits that serve the specific participants in the pilot. This information was used in the calculation of the hourly dynamic prices.

SCE directly contracted with the customer ASPs, who developed machine learning Agents to manage customer loads in response to the day-ahead dynamic prices communicated by TeMix using its protocols. The ASPs interact with the TeMix Platform to manage electric end-use technologies at customer sites, while integrating dynamic rates into the end-use technology operating schedules. TeMix and the ASPs managed the Agents to schedule the operation of devices based on the hourly dynamic prices, weather inputs, other data, and the devices' physical constraints. This schedule is then used to manage

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[15] Phase 2 Decision, OP 62

[16] Phase 2 Decision, OP 62.

the hourly pricing transactions during each day to optimize the customer's electrical costs.

During the Pilot, participating customers continue to receive and pay their OAT bill each month on a calendar basis. Additionally, the TeMix platform calculated a "shadow bill" each month, reflecting the customer's energy costs associated with the Pilot pricing method. However, this shadow bill is not settled with the customer's OAT bill each month. Instead, at the end of a full year of Pilot participation[17], the total OAT bill over twelve months is compared to the total shadow bill over the same period for settlement. If the shadow bills are lower than the OAT bills, the customer receives an incentive payment for the difference. Conversely, if the shadow bills are higher than the OAT bills, the customer does not owe any additional payment to SCE.

There were 38 Pilot participants that participated at some point through September 2024 (one opted out in 2024). July 2023 was the first month in which a customer became eligible to receive shadow bill credits after one year of Pilot participation, though most of the customers' eligibility began later in 2023. Twenty-two of the enrolled customers had validated shadow bills available for inclusion in this report, with 4 to 15 months of available data within the July 2023 through September 2024 timeframe.

The Pilot framework is based on an innovative dynamic rate design that required the creation of new hourly pricing models with interfaces to the CAISO; GridX for circuit load forecasts; SCE for current and historical meter data, OAT billing data, and OAT-based subscription costs; and ASPs and SCE for customer enrollment information. While many of the early challenges of developing these unique and unprecedented Pilot processes are now substantially resolved, their resolution contributed to schedule delays as the Pilot evolved, resulting in the smaller data set of active customers available for this report than may have been expected when the Pilot was originally executed.

The report is organized as follows: Section 2 contains a description of the Pilot; Section 3 contains an evaluation of customer load response; Section 4 contains the Pilot and OAT bill comparisons; Section 5 discusses Pilot cost recovery issues; Section 6 contains a summary of stakeholder comments on the Pilot; and Section 7 provides a summary and conclusions.

2. DESCRIPTION OF THE DYNAMIC PRICING PILOT

2.1 Pilot Description

According to the Phase 2 Decision, the CPUC adopted a dynamic rate pilot that "uses TeMix's technology to facilitate the use of dynamic rates as an incentive to shift load for customers using electric vehicles, behind the meter energy storage, and similar flexible technologies."[18] The Decision ordered SCE "to conduct a dynamic rate pilot for the

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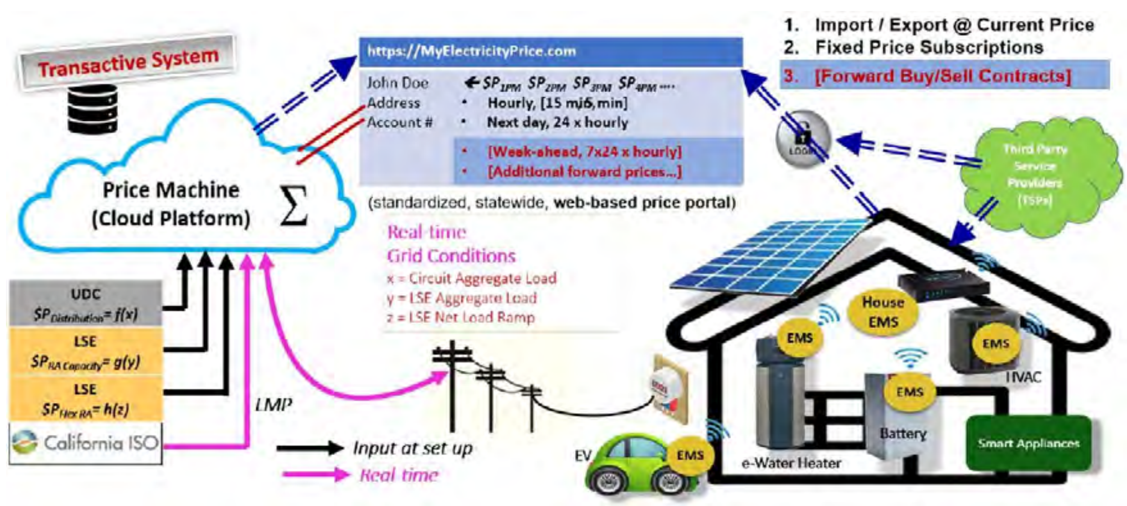
[17] Net Energy Metering customers will receive their shadow bill after the end of their relevant period.
[18] Phase 2 Decision, p. 85.

purpose of studying how price responsive pilot projects can enhance system reliability in 2022 and 2023.[19]

The Pilot is described on the Demand Response and Emerging Technologies Website.[20] Figure 2.1[21] illustrates the components of the CalFUSE framework. Inputs to the price machine are provided by the utility distribution company (UDC) and load serving entity (LSE), which in this Pilot are both SCE. A third-party vendor, GridX, was used to provide circuit load forecasts. ASPs provide the technology that receives the Pilot prices and determine how devices are managed in response to those prices.

Figure 2.1: Graphical Illustration of the CalFUSE Framework



The dynamic rate design in the Pilot employs a "two-part" pricing method, in which the customer first subscribes to a fixed quantity of electricity (the "subscription" load) priced at an OAT equivalent rate and based on the customer's historical usage from the year prior, with separate usage profiles for weekends and weekdays.[22]

During intervals when a customer's usage differs from the subscription quantity, the customer will be billed (or will be credited) the ex-post price for the difference.[23] These

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[19] Phase 2 Decision, Ordering Paragraph (OP) 59

[20] https://www.dret-ca.com/dynamic-rate-pilot/

[21] The figure is taken from page 6 of the June 22, 2022 Energy Division white paper entitled "Advanced Strategies for Demand Flexibility Management and Customer DER Compensation".

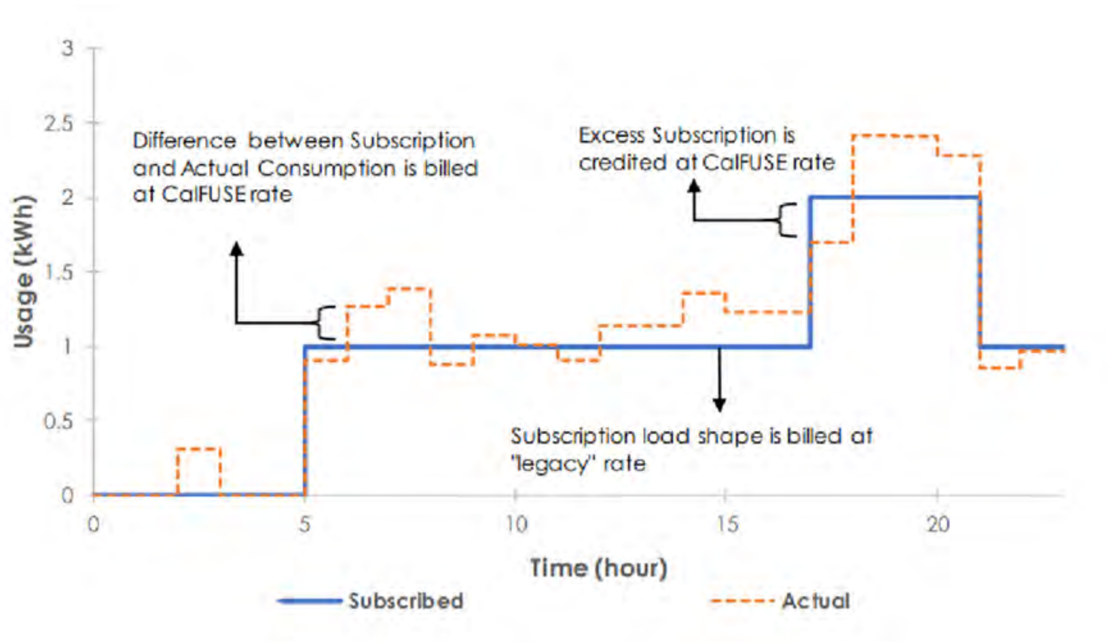
[22] SCE also considered basing the subscription on the average of three years to normalize for year-over-year changes in weather. For expediency, the Pilot opted to use only the most recent year because the effect of COVID on usage in 2020 and 2021 was adding more interpretive distortion than benefit.

[23] Initially, the Pilot platform allowed for day-ahead and hour-ahead bi-lateral transactions as well, but none of the customers active during the analysis period took advantage of that feature. However, the day-ahead and hour-ahead prices were available for the ASPs to plan the customers' load response. The day-ahead and hour-ahead prices are binding offers at which customers may transact for fixed quantities. For example, an ASP could direct the customer's thermostat to pre-

settlements were conducted for every five-minute interval of the day. For example, a customer whose load is declining over the course of an hour may be purchasing energy above its subscription early in the hour and selling (credited) its excess subscription load later in the hour. Beginning in May 2024, the Pilot transitioned to conducting settlements at the hourly level using day-ahead tenders.

The settlement process is illustrated in Figure 2.2 below, which is taken from the CalFUSE white paper.[24] In the figure, the "CalFUSE rate" is synonymous with the dynamic settlement price used in SCE's Pilot.

Figure 2.2 Example Showing the Subscription as a Hedging Product



The dynamic price tenders are set to recover the marginal energy costs, which reflect CAISO locational marginal prices (LMPs), long-run generation capacity marginal costs as vetted in Phase 2 of SCE's General Rate Case (GRC), long-run distribution capacity marginal costs also as vetted in Phase 2 of the SCE GRC, and other non-marginal revenue components and policy costs currently included in the tariffed retail rate.

The shadow bill calculation for month *m* can be represented with the equation below (where *i* indexes all 5-minute intervals during the month):

$$\text{Shadow Bill}_m = \Sigma_i \{(P^{Sub}_i \times Q^{Sub}_i) + P^{Dyn}_i \times (Q^{Obs}_i - Q^{Sub}_i)\}$$

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cool during inexpensive hours for a fixed quantity above the subscription quantity and then sell back the excess subscription quantity for the later (presumably more expensive) hours in which the thermostat's temperature is allowed to rise.

[24] CalFUSE White Paper, page 67, available at: ED-White-Paper-Advanced-Strategies-for-Demand-Flexibility-Management-June-2022.pdf (dret-ca.com)

Table 2.1: Variables in the Shadow Bill Calculation

Variable	Description
$P^{Sub}{}_i$	Subscription price during time interval *i* in $/kWh
$Q^{Sub}{}_i$	Subscription quantity during time interval *i* in kWh
$P^{Dyn}{}_i$	Dynamic price during time interval *i* in $/kWh
$Q^{Obs}{}_i$	Observed (metered) usage during time interval *i* in kWh

Table 2.2 replicates a table from the CalFUSE white paper that highlights the benefits of fixed load shape subscription pricing.

Table 2.2: Benefits of Fixed Load Shape Subscriptions

Protection	Flexibility	Predictability
• Protect customers against bill volatility by allowing a forward contract based on predictable prices. • Ease customers' transition to real-time prices.	• Accommodate changed home conditions. • Encourage opportunistic load shift.	• Stabilize revenue recovery for utility distribution companies (UDCs), load serving entities (LSEs), etc.

The subscription component of the Pilot pricing structure serves two purposes. First, it reduces the customer's exposure to the potential variability of "pure" dynamic prices, with the customer only being billed (or being paid) those prices for usage on the margin that deviates from their subscription load.[25] In the extreme, a customer who uses exactly its subscription load during an hour will not be billed for the dynamic price at all. This risk mitigation can be especially important during extended periods of highly dynamic prices. Second, it provides a means of linking the overall bill level to the retail rate and the authorized revenue requirement used when establishing the retail rate. If dynamic prices are designed to reflect the utility's marginal cost, in theory, the deviations of the bill from the OAT-based subscription level should be matched by the avoided costs associated with the customer's load response. If dynamic prices are designed to reflect the utility's marginal cost and set to recover the utility's authorized revenues, deviations of a customer's electricity use from the subscription ensures that the customer bill changes are held in parity with the OAT.

[25] In contrast, under a "one-part" real-time pricing program, the customer pays the hourly price for all usage in the hour.

2.2 Participant Summary

Customers participated in the Pilot via ASPs who installed and managed enabling technologies at the customer's site. These Pilot participants may have been customers of the ASP prior to the Pilot. Three ASPs were active in the Pilot, which we will refer to as ASP A, ASP B, and ASP C to anonymize their names.

The 22 of 38 Pilot participants for which we have validated shadow bill data for some part of the period from July 2023 through September 2024 are shown in Table 2.3. Thirteen are residential customers served by ASP C, two of which are net energy metered (NEM) customers. These customers are distributed across five rates: Domestic, TOU-D-A, TOU-D 4-9PM, TOU-D 5-8PM, and TOU-D-PRIME.

ASP A serves seven commercial customers in the education sector, all of which are NEM customers, with six served on TOU-GS-2-R and one served on TOU-GS-3-R (legacy TOU rates with a noon to 6 p.m. summer on-peak period). ASP B serves the remaining two commercial customers, one of which is a NEM customer served on TOU-GS-2-D (the default rate for the 20 to 200 kW class), with the other customer served on TOU-GS-3-D.

Table 2.3: Pilot Participant Characteristics

ID	Dates Available	NEM Type	Rate	Customer Type	Circuit Name
A-001	8/23 to 9/24	NEM 1.0	TOU-GS-2-R	Commercial	[redacted]
A-002	8/23 to 4/24	NEM 1.0	TOU-GS-2-R	Commercial	[redacted]
A-005	10/23 to 9/24	NEM 1.0	TOU-GS-3-R	Commercial	[redacted]
A-006	12/23 to 9/24	NEM 1.0	TOU-GS-2-R	Commercial	[redacted]
A-007	10/23 to 9/24	NEM 1.0	TOU-GS-2-R	Commercial	[redacted]
A-008	10/23 to 9/24	NEM 1.0	TOU-GS-2-R	Commercial	[redacted]
A-009	10/23 to 5/24	NEM 1.0	TOU-GS-2-R	Commercial	[redacted]
B-004	8/23 to 9/24	NEM 2.0	TOU-GS-2-D	Commercial	[redacted]
B-005	7/23 to 9/24		TOU-GS-3-D	Commercial	[redacted]
C-002	10/23 to 9/24		TOUD-4-9PM	Residential	[redacted]
C-004	8/23 to 9/24		TOUD-5-8PM	Residential	[redacted]
C-024	10/23 to 9/24		TOUD-5-8PM	Residential	[redacted]
C-030	10/23 to 9/24		TOUD-4-9PM	Residential	[redacted]
C-043	10/23 to 9/24		TOUD-4-9PM	Residential	[redacted]
C-044	3/24 to 9/24		TOUD-4-9PM	Residential	[redacted]
C-045	10/23 to 9/24	NEM 1.0	DOMESTIC	Residential	[redacted]
C-051	12/23 to 4/24		TOUD-5-8PM	Residential	[redacted]
C-052	12/23 to 4/24	NEM 2.0	TOU-D-A	Residential	[redacted]
C-053	12/23 to 9/24		TOUD-4-9PM	Residential	[redacted]
C-054	12/23 to 9/24		DOMESTIC	Residential	[redacted]
C-055	1/24 to 9/24		TOU-D-PRIME	Residential	[redacted]
C-056	1/24 to 4/24		TOU-D-PRIME	Residential	[redacted]

As of this writing, SCE has a total 37 enrolled customers that are receiving shadow bills, plus a 38th participant that de-enrolled from the Pilot. There are 18 Pilot participants in addition to those listed in Table 2.3 for which we did not receive validated shadow bill information in time for the analysis to be conducted.

3. EVALUATION OF LOAD RESPONSIVENESS

3.1 Methodological Overview

In this section, we present information about customer response to Pilot prices. Five sub-sections follow, including the following:

- A summary of the dynamic price tenders during the analysis period.
- A comparison of average price tenders and OAT rates by TOU pricing period.
- A comparison of usage and prices on high-price days and comparison days.

- Estimates of changes in on-peak usage relative to the pre-Pilot period.
- Estimates of within-Pilot response to prices.

It is important to note that customers simultaneously face OAT and Pilot prices, making it difficult to distinguish which prices are driving any observed price responsive behavioral changes. That is, the customer continues to pay its OAT bill during the Pilot and only receives a Pilot credit if its cumulative shadow bill after 12 months is less than its cumulative OAT bill during the same period. Therefore, the customer has an incentive to continue to be mindful of its OAT rates during the Pilot. For example, ASP interviews confirmed that they continued to consider the effect of OAT demand charges when evaluating whether/how to shift usage across hours.

In the analyses of load changes in response to price signals, the focus is on customer-specific estimates to explore the variation in response across customers. Because our sample of customers is small and heterogeneous (i.e., the 22 customers range from small residential customers to larger commercial customers), program-level summaries are not emphasized due to their lack of representativeness. That is, the program-level results would be dominated by the largest customers and those customers ([redacted]) may not be representative of the response that would be obtained if the rate was deployed at scale.

3.2 Hourly Tender Price Summaries

This section summarizes the hourly day-ahead tenders (as corrected), which were transmitted to ASPs and devices. Beginning in May 2024, the day-ahead prices were used in settlement. Prior to that time, settlement occurred at 5-minute ex-post prices, but the day-ahead hourly tenders would have been the prices that were used when determining whether and how to change customer usage in response to prices.

For a given hour, the tender can vary across circuits and according to the customer's OAT rate (which serves as the basis for adders). Therefore, there isn't a single set of tenders we can summarize that reflects the experience of all Pilot customers. We present a series of figures that show how tenders varied across customers and time.

Figure 3.1 shows the variability in average and maximum day-ahead tenders across customers. We select February 2024 because it is a month in which all included customers have data, allowing us to examine the variability in prices across all customers. Maximum tender prices in this figure are between $0.80 and $0.90. Figure 3.2 shows the same information for September 2024, for which a few customers do not have data, but the maximum prices are higher. You can see some variability in the maximum price across customers, ranging from $1.50 to $2.04 per kWh.

Figure 3.1: Average and Maximum Tender Prices by ID, February 2024

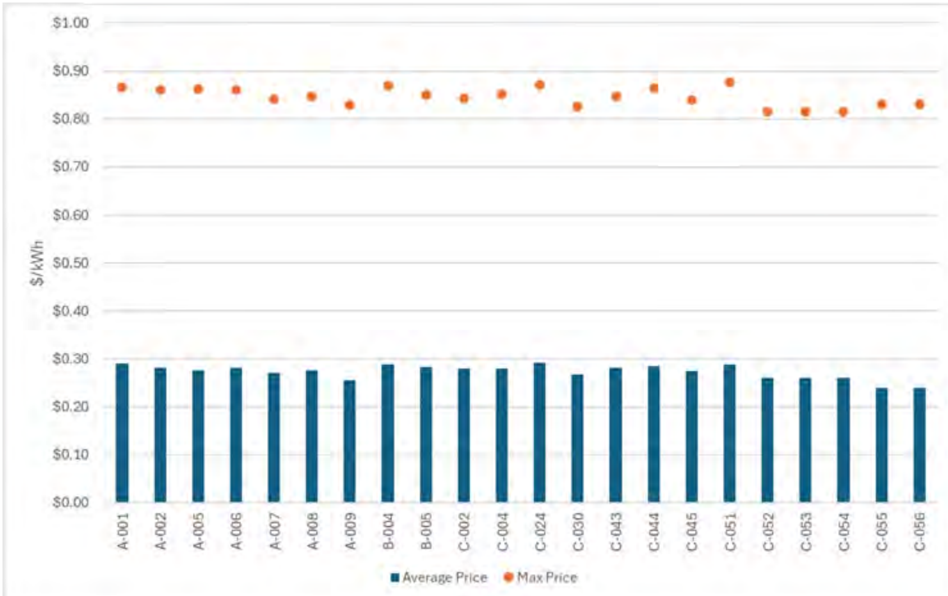
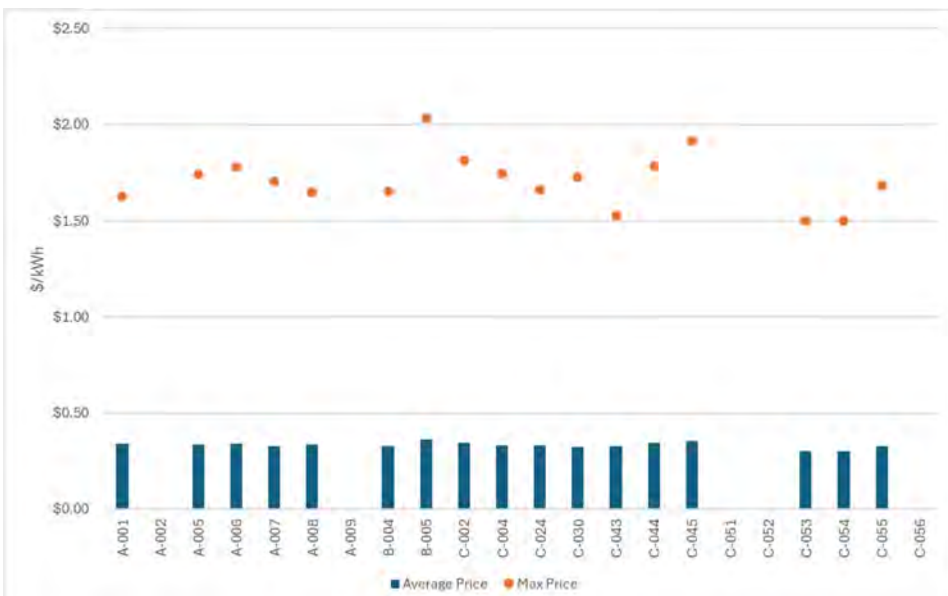


Figure 3.2: Average and Maximum Tender Prices by ID, September 2024



We selected a representative residential customer (C-004) to serve as the basis for a more in-depth exploration of the variability of tenders. This customer experienced average prices that were typical of other customers and had validated bills for almost all months included in the study (August 2023 through September 2024).

Figure 3.3 shows the monthly maximum tender and the average tender price in all hours and peak hours (5 to 8 p.m.) for C-004. Recall that the mid-term evaluation examined an August 2023 price spike ($2.35 per kWh for customer C-004), finding little evidence of response from the five customers enrolled at the time. The next highest price spike occurred in September 2024, at $1.75 per kWh. We will examine customer behavior during that time later in this section.

Figure 3.3: Average and Maximum Tender Prices by Month, C-004

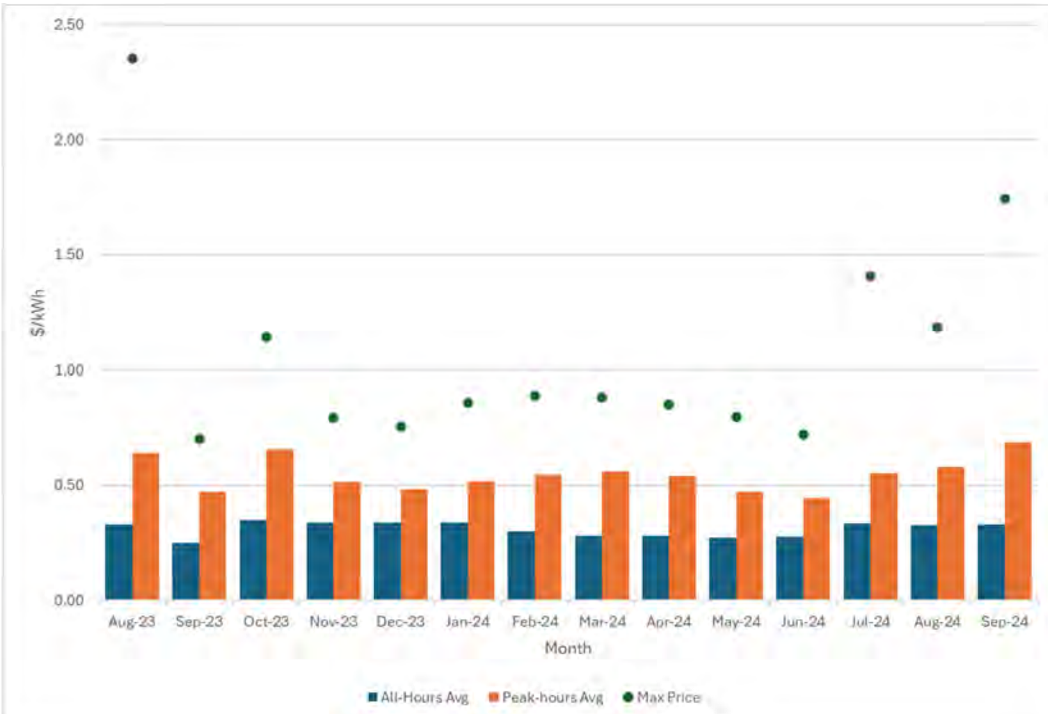
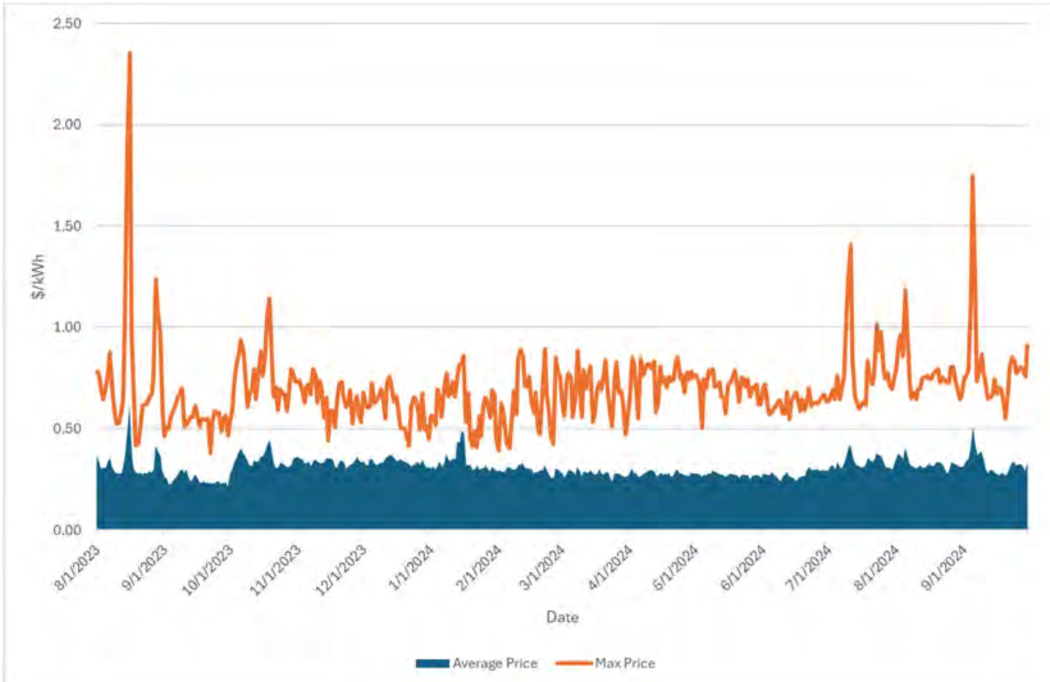


Figure 3.4 expands on Figure 3.3 by providing daily detail on the all-hours average and maximum tender prices. Price levels were fairly flat from November 2023 through June 2024, with some higher-priced days appearing later in the summer of 2024.

Figure 3.4: Average and Maximum Tender Prices by Date, C-004



Figures 3.5 and 3.6 change the focus from variability across dates to the variability across the hours of the day. Each figure shows a box-and-whisker plot[26] of the hourly tender prices, with Figure 3.5 representing winter months and Figure 3.6 representing summer months.[27]

Notice that the highest prices tend to occur during TOU on-peak hours, with hours-ending 17 through 20 (4 to 8 p.m.) having the highest winter prices and hours-ending 19 through 21 having the highest summer prices. The daily pattern of typical prices (looking at the means) tends to follow the pattern of the highest outlier prices, with the highest outlier prices limited to the same hours in which the highest average prices occur.

[26] In a box-and-whisker plot, the line in the middle of the box represents the median value, the bottom and top of the box reflect the 25th and 75th percentile values (respectively), and the highest and lowest lines represent the outlier values, excluding "outside values", which are defined as values above or below 1.5 x the interquartile range (the 25th – 75th percentile).

[27] For this customer, the available winter data is November 2023 through May 2024. The available summer data is August to October 2023 and June through September 2024.

Figure 3.5: Winter Hourly Tender Price Distributions, C-004

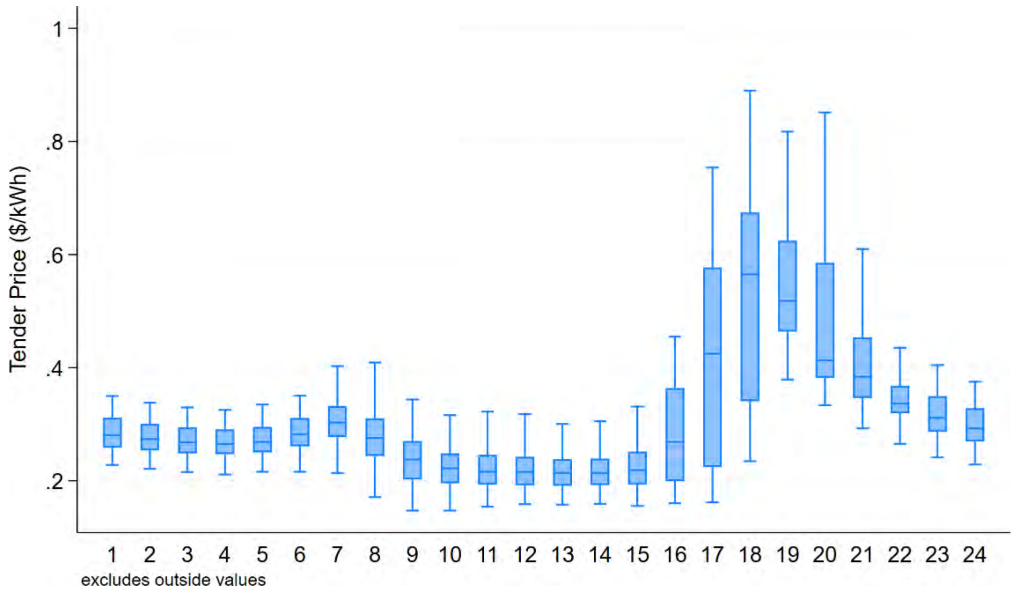
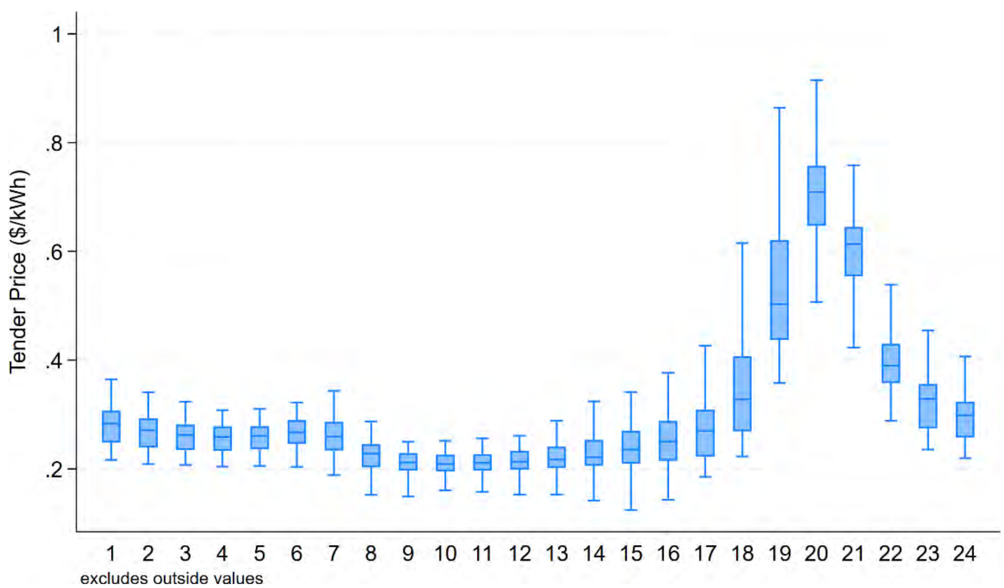


Figure 3.6: Summer Hourly Tender Price Distributions, C-004



3.3 Pilot Versus Otherwise Applicable Tariff Prices

As discussed later in Section 6, ASPs reported that the prices from the Pilot and subsequent motivation to shift load were often not as high an incentive as those offered by available TOU rates. In this section, we provide comparisons of OAT and Pilot prices for each customer.

In each table below, we summarize the average day-ahead tender price and OAT rate by TOU pricing period. (Only seasons for which we have data are included.) The average pilot price is the simple average of the hourly day-ahead tender prices within the pricing period, where the tenders have been adjusted for the fixed adders as appropriate. The tariff rate is the energy prices from the tariff, with the following caveats:

- Baseline credits (where applicable) are not included.
- Fixed $/kWh charges (e.g., Fixed Cost Recovery Charge and Modified Cost Allocation Mechanism (MCAM)[28] Charge) across all hours are not included.
- Peak-period (or Mid-peak period in winter) demand charges are included by dividing the demand charge by 100 (the approximate number of peak hours in a month) to convert it to a $/kWh effective energy charge. This is only relevant for TOU-GS-2-D and TOU-GS-3-D.[29]

While these comparisons are illustrative of average price differences, the values do not necessarily represent those that algorithms compare when determining a customer's load response. For example, ASP B reported that their method looks at prices during four-hour windows. If the average price during the first two hours is low enough relative to the average price during the second two hours, the thermostat will be instructed to pre-cool the customer's facility during the first interval so that usage can be curtailed in the second interval. As shown in Figure 3.6, price differences during various four-hour windows are likely to be smaller than the price differences across entire TOU pricing periods (i.e., 5 to 8 p.m. on-peak prices are quite a bit higher than off-peak prices on average, but the difference between 5 to 8 p.m. prices and those of the immediately preceding hours is smaller). In contrast, TOU rates are both known in advance and do not vary within pricing period. This leads to more discrete changes in incentives across TOU pricing periods relative to the dynamic prices.

The relationship between Pilot and OAT prices varies across rates. For residential rates, it is often the case that OAT rates are higher than Pilot prices (see Table 3.1a). It is common for the OAT rate to provide a higher incentive to shift from the summer On-Peak period to the Mid-Peak period than the Pilot rate for residential and commercial rates.

In Table 3.1b, which shows prices for TOU-D 5-8 PM, the dynamic prices are uniformly lower than the tariff rates. As we will show in Section 4, all three customers on this rate saved money on the Pilot. However, Table 4.2 shows that the customers had relatively little net usage to transact at dynamic prices, and their savings appear to be due to their subscription prices being lower than their average OAT prices paid.[30]

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[28] The MCAM charge recovers the net cost associated with system reliability procurement ordered by the CPUC that SCE has procured on behalf of customers whose generation services are provided by certain Electric Service Providers or Community Choice Aggregators.

[29] Omitting this "effective energy charge" (the conversion of the on-peak demand charge into an on-peak $/kWh charge) and including only the TOU energy charge would make usage in the on-peak period appear to be less costly than it is. In practice, the demand charge results in different effective energy charges depending on a customer's load factor during the pertinent billing period.

[30] The potential causes of differences between the subscription price and average OAT price paid include a) changes in customer usage relative to the historical period that were due to customer

Table 3.1a: Average Energy Prices for TOU-D 4-9 PM

ID	Period	Avg. Pilot Price ($/kWh)	Tariff Rate ($/kWh)	Pilot – OAT* ($/kWh)
C-002	Summer On-Peak	$0.563	$0.603	-$0.040
	Summer Mid-Peak	$0.526	$0.489	$0.037
	Summer Off-Peak	$0.276	$0.377	-$0.100
	Winter Mid-Peak	$0.516	$0.532	-$0.016
	Winter Off-Peak	$0.306	$0.403	-$0.097
	Winter Super Off-Peak	$0.255	$0.366	-$0.111
C-030	Summer On-Peak	$0.520	$0.603	-$0.083
	Summer Mid-Peak	$0.498	$0.489	$0.009
	Summer Off-Peak	$0.259	$0.377	-$0.117
	Winter Mid-Peak	$0.461	$0.532	-$0.071
	Winter Off-Peak	$0.277	$0.403	-$0.126
	Winter Super Off-Peak	$0.214	$0.366	-$0.152
C-043	Summer On-Peak	$0.514	$0.603	-$0.089
	Summer Mid-Peak	$0.493	$0.489	$0.004
	Summer Off-Peak	$0.268	$0.377	-$0.108
	Winter Mid-Peak	$0.494	$0.532	-$0.038
	Winter Off-Peak	$0.292	$0.403	-$0.111
	Winter Super Off-Peak	$0.245	$0.366	-$0.121
C-044	Summer On-Peak	$0.554	$0.603	-$0.049
	Summer Mid-Peak	$0.515	$0.489	$0.026
	Summer Off-Peak	$0.281	$0.377	-$0.095
	Winter Mid-Peak	$0.472	$0.532	-$0.060
	Winter Off-Peak	$0.255	$0.403	-$0.148
	Winter Super Off-Peak	$0.206	$0.366	-$0.160
C-053	Summer On-Peak	$0.478	$0.603	-$0.125
	Summer Mid-Peak	$0.460	$0.489	-$0.029
	Summer Off-Peak	$0.241	$0.377	-$0.135
	Winter Mid-Peak	$0.432	$0.532	-$0.101
	Winter Off-Peak	$0.255	$0.403	-$0.149
	Winter Super Off-Peak	$0.200	$0.366	-$0.166

*Differences in the Pilot and Tariff rates may not be exact due to rounding.

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responses to Pilot prices; b) changes in customer usage relative to the historical period due to non-Pilot factors (e.g., weather differences or structural changes to the customer's facilities); or c) errors in the subscription pricing method. We did not find evidence of errors in the subscription pricing method, but we were not provided with the subscription calculations for all Pilot participants.

Table 3.1b: Average Energy Prices for TOU-D 5-8 PM

ID	Period	Avg. Pilot Price ($/kWh)	Tariff Rate ($/kWh)	Pilot – OAT* ($/kWh)
C-004	Summer On-Peak	$0.580	$0.754	-$0.174
	Summer Mid-Peak	$0.524	$0.564	-$0.040
	Summer Off-Peak	$0.272	$0.375	-$0.103
	Winter Mid-Peak	$0.536	$0.624	-$0.089
	Winter Off-Peak	$0.302	$0.410	-$0.107
	Winter Super Off-Peak	$0.248	$0.356	-$0.108
C-024	Summer On-Peak	$0.577	$0.754	-$0.177
	Summer Mid-Peak	$0.547	$0.564	-$0.017
	Summer Off-Peak	$0.288	$0.375	-$0.087
	Winter Mid-Peak	$0.546	$0.624	-$0.078
	Winter Off-Peak	$0.307	$0.410	-$0.103
	Winter Super Off-Peak	$0.264	$0.356	-$0.092
C-051	Summer On-Peak	N/A	N/A	N/A
	Summer Mid-Peak	N/A	N/A	N/A
	Summer Off-Peak	N/A	N/A	N/A
	Winter Mid-Peak	$0.544	$0.624	-$0.081
	Winter Off-Peak	$0.306	$0.410	-$0.104
	Winter Super Off-Peak	$0.254	$0.356	-$0.102

*Differences in the Pilot and Tariff rates may not be exact due to rounding.

Table 3.1c: Average Energy Prices for TOU-D-A

ID	Period	Avg. Pilot Price ($/kWh)	Tariff Rate ($/kWh)	Pilot – OAT* ($/kWh)
C-052	Summer On-Peak	N/A	N/A	N/A
	Summer Off-Peak	N/A	N/A	N/A
	Summer Super Off-Peak	N/A	N/A	N/A
	Winter On-Peak	$0.378	$0.539	-$0.161
	Winter Off-Peak	$0.254	$0.436	-$0.182
	Winter Super Off-Peak	$0.257	$0.200	$0.057

*Differences in the Pilot and Tariff rates may not be exact due to rounding.

Table 3.1d: Average Energy Prices for TOU-D-PRIME

ID	Period	Avg. Pilot Price ($/kWh)	Tariff Rate ($/kWh)	Pilot – OAT* ($/kWh)
C-055	Summer On-Peak	$0.543	$0.612	-$0.068
	Summer Mid-Peak	$0.513	$0.386	$0.126
	Summer Off-Peak	$0.261	$0.260	-$0.001
	Winter Mid-Peak	$0.440	$0.583	-$0.143
	Winter Off-Peak	$0.253	$0.240	$0.014
	Winter Super Off-Peak	$0.156	$0.240	-$0.084
C-056	Summer On-Peak	N/A	N/A	N/A
	Summer Mid-Peak	N/A	N/A	N/A
	Summer Off-Peak	N/A	N/A	N/A
	Winter Mid-Peak	$0.445	$0.583	-$0.138
	Winter Off-Peak	$0.259	$0.240	$0.020
	Winter Super Off-Peak	$0.164	$0.240	-$0.075

*Differences in the Pilot and Tariff rates may not be exact due to rounding.

Table 3.1e: Average Energy Prices for TOU-GS-2-D

ID	Period	Avg. Pilot Price ($/kWh)	Tariff Rate ($/kWh)	Pilot – OAT* ($/kWh)
B-004	Summer On-Peak	$0.512	$0.587	-$0.075
	Summer Mid-Peak	$0.487	$0.169	$0.317
	Summer Off-Peak	$0.267	$0.127	$0.141
	Winter Mid-Peak	$0.491	$0.230	$0.261
	Winter Off-Peak	$0.287	$0.139	$0.147
	Winter Super Off-Peak	$0.238	$0.097	$0.141

*Differences in the Pilot and Tariff rates may not be exact due to rounding.

Table 3.1f: Average Energy Prices for TOU-GS-3-D

ID	Period	Avg. Pilot Price ($/kWh)	Tariff Rate ($/kWh)	Pilot – OAT* ($/kWh)
B-005	Summer On-Peak	$0.684	$0.556	$0.128
	Summer Mid-Peak	$0.604	$0.158	$0.447
	Summer Off-Peak	$0.335	$0.122	$0.213
	Winter Mid-Peak	$0.482	$0.242	$0.240
	Winter Off-Peak	$0.283	$0.134	$0.149
	Winter Super Off-Peak	$0.239	$0.092	$0.147

*Differences in the Pilot and Tariff rates may not be exact due to rounding.

In Tables 3.1g and 3.1h, the OAT rate employs the legacy TOU period definitions. This creates an odd alignment of TOU prices and tender prices during the summer months. That is, the TOU on-peak period is noon to 6 p.m., but the highest hourly tender prices from the Pilot price tend to occur from 5 to 8 p.m. Therefore, we see the “inversions” in the tables, in which the summer on-peak average tender price is lower than the summer Mid-Peak average tender price.

Table 3.1g: Average Energy Prices for TOU-GS-2-R[31]

ID	Period	Avg. Pilot Price ($/kWh)	Tariff Rate ($/kWh)	Pilot – OAT* ($/kWh)
A-001	Summer On-Peak	$0.336	$0.583	-$0.247
	Summer Mid-Peak	$0.421	$0.308	$0.113
	Summer Off-Peak	$0.306	$0.165	$0.142
	Winter Mid-Peak	$0.345	$0.172	$0.173
	Winter Off-Peak	$0.295	$0.108	$0.187
A-002	Summer On-Peak	$0.385	$0.583	-$0.197
	Summer Mid-Peak	$0.442	$0.308	$0.134
	Summer Off-Peak	$0.320	$0.165	$0.155
	Winter Mid-Peak	$0.344	$0.172	$0.172
	Winter Off-Peak	$0.295	$0.108	$0.187
A-006	Summer On-Peak	$0.326	$0.583	-$0.256
	Summer Mid-Peak	$0.409	$0.308	$0.101
	Summer Off-Peak	$0.294	$0.165	$0.129
	Winter Mid-Peak	$0.329	$0.172	$0.157
	Winter Off-Peak	$0.283	$0.108	$0.175
A-007	Summer On-Peak	$0.285	$0.583	-$0.298
	Summer Mid-Peak	$0.390	$0.308	$0.082
	Summer Off-Peak	$0.286	$0.165	$0.121
	Winter Mid-Peak	$0.314	$0.172	$0.142
	Winter Off-Peak	$0.280	$0.108	$0.172
A-008	Summer On-Peak	$0.302	$0.583	-$0.280
	Summer Mid-Peak	$0.397	$0.308	$0.089
	Summer Off-Peak	$0.292	$0.165	$0.128
	Winter Mid-Peak	$0.317	$0.172	$0.146
	Winter Off-Peak	$0.282	$0.108	$0.174
A-009	Summer On-Peak	N/A	N/A	N/A
	Summer Mid-Peak	N/A	N/A	N/A
	Summer Off-Peak	N/A	N/A	N/A
	Winter Mid-Peak	$0.298	$0.172	$0.126
	Winter Off-Peak	$0.281	$0.108	$0.173

*Differences in the Pilot and Tariff rates may not be exact due to rounding.

[31] This rate has legacy TOU periods (e.g., noon to 6 p.m. summer peak).

Table 3.1h: Average Energy Prices for TOU-GS-3-R[32]

ID	Period	Avg. Pilot Price ($/kWh)	Tariff Rate ($/kWh)	Pilot – OAT* ($/kWh)
A-005	Summer On-Peak	$0.288	$0.525	-$0.237
	Summer Mid-Peak	$0.396	$0.276	$0.121
	Summer Off-Peak	$0.286	$0.154	$0.133
	Winter Mid-Peak	$0.320	$0.167	$0.153
	Winter Off-Peak	$0.282	$0.104	$0.178

*Differences in the Pilot and Tariff rates may not be exact due to rounding.

3.4 Usage on High-Price and Surrounding Days

From September 4 through 6, 2024, Pilot prices hit the highest levels of the summer of 2024. It may be instructive to examine customer usage profiles on those dates compared to surrounding dates. The price spikes appear to be caused by unusually high temperatures, making it difficult to find days that have similar temperatures but more moderate prices. Rather than selecting a specific date to serve as a comparison day, we show how hourly usage, prices, and temperatures vary from the week before the price spikes through the following week, excluding weekends and Labor Day.

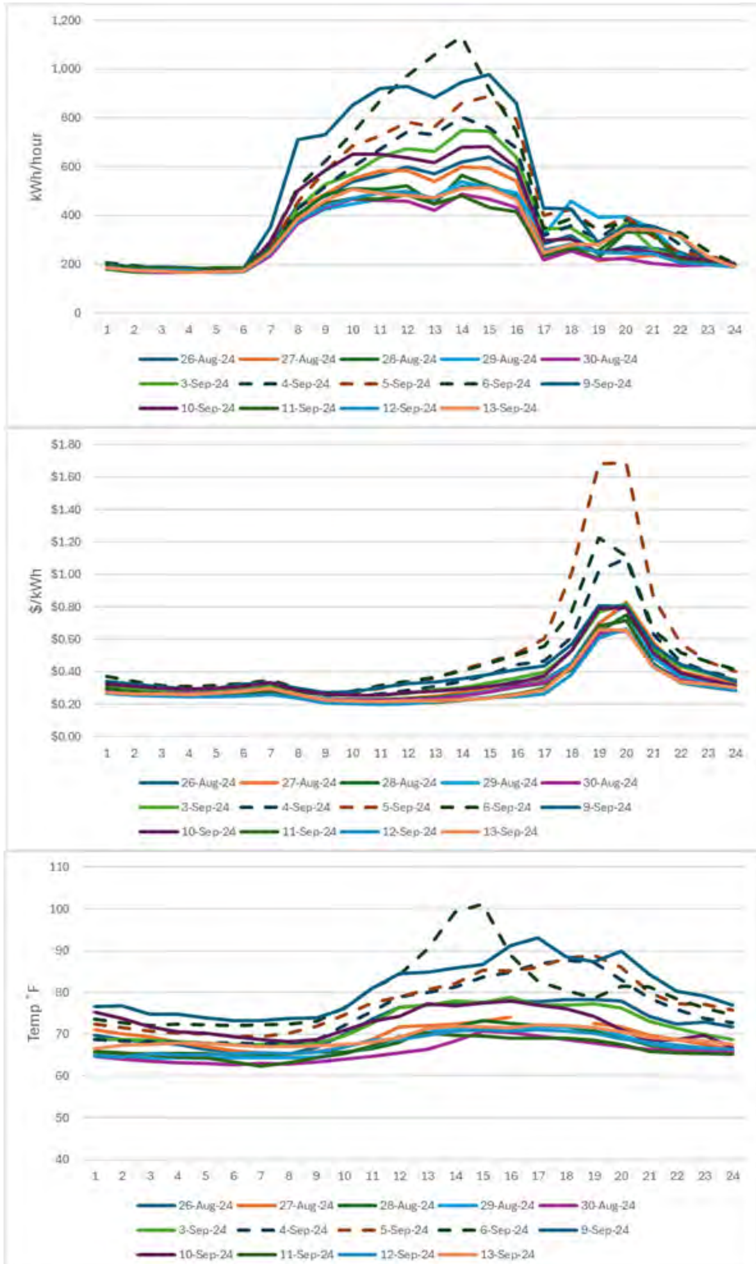
This should be viewed as a somewhat anecdotal exercise, focusing on days with the highest expected price response. Statistical analyses are more comprehensive (i.e., able to include all Pilot dates), but their complexity may render the results more difficult to understand/interpret than looking at metered usage data and Pilot prices.

We pooled ASP A's customers[redacted]) and all the residential customers served by ASP C into one figure each. The two customers served by ASP B are shown separately. Figures 3.7 through 3.10 have three panels each: the top panel shows hourly usage by date (totaled across customers where applicable), the middle panel shows average hourly prices by date, and the bottom panel shows average hourly temperatures by date. In each case, the dashed lines represent the three highest-price days (September 4-6, 2024). The highest prices on each of those days are in hour ending (HE) 19 and 20. Prices earlier in the day (especially before HE 14 or so) do not exhibit much variation across the days, especially relative to the variation in prices during peak hours.

Figure 3.7 shows the usage profiles for ASP A's custome[redacted]. Notice that their usage always drops off prior to the highest-price hours, regardless of the magnitude of the prices during HE 18-20. While there is significant variation in usage across days during the mid-day hours, it appears that this is due to differences in temperatures rather than a response to prices. For example, the usage differences in HE 11 are large relative to the price differences, though in line with the temperature differences across dates.

[32] This rate has legacy TOU periods (e.g., noon to 6 p.m. summer peak).

Figure 3.7: Daily Usage Profiles from Aug. 26-Sep. 9, All ASP A



Figures 3.8 and 3.9 show the usage profiles for ASP B's customers. There doesn't appear to be any evidence of pre-cooling during lower-price hours followed by lower usage during the high-price hours that follow. Figure 3.9 shows a consistent drop in usage during HE 19, but this occurs on all days (not just the ones with the highest prices) and we confirmed that it was also a feature of their load profile prior to joining the Pilot. Therefore, it appears that it is either a response to OAT prices or a natural feature of their demand for electricity.

Figure 3.8: Daily Usage Profiles from Aug. 26-Sep. 9, ASP B-004

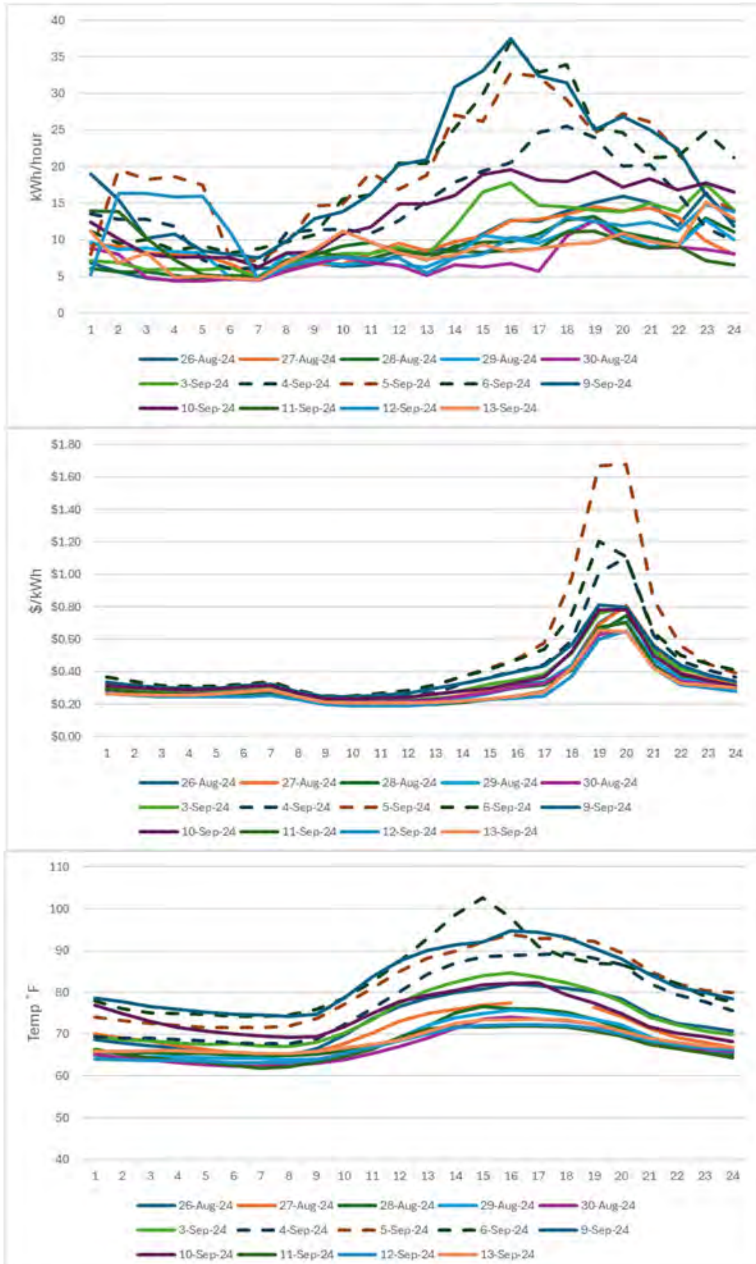
[redacted]

Figure 3.9: Daily Usage Profiles from Aug. 26-Sep. 9, ASP B-005

[redacted]

Figure 3.10 combines the loads for the residential customers served by ASP C. Residential loads can be somewhat unpredictable when the number of customers and/or days is low, so it is more difficult to discern a regular pattern for these loads versus the customers shown in Figures 3.7, 3.8, and 3.9. Nevertheless, it is difficult to infer price response from the loads shown in figures. For example, September 9 has somewhat high temperatures and loads but lower prices than September 4-6, but the load shape is not clearly different from those of the high-price days.

Figure 3.10: Daily Usage Profiles from Aug. 26-Sep. 9, All ASP C



Taken together, the figures above show little evidence that customers changed their usage in response to the highest prices during September 4-6, 2024. We do not have data indicating why this occurred, but possibilities include customers prioritizing comfort over savings, or the automated response optimizing to OAT rates rather than dynamic prices. For example, ASP A's customers are served on legacy TOU rates that provide an incentive to manage billed demand, and the peaks for these customers are likely to occur earlier than the hours with the highest Pilot prices.

3.5 Estimates of Changes in Peak Usage

The Decision approving the Pilot required SCE to "evaluate the efficacy of the pilot tariff in shifting loads enrolled in the program from peak to off-peak periods".[33] One measure of whether this occurred is to compare each customer's pre-Pilot usage to their in-Pilot usage, controlling for differences in weather conditions. Specifically, we estimated customer-specific statistical models of the following form:

$$PeakShare_t = a + b^{Pilot} \times Pilot_t + b^{CDD} \times CDD_t + b^{HDD} \times HDD_t + \sum(b^m \times month_t^m) + e_t$$

Table 3.2 explains the variables and terms in the model. The estimated coefficient of interest is b^{Pilot}, which reflects the change in the share of peak-period usage during the Pilot period, controlling for temperatures.

Table 3.2: Explanation of Terms in the Peak Share Statistical Models

Variable/Term	Description
$PeakShare_t$	The share of total usage that occurred during peak hours in month *t*
a and the various *b*s	Estimated parameters
$Pilot_t$	Indicator variable for month *t* being in the Pilot period
CDD_t	Daily average cooling degree days (base 60 degrees) during month *t*
HDD_t	Daily average heating degree days (base 60 degrees) during month *t*
$month^m_t$	Indicator variable that observation at time *t* is in month *m*
e_t	Error term

Peak hours are defined in two ways, with separate models estimated for each definition: 4 to 9 p.m. (HE 17 to 21) and 5 to 8 p.m. (HE 18 to 20). This corresponds to the alternate on-peak definitions employed in SCE's TOU rates and provides a robustness check of the hours during which customers are more likely to respond. That is, even customers on a TOU rate with a 4 to 9 p.m. peak period may observe that dynamic tender prices tend to be highest from 5 to 8 p.m. and thus concentrate load reductions on those hours.

Note that the peak usage share can lose meaning in the presence of negative usage (or near-zero total usage) for NEM customers. To ensure that we examine only days with valid peak usage shares, we remove any days with negative total peak, off-peak, or daily usage. In addition, we removed weekends for the non-residential customers, as we wanted to focus the analysis on the days with the most activity (particularly for ASP A's customers). Appendix A.1 presents a different version of the analysis, in which we use

[33] Phase 2 Decision, p. 99. Note that this excerpt concludes with the text "… and should be compared to non-participant loads." We did not compare participant and non-participant loads due to small sample sizes. For example, it would be difficult to make a meaningful comparison of peak usage shares of Pilot participants and non-participants when the number of participants is very low. Instead, we focus on pre-Pilot versus Pilot peak usage shares for participating customers, as described in this section.

the total peak-period usage as the dependent variable. This allows us to retain the observations with negative usage. A potential disadvantage of this alternate model is that the estimates may be more likely to reflect exogenous changes in a customer's overall usage level rather than a price-induced substitution from high- to low-price hours.

Table 3.3 shows the estimated peak share coefficients for every customer and for the two peak-period definitions examined. The p-value corresponding to the estimate is in parentheses. An asterisk indicates a p-value less than 0.05. Highlighting is used to designate customers on track to receive a Pilot credit.

Table 3.3: Estimates of Changes in Ratio of Peak-Period Usage

			Pilot Coefficient Estimate	
			Peak = HE 17-21	Peak = HE 18-20
A-001	8/23 to 9/24	1.0	0.001 (0.760)	0.001 (0.565)
A-002	8/23 to 4/24	1.0	-0.018* (0.000)	-0.009* (0.008)
A-005	10/23 to 9/24	1.0	-0.007* (0.001)	-0.006* (0.000)
A-006	12/23 to 9/24	1.0	0.005 (0.267)	0.000 (0.938)
A-007	10/23 to 9/24	1.0	-0.011* (0.015)	-0.011* (0.002)
A-008	10/23 to 9/24	1.0	-0.008* (0.030)	-0.009* (0.000)
A-009	10/23 to 5/24	1.0	-0.016 (0.370)	-0.004 (0.709)
B-004	8/23 to 9/24	2.0	0.005* (0.023)	0.000 (0.741)
B-005	7/23 to 9/24		-0.011* (0.000)	-0.009* (0.000)
C-002	10/23 to 9/24		0.003 (0.521)	0.003 (0.330)
C-004	8/23 to 9/24		0.009 (0.085)	0.012* (0.002)
C-024	10/23 to 9/24		0.002 (0.625)	0.003 (0.317)
C-030	10/23 to 9/24		-0.007* (0.043)	-0.005* (0.036)
C-043	10/23 to 9/24		-0.004 (0.471)	-0.002 (0.611)
C-044	3/24 to 9/24		0.022* (0.003)	0.021* (0.001)
C-045	10/23 to 9/24	1.0	-0.044 (0.107)	-0.073* (0.001)
C-051	12/23 to 4/24		0.005 (0.560)	0.004 (0.559)
C-052	12/23 to 4/24	2.0	0.017 (0.660)	0.079* (0.040)
C-053	12/23 to 9/24		0.001 (0.905)	0.002 (0.700)
C-054	12/23 to 9/24		-0.010* (0.033)	-0.007 (0.096)
C-055	1/24 to 9/24		-0.009* (0.035)	-0.006* (0.040)
C-056	1/24 to 4/24		0.003 (0.816)	0.000 (0.985)

The estimates show mixed evidence of consistent reductions in peak usage shares during the Pilot period.

- Using either peak-period definition, 8 of the 22 customers had a statistically significant reduction in the peak usage share during the Pilot [redacted].
- In contrast, three customers (two when defining peak as HE 17 to 21 and three using the HE 18 to 20 definition) reflect statistically significant *increases* in the peak usage share during the Pilot.

The analysis provides evidence that some enrolled customers changed their load profile during the Pilot, reducing the share of peak-period usage. However, the majority of the customers (14 out of 22) did not show evidence of a lower peak usage share, and the evidence provided in the next sub-section (which looks at the relationship between in-Pilot price and usage changes) casts doubt on whether the peak-share reductions estimated in this sub-section are due to Pilot participation. It is possible that the estimates reflect exogenous (non-temperature) effects on customer usage profiles.

This section focused on a before vs. during Pilot comparison of customer usage. In the following section, we will examine whether customer response to prices differed with Pilot tender price levels.

3.6 Statistical Estimates of Load Impacts

3.6.1 ASP A Estimates using Randomized Treatment Days

ASP A has been collaborating with University of California Berkeley Center for the Built Environment (CBE) to apply a testing protocol by which they can estimate the response to the Pilot pricing and enabling technology relative to the actions customers would have taken in the absence of the Pilot. This entailed randomly selecting days on which customer facilities were controlled by ASP A's algorithms versus the customer's typical decision-making processes. With a large enough sample of dates and sites, the randomization allows for a simple comparison of hourly loads on treated vs. untreated dates to estimate Pilot load response.

The randomization was applied to three ASP A sites, summarized in Table 3.4. Two of them were active in the Pilot at the time, while a third was served on TOU rates during the experimental period. The TOU customer (A-006) subsequently enrolled in the Pilot. Only one of the sites (A-001) is expected to have significant load response capabilities during the heating season, which is why that is the only customer with the later (winter) experimental period.[34]

[34] While A-001 is the only customer with a "core" winter experimental period, all three customers have experimental data during October, which is a winter pricing month.

Table 3.4: ASP A Customers with Randomized Treatment Days

ID	Experimental Period(s)	Description
A-001	8/16/2023 to 10/30/2023; 12/11/2023 to 3/8/2024	Enrolled in the Pilot during experimental period; has space heat.
A-002	8/16/2023 to 10/30/2023	Enrolled in the Pilot during experimental period; no space heat.
A-006	8/14/2023 to 10/24/2023	On TOU during controlled period; no space heat.

Figure 3.11 contains four panels, each of which shows the average hourly usage on treated days (i.e., when algorithms are applied to respond to Pilot or TOU prices) versus untreated days (i.e., when the customer does what it would do in the absence of ASP A's algorithms). For purposes of the figure, October is pooled with the summer months so that we have one panel for each experimental period listed in Table 3.4. The load profiles show the following:

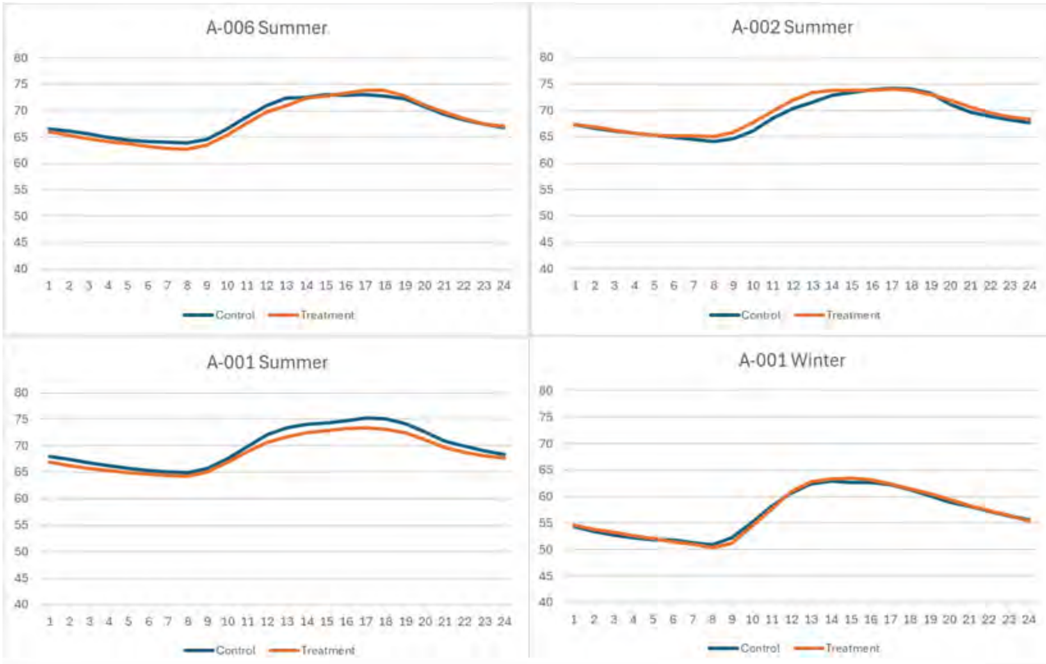
- A-006 (the TOU customer) uses less during midday hours of summer treatment days.
- A-001 and A-002 usage profiles are similar on treatment and control days.

Figure 3.11: Average Hourly Load Profiles for ASP A Customers on Treated vs. Control Dates

[redacted]

Figure 3.12 shows the average temperatures associated with the load profiles shown in Figure 3.11. For customer A-006, the usage difference is directionally consistent with the temperature difference across the day types, though the usage difference may be larger than the temperature difference can explain.

Figure 3.12: Average Hourly Temperatures for ASP A Customers on Treated vs. Control Dates



We estimated statistical models to determine whether the usage differences shown in Figure 3.11 are statistically significant. The model specification is shown below, with the terms described in Table 3.5. For customers A-001 and A-002, we also included the Pilot price and the price interacted with the treatment variable, which provides an estimate of the extent to which usage is related to price on treatment days.

$$kWh_t = a + b^{Treat} \times Treatment_t + b^{Temp} \times Temperature_t + b^{Mon} \times Monday_t + b^{Fri} \times Friday_t + e_t$$

Table 3.5: Explanation of Terms in the ASP A Hourly Models

Variable/Term	Description
kWh_t	The customer's usage in hour *t*
a and the various *b*s	Estimated parameters
$Treatment_t$	Indicator variable for hour *t* being a treated hour
$Temperature_t$	Temperature in hour *t* in degrees Fahrenheit
$Monday_t$	Indicator variable for hour *t* being on a Monday
$Friday_t$	Indicator variable for hour *t* being on a Friday
e_t	Error term

Separate models are estimated for each customer, season (where applicable), and hour of day, resulting in 96 estimated treatment effects (24 per day for four different customer/season combinations).[35] Of these estimates, only 5 of the 96 are statistically significantly different from zero. Our conclusion from this is that while some of the treatment vs. control hourly usage differences appear to be notable in the figures, the differences are not large enough to be statistically significant once one accounts for the low number of treated days, the day-to-day variability of usage, and the temperature differences across the day types (which is controlled for in the regressions but not in the usage figures). That is, we do not find evidence that customer usage behavior differed on treatment and control days. Over time, additional data from cooling seasons will provide a better opportunity to demonstrate the load response capabilities of ASP A's algorithms and technologies.

3.6.2 Estimates of Price Response using a Non-Experimental Design

Unlike the customers described above, most Pilot customers (i.e., all ASP B and ASP C customers as well as the ASP A customers not on the testing protocol) did not have an experimental testing design in place for use in estimating Pilot load response. For these customers, we analyzed whether the daily share of usage in peak hours is related to the daily peak to off-peak price ratio, controlling for temperatures and day type. Specifically, the estimated model is:

$$Peak\_Share_t = a + b^P \times Price\_Ratio_t + b^{CDD} \times CDD_t + b^{HDD} \times HDD_t + \Sigma_d(b^d \times DOW^d{}_t) + \Sigma(b^m \times month^m{}_t) + e_t$$

Table 3.6: Explanation of Terms in the Price Ratio Models

Variable/Term	Description
$Peak\_Share_t$	The share of the customer's usage on day *t* that occurs in peak hours
a and the various *b*s	Estimated parameters
$Price\_Ratio_t$	The peak price divided by the off-peak price on day *t*
CDD_t	Cooling degree days (60-degree threshold) on day *t*
HDD_t	Heating degree days (60-degree threshold) on day *t*
$DOW^d{}_t$	Day-of-week indicator variables for day *t* being day of week *d*
$month^m{}_t$	Month indicator variables for day *t* being in month *m*
e_t	Error term

The estimate of interest is b^P, which reflects the estimated change in the share of peak usage as the price ratio changes. We would expect the estimate to be negative and statistically significant, indicating that a higher peak price relative to the off-peak price would be associated with a lower share of usage in the peak hours. As in the pre-Pilot vs. in-Pilot peak share models, we remove any days with negative total peak, off-peak, or daily usage, as well as weekends for the non-residential customers. We also continued to define "on-peak" in two ways: hours-ending 17 to 21 and hours-ending 18 to 20. Table 3.7 shows the estimates of b^P, with an asterisk indicating a p-value below 0.05.

35 [redacted]

Table 3.7: Estimates of Changes in the Peak Usage Share in Response to the Price Ratio

ID	Dates	NEM?	Peak = HE 17-21	Peak = HE 18-20
A-005	11/23 to 9/24	1.0	0.030* (0.000)	0.018* (0.000)
A-007	11/23 to 9/24	1.0	0.009 (0.456)	0.006 (0.410)
A-008	11/23 to 9/24	1.0	0.027* (0.019)	0.019* (0.003)
A-009	10/23 to 5/24	1.0	0.001 (0.930)	0.005 (0.470)
B-004	9/23 to 9/24	2.0	0.010 (0.091)	-0.001 (0.816)
B-005	7/23 to 9/24		-0.001 (0.820)	0.000 (0.957)
C-002	10/23 to 9/24		0.005 (0.774)	-0.010 (0.357)
C-004	8/23 to 9/24		0.030* (0.019)	0.025* (0.004)
C-024	10/23 to 9/24		-0.012 (0.316)	-0.012 (0.136)
C-030	10/23 to 9/24		-0.012 (0.260)	-0.013* (0.049)
C-043	10/23 to 9/24		0.008 (0.649)	0.002 (0.833)
C-044	3/24 to 9/24		-0.015 (0.373)	-0.006 (0.606)
C-045	11/23 to 9/24	1.0	0.008 (0.929)	0.030 (0.645)
C-051	12/23 to 4/24		-0.023 (0.351)	-0.007 (0.661)
C-052	12/23 to 4/24	2.0	0.704* (0.000)	0.778* (0.000)
C-053	12/23 to 9/24		0.007 (0.691)	0.001 (0.909)
C-054	12/23 to 9/24		0.011 (0.452)	0.009 (0.409)
C-055	1/24 to 9/24		-0.007 (0.367)	-0.005 (0.372)
C-056	1/24 to 4/24		-0.010 (0.608)	-0.027 (0.060)

To interpret the coefficients, consider the -0.013 estimate for C-030 using the HE 18 to 20 peak definition. This estimate means that as the peak to off-peak price ratio increases by 1 (e.g., the peak price went from $0.50 per kWh to $0.75 per kWh as the off-peak price remained unchanged at $0.25 per kWh), the share of peak usage declines by 1.3 percentage points.

Only one of the estimates (C-030 using the HE 18-20 peak-period definition) showed the expected price response effect, which is a negative and statistically significant coefficient (which indicates that the share of peak-period usage goes down as the peak price increases relative to the off-peak price).

The sole responder, C-030, also had negative and significant estimates in the before vs. during Pilot estimates presented in Section 3.5. That is, that customer displayed both an overall reduction in the peak share of usage during the Pilot period and greater relative reductions in peak usage when intra-day price differentials were higher. However, we did not find evidence of peak-shifting behavior for the majority of the customers included in this study.

4. BILL IMPACTS

As described in the Introduction, Pilot participants will continue to be on their OAT during the Pilot and be billed under that SCE rate. Each calendar month, a shadow bill is calculated representing what they "*would have"* paid under the subscription + dynamic pricing model. At the end of the relevant 12-month period, the customer is credited for savings they would have realized under dynamic pricing rate, but they will not be billed for more if the OAT bills are lower than the Pilot bills. The equation below shows the calculation of the dynamic bill credit for customer *c* during months *m*.

$$\text{Dynamic Pilot Credit}_c = \text{MAX}\{\Sigma_m(\text{OAT Bill}_{c,m} - \text{Shadow Bill}_{c,m}), 0\}$$

In the equation, MAX is the maximum function, Σ_m is the summation function, "OAT $\text{Bill}_{c,m}$" is customer *c*'s bill on their OAT using metered usage during month *m*, and "Shadow $\text{Bill}_{c,m}$" is customer *c*'s shadow bill during month *m*. The shadow bill incorporates a subscription component and a settlement component, as described in Section 2.1.

Table 4.1 summarizes the OAT and shadow bills available at the time of this report.[36] Shading is used to indicate customers on track to receive a credit (i.e., the cumulative shadow bill is less than the cumulative OAT bill). As the table shows, 9 of the 22 customers were on track to receive a bill credit given the Pilot experience available for us to examine. The largest credit [redacted]) is attributable to customer B-005. The only higher percentage credit is associated with customer C-056, though their credit is small in absolute terms [redacted]).

[36] Note that the Pilot credit summaries presented here in the evaluation are based on all available months for each customer. For the actual shadow billing, the shadow bill credit calculation for customers was conducted at the end of their relevant period for NEM customers and at the end of the 12 months of participation for non-NEM customers, with the months in the following period being included in a subsequent shadow bill credit calculation. This change in the timing of the calculation may affect whether a customer received a credit, as the calculation is cumulative over the shadow bill period. For example, customer C-045 was due a credit at the end of their relevant period, while the table reflects the fact that their total shadow bill was higher than their total OAT bill across all 12 Pilot months.

Table 4.1: Overall Bill Impacts

(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
ID	Dates	Total kWh	OAT Bill	Shadow Bill	OAT $/kWh (D/C)	Shadow $/kWh (E/C)	% Bill Diff (E/D)-1
A-001	8/23 to 9/24	[redacted]					
A-002	8/23 to 4/24	[redacted]					
A-005	10/23 to 9/24	[redacted]					
A-006	12/23 to 9/24	[redacted]					
A-007	10/23 to 9/24	[redacted]					
A-008	10/23 to 9/24	[redacted]					
A-009	10/23 to 5/24	[redacted]					
B-004	8/23 to 9/24	[redacted]					
B-005	7/23 to 9/24	[redacted]					
C-002	10/23 to 9/24	6,111	$2,068	$2,093	$0.338	$0.343	1.2%
C-004	8/23 to 9/24	2,799	$797	$780	$0.285	$0.279	-2.2%
C-024	10/23 to 9/24	2,478	$664	$655	$0.268	$0.264	-1.4%
C-030	10/23 to 9/24	9,436	$3,473	$3,565	$0.368	$0.378	2.7%
C-043	10/23 to 9/24	10,212	$3,743	$3,875	$0.366	$0.379	3.5%
C-044	3/24 to 9/24	7,960	$2,700	$3,019	$0.339	$0.379	11.8%
C-045	10/23 to 9/24	4,429	$1,201	$1,307	$0.271	$0.295	8.9%
C-051	12/23 to 4/24	4,306	$1,568	$1,542	$0.364	$0.358	-1.7%
C-052	12/23 to 4/24	-885	-$691	-$422	$0.782	$0.478	N/A
C-053	12/23 to 9/24	11,521	$4,450	$4,623	$0.386	$0.401	3.9%
C-054	12/23 to 9/24	6,621	$2,119	$2,187	$0.320	$0.330	3.2%
C-055	1/24 to 9/24	11,380	$3,347	$3,527	$0.294	$0.310	5.4%
C-056	1/24 to 4/24	987	$297	$277	$0.300	$0.281	-6.6%
Total Res.	8/23 to 9/24	77,356	$25,736	$27,027	$0.333	$0.349	5.0%
Total Non-Res.	7/23 to 9/24	5,303,588	$1,388,061	$1,412,089	$0.262	$0.266	1.7%

Table 4.2 shows how the total usage was divided between subscription purchases and the net ex-post kWh for the month.[37] It also adds the subscription average price paid to the

[37] The net ex-post quantity for a month is the total kWh purchased above the subscription quantities minus the total kWh sold below the subscription quantities (i.e., the "unused" subscription quantity).

table, thereby allowing comparisons to the average prices under OAT and shadow bill. This information provides additional context for the credits (or lack thereof) shown in Table 4.1.

For example, A-006 and A-008 are both on track to receive credits of [redacted]. In each case, the Table 4.2 shows the customer saved on its subscription relative to the OAT [redacted]). The customer with the largest credit, B-005, sav[redacted] on its subscription relative to the OAT average price. The next table will help explain the rest of their credit.

Figure 4.1 shows the extent to which the shadow bill credit calculation is affected by the relationship between the customer's average OAT price and their subscription price.[38] The correlation between the two data series is 0.936, indicating a very strong relationship between the shadow bill credit and the relationship between the OAT and subscription prices. The figure shows that shadow bill outcomes are largely due to how the subscription is priced relative to the customer's average OAT price. Because the subscription is priced at current OAT rates, differences in the two values are likely to be attributable to changes in their load profile from the pre-Pilot to in-Pilot periods. For example, a customer who reduced their share of peak-period usage during the Pilot would experience an average OAT price that is less than their subscription price (which is priced using the load profile with the higher share of peak-period usage).[39]

There are a few potential reasons for the differences between OAT and subscription prices, including:

- If automation was not present in the pre-Pilot period, the load changes could represent the customer's enhanced ability to respond to OAT prices, or perhaps a response to typical dynamic price patterns.
- Exogenous (i.e., unrelated to Pilot pricing or automation technology) changes in the Pilot period relative to the pre-Pilot period. Weather and structural changes to buildings are two potential sources of exogenous effects on a customer's load profile.

The statistical analyses of dynamic price response do not find strong evidence of customer response to day-to-day and hour-to-hour dynamic price variation, which is another potential source of the difference between OAT and subscription average prices.

[38] Customer C-052 is omitted from the figure because their negative subscription price produces an outlier in the "OAT – Subscription in $/kWh" that obscures the variation across other customers.

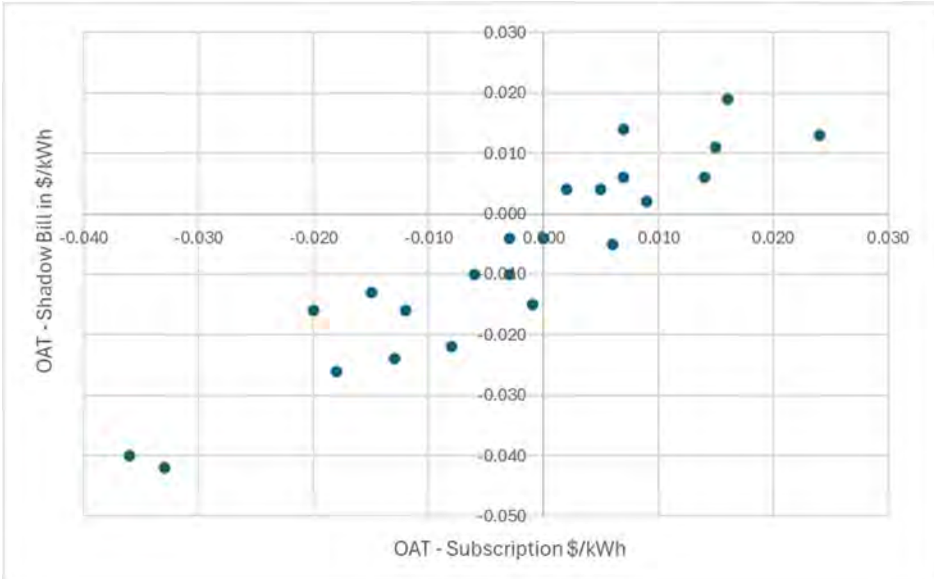
[39] The reduction in the OAT bill may affect the customer's ability to earn a Pilot credit (which requires that the cumulative Pilot bill is lower than the OAT bill), but that doesn't imply that the customer was worse off for having had the change in its usage profile. The absence of a credit just indicates that the OAT provided a larger benefit for the usage change than the Pilot did.

Table 4.2: Comparison of OAT and Subscription Average Price Paid[40]

ID	Dates	Total kWh	Total Subscription kWh	Total Ex-Post kWh	OAT $/kWh	Subscription $/kWh	Shadow $/kWh
A-001	8/23-9/24	[redacted]					
A-002	8/23-4/24						
A-005	10/23-9/24						
A-006	12/23-9/24						
A-007	10/23-9/24						
A-008	10/23-9/24						
A-009	10/23-5/24						
B-004	8/23-9/24						
B-005	7/23-9/24						
C-002	10/23-9/24	6,111	5,929	182	$0.338	$0.332	$0.343
C-004	8/23-9/24	2,799	2,905	-106	$0.285	$0.271	$0.279
C-024	10/23-9/24	2,478	2,537	-59	$0.268	$0.263	$0.264
C-030	10/23-9/24	9,436	9,382	55	$0.368	$0.371	$0.378
C-043	10/23-9/24	10,212	11,964	-1,752	$0.366	$0.381	$0.379
C-044	3/24-9/24	7,960	7,564	396	$0.339	$0.375	$0.379
C-045	10/23-9/24	4,429	2,624	1,323	$0.271	$0.284	$0.295
C-051	12/23-4/24	4,306	4,428	-122	$0.364	$0.357	$0.358
C-052	12/23-4/24	-885	349	-1,234	$0.782	-$0.324	$0.478
C-053	12/23-9/24	11,521	11,807	-286	$0.386	$0.387	$0.401
C-054	12/23-9/24	6,621	6,869	-248	$0.320	$0.326	$0.330
C-055	1/24-9/24	11,380	11,607	-227	$0.294	$0.314	$0.310
C-056	1/24-4/24	987	1,038	-51	$0.300	$0.284	$0.281
Total Res.	8/23-9/24	77,356	79,003	-2,128	$0.333	$0.345	$0.349
Total Non-Res.	7/23-9/24	5,303,588	5,074,333	225,972	$0.262	$0.265	$0.266

[40] The average prices show in the total row represent the load-weighted average of the customer-specific prices, where the load weight is "Total kWh" for the "OAT $/kWh" and "Shadow $/kWh" values, while the load weight is "Subscription kWh" for the "Subscription $/kWh" value.

Figure 4.1: OAT – Shadow Bill vs. OAT – Subscription Price ($/kWh)



While the previous table showed the total ex-post kWh, Tables 4.3a (for non-residential customers) and 4.3b (for residential customers) separately show the ex-post purchases above the subscription quantity and the ex-post sales of excess subscription load. Returning to customer B-005, the table shows that the customer was a net seller of subscription load and that those sales tended to be profitable, with an average selling price of [redacted] per kWh after having purchased the usage at a subscription price of [redacted] per kWh.

Table 4.3a: Transaction Summaries by Customer, ASPs A and B

ID	Buy or Sell	% Sell Hours (kWh<Sub)	Total Subscription kWh	Total Ex-Post kWh	Subscription Price	Ex-Post Price
A-001	Sell	[redacted]				
	Buy					
A-002	Sell					
	Buy					
A-005	Sell					
	Buy					
A-006	Sell					
	Buy					
A-007	Sell					
	Buy					
A-008	Sell					
	Buy					
A-009	Sell					
	Buy					
B-004	Sell					
	Buy					
B-005	Sell					
	Buy					

Table 4.3b: Transaction Summaries by Customer, ASP C

ID	Buy or Sell	% Sell Hours (kWh<Sub)	Total Subscription kWh	Total Ex-Post kWh	Subscription Price	Ex-Post Price
C-002	Sell	57%	3,575	-901	$0.359	$0.368
	Buy		2,354	1,083		$0.421
C-004	Sell	60%	1,849	-707	$0.325	$0.311
	Buy		1,056	601		$0.353
C-024	Sell	61%	1,695	-512	$0.325	$0.317
	Buy		843	453		$0.332
C-030	Sell	60%	5,546	-1,541	$0.388	$0.310
	Buy		3,836	1,596		$0.352
C-043	Sell	53%	7,554	-3,807	$0.394	$0.368
	Buy		4,410	2,055		$0.350
C-044	Sell	50%	4,133	-733	$0.387	$0.346
	Buy		3,431	1,129		$0.385
C-045	Sell	53%	1,883	-2,725	$0.344	$0.312
	Buy		742	4,047		$0.349
C-051	Sell	53%	2,622	-726	$0.377	$0.339
	Buy		1,806	605		$0.341
C-052	Sell	67%	204	-1,995	-$0.076	$0.248
	Buy		146	761		$0.243
C-053	Sell	65%	7,738	-3,315	$0.394	$0.271
	Buy		4,072	3,032		$0.316
C-054	Sell	68%	4,740	-1,079	$0.339	$0.317
	Buy		2,130	830		$0.348
C-055	Sell	58%	7,187	-1,910	$0.321	$0.332
	Buy		4,421	1,683		$0.310
C-056	Sell	70%	759	-317	$0.367	$0.302
	Buy		279	266		$0.292

Table 4.4 provides a summary of Pilot credits with the customers organized by their OAT rate, using gray shading to separate rates. Small samples on each rate prevent us from making general conclusions within and across OAT rates. For example, none of the TOU-D 4-9 PM customers earned a credit, while all TOU-D 5-8 PM customers did. Note that only eight customers are on one of those rates, so it would be unwise to make a general conclusion about what would happen to other customers on those rates if they were to face Pilot pricing.

Table 4.4: Credits by Customer, Organized by OAT Rate

ID	Dates	Total kWh	Pilot Bill	OAT Bill	Credit	OAT Rate
A-001	8/23 to 9/24	[redacted]	[redacted]	[redacted]	[redacted]	TOU-GS-2-R
A-002	8/23 to 4/24	[redacted]	[redacted]	[redacted]	[redacted]	TOU-GS-2-R
A-006	12/23 to 9/24	[redacted]	[redacted]	[redacted]	[redacted]	TOU-GS-2-R
A-007	10/23 to 9/24	[redacted]	[redacted]	[redacted]	[redacted]	TOU-GS-2-R
A-008	10/23 to 9/24	[redacted]	[redacted]	[redacted]	[redacted]	TOU-GS-2-R
A-009	10/23 to 5/24	[redacted]	[redacted]	[redacted]	[redacted]	TOU-GS-2-R
A-005	10/23 to 9/24	[redacted]	[redacted]	[redacted]	[redacted]	TOU-GS-3-R
B-004	8/23 to 9/24	[redacted]	[redacted]	[redacted]	[redacted]	TOU-GS-2-D
B-005	7/23 to 9/24	[redacted]	[redacted]	[redacted]	[redacted]	TOU-GS-3-D
C-045	10/23 to 9/24	4,429	$1,307	$1,201	$0	DOMESTIC
C-054	12/23 to 9/24	6,621	$2,187	$2,119	$0	DOMESTIC
C-052	12/23 to 4/24	-885	-$422	-$691	$0	TOU-D-A
C-002	10/23 to 9/24	6,111	$2,093	$2,068	$0	TOUD-4-9PM
C-030	10/23 to 9/24	9,436	$3,565	$3,473	$0	TOUD-4-9PM
C-043	10/23 to 9/24	10,212	$3,875	$3,743	$0	TOUD-4-9PM
C-044	3/24 to 9/24	7,960	$3,019	$2,700	$0	TOUD-4-9PM
C-053	12/23 to 9/24	11,521	$4,623	$4,450	$0	TOUD-4-9PM
C-004	8/23 to 9/24	2,799	$780	$797	$17	TOUD-5-8PM
C-024	10/23 to 9/24	2,478	$655	$664	$9	TOUD-5-8PM
C-051	12/23 to 4/24	4,306	$1,542	$1,568	$26	TOUD-5-8PM
C-055	1/24 to 9/24	11,380	$3,527	$3,347	$0	TOU-D-PRIME
C-056	1/24 to 4/24	987	$277	$297	$19	TOU-D-PRIME
Total Res.	8/23 to 9/24	77,356	$27,027	$25,736	$71	N/A
Total Non-Res.	7/23 to 9/24	5,303,588	$1,412,089	$1,388,061	$33,155	N/A

Table 4.5 shows (in the rightmost column) customer bills if all customer usage was billed at day-ahead hourly tender prices (i.e., there was no subscription). The table includes shadow and OAT bills for comparison.

Fourteen of the 22 customers would have had a lower Pilot bill had they been priced solely at the hourly tender prices, while 13 of the 22 customers would have paid less than the OAT bill if priced at hourly tender prices. However, some of the differences are large. For example, customer B-005 would have paid [redacted] more on its shadow bill if they had been priced entirely at settlement prices. This is another illustration of the benefit that customer received from its subscription pricing. In addition, note that removing the subscription would expose the customers to more price risk. That is, with subscriptions, a sustained period of high prices can provide an opportunity to benefit by selling subscription load at high prices and limit the need to purchase expensive energy to the quantity above the subscription quantity.

Table 4.5: Bills When Priced Entirely at Day-Ahead Tenders

ID	Dates	NEM?	Total kWh	Shadow Bill	OAT Bill	Bill @ Hourly Tenders
A-001	8/23 to 9/24	[redacted]				
A-002	8/23 to 4/24	[redacted]				
A-005	10/23 to 9/24	[redacted]				
A-006	12/23 to 9/24	[redacted]				
A-007	10/23 to 9/24	[redacted]				
A-008	10/23 to 9/24	[redacted]				
A-009	10/23 to 5/24	[redacted]				
B-004	8/23 to 9/24	[redacted]				
B-005	7/23 to 9/24	[redacted]				
C-002	10/23 to 9/24		6,111	$2,093	$2,068	$2,161
C-004	8/23 to 9/24		2,799	$780	$797	$944
C-024	10/23 to 9/24		2,478	$655	$664	$819
C-030	10/23 to 9/24		9,436	$3,565	$3,473	$3,057
C-043	10/23 to 9/24		10,212	$3,875	$3,743	$3,413
C-044	3/24 to 9/24		7,960	$3,019	$2,700	$2,626
C-045	10/23 to 9/24	1.0	4,429	$1,307	$1,201	$1,763
C-051	12/23 to 4/24		4,306	$1,542	$1,568	$1,372
C-052	12/23 to 4/24	2.0	-885	-$422	-$691	$220
C-053	12/23 to 9/24		11,521	$4,623	$4,450	$3,372
C-054	12/23 to 9/24		6,621	$2,187	$2,119	$1,946
C-055	1/24 to 9/24		11,380	$3,527	$3,347	$3,320
C-056	1/24 to 4/24		987	$277	$297	$261
Total Res.	8/23 to 9/24		77,356	$27,027	$25,736	$25,276
Total Non-Res.	7/23 to 9/24		5,303,588	$1,412,089	$1,388,061	$1,727,985

5. COST RECOVERY

As noted in the introduction, the Decision calls for "[a]n evaluation of the cost recovery which assess[es] the impact of any under-collection of revenues associated with the Pilot similar to the evaluation required of the VCE dynamic rate pilot."[41]

In consultation with the ED, the interpretation of this text is that there is no under-collection to examine if the customer pays the amount of their OAT bill (i.e., they do not receive a Pilot credit). Therefore, the cost recovery analysis focuses on customers who are on track to receive a credit on the Pilot.

The design of the Pilot "two-part" rate design suggests that the Pilot may adequately recover the costs to serve the participants, thus limiting the potential of cost shifts to

41 Decision 21-12-015, p. 99.

non-participating customers.[42] That is, the subscription pricing method ensures that OAT-level revenues are recovered for the customer's historical load profile. The dynamic pricing method has CAISO energy prices as its basis, adding components that allocate fixed capacity-related costs to hours in proportion to their system net loads. Any assessment that determines that this method does not produce prices that recover avoided costs is likely driven by different assumptions about how to allocate fixed costs across hours, as these costs are not directly observable in a market in the same manner as LMPs.

In general, there two primary potential sources of Pilot credits:

1. *The difference between their average price per kWh on the OAT rate and on the subscription.* A customer that changes its usage level and shape relative to the pre-Pilot period may experience a change in its OAT average price paid. For example, if they increase their share of usage during on-peak hours, or reduce their load factor during the Pilot, one expects their current OAT average price to be higher than their subscription average price (which reflects their historical usage priced at OAT rates).

2. *Whether the customer benefited from ex-post transactions.* For example, one customer increased usage relative to pre-Pilot levels and the ex-post average price was significantly lower than the OAT and subscription average price, thus allowing them to expand usage at a lower average price per kWh. Another way for the customer to save via ex-post transactions is if they tend to sell subscription usage when the settlement price is high and purchase kWh above the subscription amount when the settlement price is low.

Table 5.1 summarizes these factors for the customers currently on track to receive a Pilot credit. The two rightmost columns calculate the components of the shadow bill credit, including:

- The credit due to OAT vs. Pilot pricing of the subscription quantities. This is calculated as the subscription quantity multiplied by the difference between the OAT and subscription average prices per kWh. A positive value indicates that the customer paid more on the OAT rate, thus contributing to a shadow bill credit for the customer.[43]

- The credit associated with settlements around the subscription quantities. This amount has two components: the average OAT price multiplied by the difference between actual and subscription usage; and the net ex-post settlement transaction dollars (i.e., the net amount of the shadow bill represented by settlements around the subscription quantities). The difference between the

[42] This is only considering revenue and cost changes at the margin due to load response. Cost shifting could still occur if the benefits of the program are outweighed by the costs to launch and implement the Pilot.

[43] The values required for this calculation can be found in Table 4.2.

components represents how much more (or less) the customer paid for its settlement quantities on the OAT rate versus the Pilot rates.[44]

An example may assist readers in interpreting the table. Customer B-005 was on track to receive a [redacted] credit. This customer pai[redacted] less for its subscription usage on the Pilot versus the OAT, and benefited b[redacted] on the ex-post settlements, thus producing the credit of [redacted].

All nine customers in the table had savings on their subscription quantity, while three of the nine had additional savings on their ex-post transactions.

Table 5.1: Factors Contributing to Customer Shadow Bill Credits

ID	OAT Bill	Pilot Credit	Subscription Savings	Ex Post Savings
A-002	[redacted]			
A-006				
A-007				
A-008				
B-005				
C-004	$797	$17 (2.2%)	$40	-$23
C-024	$664	$9 (1.4%)	$13	-$4
C-051	$1,568	$26 (1.7%)	$31	-$5
C-056	$297	$19 (6.6%)	$17	$3
Total Non-Res.	$700,476	$33,155 (4.7%)	$20,855	$12,300
Total Res.	$3,326	$71 (2.1%)	$101	-$29

As noted at the beginning of this section, we believe that the design of the Pilot pricing method is likely to prevent cross-subsidies due to price response (of which we have little evidence). While some pricing parameters can be debated and/or adjusted (e.g., the allocation of capacity-related costs to hours in a peaky or less peaky fashion), there is a range of pricing parameters over which it is reasonable to expect that the prices are a good reflection of the avoided costs.

An analysis of the customers currently on pace to receive a credit leads us to conclude that the subscription pricing method is an important source of credits, or a reduced ability to earn a credit via price response. This raises questions about what constitutes a cross

[44] Tables 4.2 and 4.3 provide the information required for these calculations.

subsidy or is a "fair" outcome. For example, even if one assumes that a customer's pre-Pilot vs. in-Pilot load profile difference is entirely due to exogenous factors (i.e., not due to the Pilot itself), the customer paid OAT rates for its subscription load. The credit is due to deviations from the subscription load being priced at dynamic prices rather than OAT prices. This produces a *different* outcome than would have occurred in the absence of the Pilot, but it may be a more cost reflective outcome if dynamic prices are more closely aligned with system costs than OAT prices.

The optimal method of subscription pricing (e.g., whether/how to update quantities over time, how to deal with customer changes such as NEM adoption) is a topic worthy of in-depth research that is beyond the scope of this study.

6. STAKEHOLDER COMMENTS

The Pilot has been a complex undertaking involving coordination across multiple parties: the ASPs, TeMix, and SCE. We conducted interviews and sought written feedback from these parties to ensure that we reflected their experience on the Pilot and were given an opportunity to provide their lessons learned. The sub-sections below contain the direct feedback we received, and views expressed in all but the SCE subsection reflect those of each of the ASPs and of TeMix. In some cases, we provide written comments provided by the party. In other cases, we summarize conversations that we had with the party.

6.1 ASP A

The following is summarized from written feedback provided by ASP A for inclusion in the evaluation.

ASP A enrolled customers into the Pilot who had advanced HVAC controls that can respond to price fluctuations and maintain building comfort while reducing/shifting peak demand. ASP A noted multiple critical aspects that were unique and different from the state of the art in many ways:

1. **An innovative rate and tariff structure:** While ASP A service originally was built to accept a dynamic price, incorporating a forward transactive element (i.e., forecasting demand and then buying or selling excess) added a layer of complexity. Building out this functionality was not as simple as accepting a pricing feed through an Application Programming Interface (API), since ASP A wanted to make sure to account for customer comfort as well as price impacts. Its engineering team worked with TeMix to better understand the concept, with Lawrence Berkeley National Laboratory (LBNL) to think through the potential impacts on comfort optimization, and then developed and tested the programming logic. This took most of 2022 to test on its (at the time) two enrolled sites. The early sites showed promise and ASP A asked to enroll six additional sites in the pilot to participate by summer of 2023.[45]

[45] This study included six ASP A customers based on the shadow bills made available to the evaluation team.

2. **Integration of advanced technology and real-time response mechanisms is going to have hiccups:** Whereas the state of the art in HVAC controls typically uses schedules, indoor temperature setbacks, or turns off HVAC during peak periods (causing high opt-out and override rates), ASP A technology was reportedly built to optimize energy use within comfort bounds [redacted] This new program introduced a lot of moving parts from pricing integration and communication logistics to communicating with business officials and occupants. It was therefore not realistic to make all of those things work together without a hitch and go from two test sites and multiple new prices, technology deployments, and customer messages to immediately and without hiccups produce plug and play demand shift. ASP A selected a handful of sites for the 2023 testing season and addressed technical and non-technical questions as they came up:

   - how resilient were the technologies to large gaps in price (when, for example, the price server had outages);
   - how resilient were the technologies to networking reliability (when the same events driving lack of reliability on the grid caused communication failures); and
   - how much did customer and end user education and qualification impact the ability to operate the system reliably and produce results.

   ASP A noted these critical interim questions to ask and problems to solve to avoid the same hurdles it faced.

3. **Comprehensive measurement and verification (M&V):** Many of the [redacted] ASP A sought to enroll are large and complex with morning startup peaks of ~2MW (note, as much of 80% of this load can be from HVAC use). Typical M&V for energy counterfactuals is already difficult to prove on such [redacted]; however, at the time ASP A provided written comments to SCE's evaluator in September 2024, it had not received shadow bills yet and it therefore had to try to infer impact comparisons after the summer testing season was over to try to ascertain lessons learned and ask ourselves how rollout could have gone more smoothly. There were many issues with getting this kind of quantifiable feedback. According to ASP A, shadow bills were not available when it tried to piece together the impacts from TeMix[46], which meant they had to do a lot of back and forth to try and interpret what had actually happened from a cost and savings perspective. ASP A therefore had to wait to receive feedback about the 2023 summer heating season to make improvements to their HVAC optimization strategies for the following summer. ASP A noted the following: "At the end of the day it felt like what the M&V was measuring was…missing a more strategic question about what got in the way of actually being able to evaluate impact or remove barriers to it on the road to creating a scalable program or tariff."

In the intervening years, ASP A received a CEC CaltestBed voucher for independent testing, measurement, and verification work performed by the University of California

[46] SCE sent shadow bills to ASP A from mid-September through mid-November.

Berkeley CBE. The CBE team supported the efforts of ASP A to identify a subset of up to six representative [redacted] for field testing and defined and scoped an M&V plan and protocols to measure energy, power, and occupant comfort. For testing, they designed a 'randomized block' testing scheme during pre-defined testing periods to alternate between ASP A MPC+ML[47] controller and the customer's own baseline control policy (typically this is basic thermostat default schedules or an Energy Management System). The 15-week randomization process minimized sample bias and ensured that the same number of days are assigned to control and intervention strategies for each testing period. It allowed direct comparison of the MPC+ML (intervention) and control samples compared to a typical M&V approach. Implementing the testing protocol and then thinking about also layering on the complexity of how to compare various pricing approaches at similar sites were all details on which the ASP A and CBE teams worked. ASP A noted that the insights gained for this effort could have provided evaluation feedback that all ASPs could use.

6.2 ASP B

The following comments were provided by ASP B during conversations and via email.

- The prompt payment of promised incentives is the most important aspect for ASP B. Because the shadow bills were delivered late, ASP B believes incentives are overdue to some customers. This puts the ASPs in a difficult position.

- It would have been useful to understand when these customers were "officially enrolled" in the Pilot to help manage their expectations about when incentive settlements would occur. ASP B felt that SCE did not clearly communicate this information to them.

- ASP B primarily responds to dynamic prices by looking at four-hour windows, comparing the average price during the first two hours (when they'd pre-cool) to the average price during the second two hours. Twenty-five cents/kWh differences or more is what they're targeting. They don't want to shift for small returns. Sometimes the intra-day price differentials are not high enough to motivate significant shifting of load. Other times, they are. They'd get a higher return from responding to TOU-GS-2 incentives. ASP B staff noted the importance of ensuring that price differentials are higher in total than existing tariffs so that load shifting is properly incentivized.

- Their customers prioritize comfort and convenience. They are not as energy intensive as some customers, so they are not going to focus solely on reducing electricity costs. Being able to rapidly address problems is important for the facilities managers, who have many demands on their time.

- Customers have not grasped the transactive model, as it is unnecessarily complicated for a customer-facing pilot. The message ASP B customers can comprehend is that the ASP will help them to use less electricity when it is expensive and more when it is cheap.

[47] MPC = model predictive control; ML = machine learning.

- ASP B reports continuing to respond to OAT incentives by managing billed demand and wanting to avoid setting a new peak demand when pre-cooling.
- Timely receipt of shadow bills was also an issue. "It would be very helpful to both customers and to ASPs to have monthly access to ongoing calculations of 'how we're doing.' Waiting for an annual true-up without knowing what our performance and that of our customers has been, is not the best situation."

6.3 ASP C

The following comments were provided by ASP C during conversations.

- ASP C description of the Pilot reported that they "were driving the car as we were building it." ASP C recognized the many challenges of implementing this pricing method and therefore did not want to be overly critical of anyone.
- ASP C found the enrollment process, which insisted on using the intimidating UtilityAPI, difficult initially, which led to some customers losing interest. The insistence that the permission sharing request come from TeMix and not ASP C was another barrier to increasing enrollment.
- ASP C customers have no awareness of prices, so the only source of demand response would be controlled loads (e.g., thermostats or electric vehicles such as Teslas).
- TeMix was very responsive to some technical problems (e.g., working with thermostats that had their own algorithms, or interfacing with Tesla), but ASP C encountered resistance from the TeMix project manager when implementing simpler and less intrusive customer requests or customer interface tools such as an App-Energy Expert (i.e., resistant to their input).
- When installers were sent to customers, they would focus on explaining the dynamic prices (why they vary across hours and days), because subscription pricing as a component of two-part pricing is more complex for customers to grasp.
- ASP C was frustrated that they had not received any shadow bill/credit information in a timely manner to pass on to customers.
- The most important issues for ASP C going forward are:
  - It has to be easy for the customer get feedback on how they're doing and have an easier interface to obtain and provide information (2-way).
  - Ideally, customers would have an app that provides real-time feedback and allows them to enter their own preferences (e.g., temperature ranges for comfort).

6.4 TeMix

The following text reflects written feedback we received directly from TeMix for inclusion in the evaluation. Text has been edited for brevity; note these comments reflect TeMix's position on the pilot.

TeMix believes this pilot, its sister PG&E/VCE[48] pilot, and the preceding RATES[49] pilot have shown that the CALFUSE vision is technically sound and feasible. According to TeMix this should reassure everyone about CALFUSE's direction and its potential for future success. The CALFUSE vision is for a two-part subscription and dynamic transactive price tariff. The subscription portion ensures stable bills and cost recovery while enabling equity policies. Customer-facing dynamic prices reflect locational scarcity and abundance in wholesale conventional and renewable generation, storage, and transmission. Additionally, these customer-facing prices reflect retail customer price responsive usage, distributed generation and storage, and locational distribution two-way scarcity and losses. Though TeMix, SCE, ASPs, and participants encountered pain points over the course of the pilot, the DRP pilot, its sister PG&E/VCE[50] pilot, and the preceding RATES[51] pilot were able to execute the CALFUSE strategy.

California's clean energy policies, combined with increasing wholesale and distributed renewable, variable generation, and storage, are stressing the existing systems in new ways. Suppliers' and customers' operations and investments need to adapt. The market, formed by customers' and suppliers' crucial investment and operational decisions, is responding. The CALFUSE vision provides the correct signals for these investment and operational decisions, valuing the role of each participant in the system. The TeMix Platform provides the computing infrastructure and methodology to implement the CALFUSE vision fully.

The California energy system is increasingly fixed-cost, comprising renewable generation, storage, wires, and energy-consuming devices that consume no fuel. The challenge is that there is no easy way to calculate the customer-facing marginal cost of energy. Instead, the energy price is determined by customer willingness to shift and shape energy usage and the shifting and shaping of fixed-cost distributed generation and storage especially in extreme weather and grid events. Price-responsive investment decisions also determine the energy price. The pricing formulas used in the two current CALFUSE pilots rely too heavily on outdated marginal cost concepts that mute the strength of the price signal, highlighting the need for improved dynamic scarcity pricing models.

TeMix understands that California's electricity institutions' full implementation of the CALFUSE vision will take time because tariff pricing, distribution services, and wholesale operations are typically siloed. Dynamic pricing scares some, but in the context of the CALFUSE two-part subscription transactive tariff, it should not. The transactive elements of the CALFUSE vision are essential to support forward operational planning and savings

48 CPUC Decision (D.) 21-12-015

49 [Complete and Low-Cost Retail Automated Transactive Energy System (RATES) (dret-ca.com)]

50 CPUC Decision (D.) 21-12-015

51 [Complete and Low-Cost Retail Automated Transactive Energy System (RATES) (dret-ca.com)]

by customers and suppliers. The transactive elements enable intra-day and intra-hour price response for grid reliability and savings, especially during extreme grid conditions.

The current command and control, dispatchable, overly centralized system is being significantly displaced by customer-owned and operated storage, solar generation, and flexible end-user devices such as electric vehicles, heat pumps, and intelligent controls. CALFUSE and its pilots show the way forward.

In an interview, TeMix had additional comments:

TeMix's comments on the pricing and billing role were as follows:

- SCE could have communicated the subscription values (monthly kWh and cost) to TeMix in simple tables, which would have allowed both TeMix and SCE to verify that TeMix was using the correct values. Instead, SCE transmitted subscription prices for multiple rates per customer with other data in large spreadsheets, which, early on, resulted in some errors that had to be corrected, and shadow bills recreated.

- TeMix was able to distill SCE's pricing models to about 10 parameters that are imported to their models, which worked well. There were some issues with flat adders (i.e., a constant $/kWh value applied to all hours) that were resolved over time.

- TeMix advocates moving to a more automated enrollment process.

    - SCE sets the pricing parameters that determine how "peaky" the dynamic prices are. That is, capacity costs are allocated across hours and some methods will spread those costs across more hours than others. The fewer hours that are assigned capacity costs, the peakier the affected hours will be (though there will be fewer higher-priced hours). TeMix would prefer a pricing method that results in higher but less frequent peaks so that the reliability of the grid to meet peaks is higher.

    - There were significant problems obtaining accurate meter load data in a timely manner. Initially, a third-party provider was used to process SCE's published data and billing data for use by TeMix, which led to problems that took significant resources to resolve. Issues included both missing data and data that changed over time. SCE has since implemented a process in which they provide the meter bill data directly to TeMix. This eliminated most meter and bill data issues as of early 2024, though data gaps and significant delays in receiving meter data still need to be resolved in some cases. Although the initial challenge of accurate meter data was mitigated by leveraging SCE data directly in early 2024, there have still been a few ongoing challenges, including delays in confirming that the meter data is the actual meter data used for customer billing.

- The meter data issues described above have often delayed providing shadow bills. TeMix's process of generating shadow bills is entirely automated once TeMix receives validated meter and OAT billing data. However, when such data problems occur, it is time-consuming to resolve them, which significantly increases TeMix's costs and delays the publication of shadow bills. However, due to considerable work by SCE and TeMix, the direct communication of meter and bill data has improved significantly.

TeMix's comments on their role managing ASP C's residential customers were as follows:

- The residential customer enrollments only included thermostat-controlled loads. Electric vehicles and battery storage were not able to be included (SCE budget did not have the funds to pay the ASP). This limited the potential for price response.
- TeMix's algorithm used for ASP C learns a model of the house (thermodynamic machine learning) and finds the least-cost way to operate the air conditioner or heat pump while maintaining comfort. TeMix's technology can incorporate customer input via Alexa (i.e., helping refine comfort levels). Still, ASP C did not have funding to implement that feature in this pilot, which led to all customers being operated using a standard set of parameters.
- TeMix would like more manufacturer involvement. Tesla and ecobee could be excellent partners, but they have yet to develop algorithms that respond to the Pilot's dynamic prices. Instead, their algorithms focus on managing usage in response to standard TOU rates. It can be difficult for TeMix to manage devices that have their own algorithms – a more direct approach is for the manufacturers' algorithms to respond directly to the dynamic prices. TeMix believes the CPUC could provide incentives to manufacturers to adapt their algorithms to the Pilot's pricing.

Overall, TeMix reported that they have enjoyed working with SCE and the ASPs and that the Pilot has provided valuable experience.

6.5 SCE

Implementation

The original concept of the SCE Pilot arose from a dynamic pricing research study funded by the California Energy Commission (CEC) called the Retail Automated Transactive Energy System (RATES). RATES was implemented by TeMix in 2016 with SCE's participation. Its research objective was to demonstrate a "transactive energy" trading pricing and settlement platform that allows customers to respond to dynamic prices while managing their energy usage in real time. The RATES project enrolled over 100 residential customers and concluded in 2019.[52]

During Phase 2 of the CPUC's Summer Reliability rulemaking in 2021, TeMix proposed revisiting RATES as a means to provide load management for customers and ensure reliable electric service during the summer of 2022. In D.21-12-015, the CPUC mandated SCE and PG&E to each implement a pilot based on the TeMix proposal, which would operate from 2022 through 2024. SCE filed its Pilot plan approach in AL-4684-E on

52 https://www.energy.ca.gov/sites/default/files/2021-05/CEC-500-2020-038.pdf

January 5, 2022 in compliance with D.21-12-015. This, along with supplemental AL 4684-E-A, outlined the overall scope, Pilot partners, shadow bill implementation, schedule, and tariff design for the proposed Pilot.

Over the development and implementation of the dynamic rate Pilot plan, SCE faced many design and operational challenges which required innovative approaches to Pilot initiation and ASP engagement, with constant process adjustments during the term of the Pilot. These included the need to meet a short implementation window for the summer of 2022 coupled with delays in developing the dynamic pricing models and subscriptions, delays in developing the circuit load forecasts, and further delays associated with the process of validating and revising customer shadow bills. Each of these issues are addressed in the following sections.

Design Challenges

- The Pilot's tariff design was unprecedented for SCE, hence this dynamic rate pricing endeavor should be viewed as an experimental pilot. Over its course, SCE staff needed to account for changes in transmission and distribution costs and non-bypassable charges in the hourly prices at a couple of points during the Pilot's operation. These changes in costs were reflected in updated flat adders that needed to be incorporated in customer shadow bills, not all of which were correctly included in the initial adjustments made by SCE.

- Because of the experimental nature of the Pilot's design, SCE updated dynamic price models as the Pilot continued; due to the manual nature of the changes and the short timeframe to implement, some of the activities were not fully documented at first, and as a result, the initial records of these price changes were incomplete.

- For some, forward transactions (originally included as a feature in the transactive pricing model) were difficult to execute and were ultimately not used by the ASPs and their customers; SCE therefore requested a discontinuation of forward transactions during the Pilot.

- SCE faced challenges with staff availability across multiple departments as data and validation tasks developed over the course of pilot. Few individuals had the Pilot as a dedicated day-to-day responsibility. This led to delays in Pilot implementation, billing, and data validation. Most Pilot activities required shared resources from other departments. For instance, the design and development of the hourly dynamic price models involved ongoing detailed discussions with the CPUC and the SCE rate design department, which delayed their delivery to TeMix.

- Community Choice Aggregation (CCA) customers were not eligible for the Pilot, which posed a significant challenge for verifying participant eligibility. The automatic enrollment campaign for CCAs coincided with the launch of the Pilot enrollment campaign, necessitating eligibility checks before and after Pilot customer enrollments. This process required coordination across multiple SCE teams to confirm bundled account status, ultimately eliminating over 75 unbundled CCA accounts that were previously eligible.

- The challenges mentioned above were some of the hurdles that various SCE resource teams resolved manually and through data systems to retrieve and quality check the required data. The Pilot consisted of 38 customer accounts across 33 SCE circuits. As an experimental Pilot, scaling up to a larger participant group was desired but not attainable with the existing resources and manual processes.

<u>Shadow Bills - Data Issues and Validation</u>

Pilot participants continued to pay their electric bills (based on their OATs) while the customers' monthly shadow bills were calculated by TeMix separate from SCE's billing system. At the end of one year of Pilot participation (or the customer's NEM relevant period), participants were eligible to receive incentives based on the differences in their shadow bills and OAT bills. As noted in SCE's brochure describing the Pilot, "At the end of 12 months of participation, the monthly regular bills you paid will be compared against the bills based on the SCE flexible pricing rate under the pilot. If you saved money on the SCE flexible pricing rate, your ASP will provide you with an incentive payment for the difference. If you did not save money on the SCE flexible pricing rate, you will incur no cost."

Below are some of the challenges encountered with shadow bill validations:

- TeMix contracted with a third-party to obtain interval meter data for customers participating in the pilot, as it had a system in place to accept data files from the third-party source. SCE conducted a validation of this third-party data, discovered issues with missing data, and advised TeMix of this finding. These interval data issues from the third-party provider caused problems in creating accurate weekday/weekend profiles, delaying the generation of shadow bills. To address these data issues, SCE developed an internal process to retrieve and send all customer billing interval data directly to TeMix starting in December 2023. This improved TeMix's shadow billing process.

- The Pilot team faced challenges in completing data validation and shadow bill calculations promptly, as these tasks were manually intensive and often required the involvement of multiple SCE staff from different departments to resolve issues. Upon review, the validation team found some errors in factors and other details that necessitated the regeneration of shadow bills. SCE manually adjusted a subset of TeMix shadow bills to account for CPP charges and incentives, NEM tracked charges, rate factor changes, and other elements. Identifying these elements caused several stops and starts, impacting the finalization of shadow bill deliverables. SCE decided to make these adjustments to reduce the additional back-and-forth of shadow bill calculation adjustments with TeMix.

- SCE also had additional learnings related to select account scenarios that required adjustments to the way accounts were calculated to provide customers with a "level playing field". Examples include subscription adjustments for customers moving from non-NEM to NEM, adjustments to exclude tracked charges from OAT bills for months when the customer was not on the pilot, handling situations where the customer changed their OAT rate or rate class, etc. Implementing forecasts from multiple circuits and the inclusion of hourly dynamic rate factors, changing every 24 hours, introduced significant billing complexities and potential inaccuracies.

- The information exchange between SCE, its vendors, and customers was manual and inefficient due to the experimental nature of the Pilot design, which lacked traditional processes. For instance, the SCE Rate Design team generated spreadsheets to transmit subscription pricing to TeMix, while TeMix provided Excel-based shadow bill summaries to SCE.[53] Additionally, the evaluation team requested circuit-level tender prices for specific periods but had to repeatedly coordinate with TeMix to obtain all relevant files. This was mainly because some circuit load forecasts from GridX were not initiated until after the original customer start date. The challenge lay in the inability to transmit real-time meter data daily across SCE's service-wide territory for daily circuit forecasts, as this capability was currently unavailable.

- Due to the delays in generating and validating shadow bills, ASPs and customers did not know whether customers were earning credit during a majority of the Pilot's operation. The information was not shared with them at the end of one year of participation due to the validation challenges.

- The Pilot experiences with manual processes (typical for experimental pilots with limited customers) provided both the starting point for a dynamic tariff design but also many learnings with regards to system limitations. These learnings demonstrated the need for a centralized customer information database and automated data exchange for future dynamic pricing rates to be effectively scaled.

Dynamic Prices

One of the goals of this Pilot was to derive hourly dynamic prices that would vary day-to-day and provide the basis for the ASP's customer end-use load response. The Pilot team was interested in understanding the ASP response to the dynamic prices compared to the customers' OAT.

- The within-day price variation from the prices in the Pilot was not as high a differential as the ASPs expected for managing customer costs. So some of the ASPs managed to the OAT tariff so that it would be more rewarding for customer incentives from load shifts.

- SCE can consider whether the price model parameter values can be adjusted to produce higher intra-day incentives to shift load. SCE is also examining different price functions (sigmoidal versus quadratic) for use in future dynamic price design.

[53] TeMix noted that it had a centralized database for the Pilot, but other than CAISO inputs and GridX forecasts, most of the data inputs from SCE to TeMix were based on manual processes. The creation of shadow bills by TeMix for SCE was automated and, according to TeMix, the provided spreadsheets were intended to be read-only reports and not the basis for reprocessing shadow bills.

Manufacturer Interest

SCE reached out to multiple third-party entities when the Pilot was in its design stage to identify supporting resources, determine market participant interest and customer availability in working with SCE in the Pilot. These companies were investigated as potential ASPs, and they ranged from traditional demand response aggregators, automation technology startups, energy management service providers, as well as appliance and systems manufacturers, distributors, and consumer trade organizations.

SCE found in their discussions with these parties that the business models for many of these entities did not align with the limited value proposition that participating as an ASP in the Pilot provided. As would be expected, many of the manufacturers of electrical equipment were mostly concerned with maximizing equipment sales, enhancing market shares, and often did not provide the technology or connectivity services as required by the Pilot. Manufacturer interest was therefore limited but not totally absent or rejected outright. Many manufacturers of consumer goods such as smart appliances, electric vehicles, battery storage and air conditioning systems indicated some interest and requested engagement at a later time as the Pilot outcomes and business use cases became more developed.

Customer Reactions

Between November 12, 2024 and February 4, 2025, SCE conducted a survey with a subset of participants after they received their flexible comparison reports.[54] SCE invited 21 participants to take the survey over two waves. A total of six respondents completed the survey, and provided the following anecdotal results:

- Satisfaction from these six respondents varied. As noted by one respondent, "Paying attention to the hours we could 'save' electricity is stressing my family members and we have stopped doing things because of the higher prices." Other comments included the inability to modify thermostat changes from the ASP (a residential account), as well as the desire for more communication regarding the pilot. More surveys are being conducted to gather more meaningful results.

- Education: One customer commented that they did not even know they were on a dynamic rate. Conversely, half of the customers who responded (three) were aware of the SCE Pilot fact sheet and found it somewhat or a little useful. Customer responses from this group are anecdotal, however it aligns with the potential benefit that education has provided for SCE rate offerings.

- Device Upgrades: Half of the customers who responded (three) had to upgrade their existing devices to smart devices in order to participate in the Pilot. This was expected as the ASPs provided technology in almost all instances for their customers as part of the Pilot design. The need for smart devices is considered a

[54] SCE delivered Flexible Comparison Reports to participants that shows how flexible rates impact customer bills compared to their bills on their OATs. At the end of 12 months of participation, the monthly regular bills participants paid are compared to bills based on the flexible pricing rate under the pilot to determine whether participants receive incentives.

future requirement for effective price response, either through an ASP or with direct customer participation.

7. SUMMARY AND CONCLUSIONS

The Decision approving the Pilot included evaluation requirements that are quantitative in nature and implied that the Pilot duration was sufficiently long that the customer Pilot experience would be informative about the expected benefits and costs associated with the Pilot pricing mechanism.[55]

As it happened, the complexity of the pricing mechanism and technologies surrounding it (e.g., to create and transmit prices and bills; and to enable customer-side price response) have meant that the Pilot has been most instructive in the lessons learned that can be carried forward for future dynamic tariff design.

The key takeaways we have from the Pilot are described below.

- The evaluation of load responsiveness found the following:
    - The ASPs in the Pilot reported the ability to successfully respond to the hourly dynamic price signals from TeMix. ASPs were able to integrate technologies (primarily smart thermostats) in the Pilot that responded to the ASP Agent schedules based on the day-ahead price signals without customer intervention.
    - The analysis did not find evidence of consistent and/or large changes in hourly energy usage due to ASP/customer price response. Possible explanations for this finding include:
        - Extended time required to set up and implement Pilot activities, including time for the ASPs to refine their response algorithms, time to acclimate customers to the Pilot (e.g., ensure they understand the kinds of changes they can expect to experience as their AC units respond to prices), and time to produce information that provides ASPs and customers with feedback to understand the value of their participation and evaluate how they can improve performance.
        - The shadow bill credit methodology gives customers an incentive to simultaneously pay attention to OAT rates and dynamic prices. It is possible that ASPs prioritized reducing costs from the OAT during the Pilot period as those were more visible monthly to customers (shadow bills were not). Because of the "dual incentives" issue, the Pilot was not designed to obtain statistically valid estimates of customer response to dynamic prices.

[55] Specifically, there are requirements to evaluate load responsiveness, bill impacts, and cost recovery.

- Hourly price differences from the dynamic rates may not have been high enough to induce significant price responses. At a given time, ASPs and customers may have prioritized maintaining comfort over the possible shadow bill savings available from shifting air conditioning loads.

- The monthly bill impacts of the Pilot dynamic rate (shadow bill) in comparison to a customer's OAT showed 41% (9 of the 22) of the customers evaluated in this report saved money on the Pilot. At the time of this evaluation:[56]

  - 4 of 13 residential customers were on track to receive a credit averaging 2.1% of their OAT bill.

  - 9 of 13 residential customers had shadow bills that were, in aggregate, 6.1% higher than their OAT bills.

  - 5 of 9 commercial customers were on track to receive a credit averaging 4.7% of their OAT bill.

  - 4 of 9 commercial customers had shadow bills that were, in aggregate, 8.3% higher than their OAT bills.

- The evaluation of cost recovery concluded that subscription savings were the most important factor in determining whether a customer was due a shadow bill credit. The optimal method of subscription pricing (e.g., whether/how to update quantities over time, how to deal with NEM or electric vehicle adoption) is a topic worthy of in-depth research that is beyond the scope of this study.

- The ASPs reported that they did not receive timely information on shadow bills and credits as expected for customer communications. The Pilot experienced significant delays in providing information to ASPs due to implementation issues and a largely manual infrastructure (e.g., customer-specific shadow bill spreadsheets).

- ASPs suggested that customer engagement could be improved by providing closer to real-time feedback and the ability to set preferences (e.g., desired temperature ranges) in a smartphone application (or something similar).

[56] Note that the Pilot credit summaries presented here in the evaluation are based on all available months for each customer. For the actual shadow billing, the shadow bill credit calculation for customers was conducted at the end of their relevant period for NEM customers and at the end of the 12 months of participation for non-NEM customers, with the months in the following period being included in a subsequent shadow bill credit calculation. This change in the timing of the calculation may affect whether a customer received a credit, as the calculation is cumulative over the shadow bill period.

- ASPs report that intra-day price variation needs to be higher to provide sufficient incentives to shift loads. It appears that the existing TOU rates in the customer OATs often provided higher incentives to shift.[57]

- Consider implementing a formal testing algorithm (i.e., the randomized treatment days used by one of the ASPs) on a more widespread basis to assist in evaluating the efficacy of the Pilot tariff in shifting loads enrolled in the program from peak to off-peak periods, compared to non-participant loads.

[57] Even if one assumes that the Pilot provides the "correct" incentive to shift loads and the TOU rates overpay customers, a customer will be likely to choose the TOU rate if it provides a higher reward for their usage changes.

GLOSSARY OF KEY PILOT TERMS

Automation Service Provider (ASP): companies that install and manage enabling technologies at retail customer sites.

Dynamic price tender (or just "tender"): a binding price for electricity during a specified period of time. These can be offered from an hour to days ahead of the time the electricity is consumed.

Ex-post price: the dynamic price at the time the electricity is consumed. Ex-post pricing occurred in 5-minute intervals until May 2024, when the Pilot changed to hourly settlements at the day-ahead dynamic price tender.

Otherwise Applicable Tariff (OAT): The SCE rate schedule a Pilot customer is served on prior to and during the Pilot, (e.g., TOU-GS-2-R).

Shadow bill: the total dollars associated with Pilot participant's electricity usage when billed at Pilot prices. This combines the subscription cost and the dynamic pricing components.

Shadow bill credit: the credit a Pilot customer receives at the end of 12 participating months on the Pilot if the total of their shadow bills is less than the total of their OAT bills. The customer does not pay if the total of their shadow bills is higher than the total of their OAT bills.

Subscription quantity: a fixed hourly quantity of electricity the customer purchases at OAT prices. The quantities are based on the customer's historical usage.

Subscription price: the customer's subscription load priced at the customer's OAT divided by their total subscription load.

APPENDIX

- Table A.1, below
- SCE Advice Letter 4684-E
- SCE Advice Letter 4684-E-A

Appendix Table A.1: Estimates of Changes in Peak-Period Usage

			Pilot Coefficient Estimate	
			Peak = HE 17-21	Peak = HE 18-20
A-001	8/23 to 9/24	1.0	1.628 (0.302)	1.622 (0.136)
A-002	8/23 to 4/24	1.0	-10.675* (0.000)	-5.359* (0.000)
A-005	10/23 to 9/24	1.0	71.043* (0.000)	36.752* (0.000)
A-006	12/23 to 9/24	1.0	9.712* (0.000)	6.326* (0.000)
A-007	10/23 to 9/24	1.0	3.851* (0.027)	1.968 (0.070)
A-008	10/23 to 9/24	1.0	9.330* (0.000)	3.490* (0.000)
A-009	10/23 to 5/24	1.0	-1.612 (0.773)	-1.899 (0.566)
B-004	8/23 to 9/24	2.0	142.076* (0.000)	82.907* (0.000)
B-005	7/23 to 9/24		-156.574* (0.000)	-101.592* (0.000)
C-002	10/23 to 9/24		0.105 (0.447)	0.089 (0.359)
C-004	8/23 to 9/24		-0.039 (0.515)	0.020 (0.647)
C-024	10/23 to 9/24		0.011 (0.846)	0.023 (0.577)
C-030	10/23 to 9/24		-0.095 (0.500)	-0.088 (0.337)
C-043	10/23 to 9/24		-0.646* (0.042)	-0.381 (0.064)
C-044	3/24 to 9/24		0.988* (0.005)	0.897* (0.000)
C-045	10/23 to 9/24	1.0	0.489* (0.010)	0.198 (0.106)
C-051	12/23 to 4/24		-0.179 (0.811)	-0.130 (0.794)
C-052	12/23 to 4/24	2.0	-1.183* (0.020)	-0.756* (0.015)
C-053	12/23 to 9/24		-0.258 (0.239)	-0.090 (0.554)
C-054	12/23 to 9/24		-0.416* (0.045)	-0.268 (0.083)
C-055	1/24 to 9/24		-0.902* (0.000)	-0.606* (0.000)
C-056	1/24 to 4/24		0.033 (0.838)	0.018 (0.865)

PUBLIC UTILITIES COMMISSION
505 VAN NESS AVENUE
SAN FRANCISCO, CA 94102-3298

April 26, 2022

Shinjini C. Menon
Managing Director, State Regulatory Operations
Southern California Edison Company
8631 Rush Street
Rosemead, CA

***Subject*: Southern California Edison Company Advice Letter 4684-E**

Dear Ms. Menon:

Southern California Edison Company (SCE) Advice Letter (AL) 4684-E and SCE AL 4684-E-A, which provide information regarding SCE's forthcoming Dynamic Rate Pilot (Pilot) pursuant to Decision (D.) 21-12-015, are approved as filed, effective March 7, 2022.

The appendix of this letter contains a discussion of the AL, protests by the Small Business Utility Association (SBUA) and Enel X North America (Enel X), SCE's reply to these protests, SCE's Supplemental AL 4684-E-A, and Energy Division staff's disposition on the protested issues.

If you have any questions, please contact Achintya Madduri at (415) 696-7350 or achintya.madduri@cpuc.ca.gov.

Sincerely,

FOR

Pete Skala
Interim Deputy Executive Director for Energy and Climate Policy/
Interim Director, Energy Division

cc: ED Tariff Unit
Achintya Madduri (ED)
Paul Phillips (ED)
Dan Buch (ED)
Jennifer L. Weberski (SBUA)
Sara Steck Myers (Enel X)

Appendix: Energy Division Technical Review and Analysis

Background

On November 19, 2020, the California Public Utilities Commission (CPUC) initiated Rulemaking (R.)20-11-003 to establish policies, processes, and rules to ensure reliable electric service in California in the event of an extreme weather event in 2021.

Ordering Paragraph (OP) 59 of Decision (D.) 21-12-015 (also referred to herein as the "Decision"), issued December 2, 2021, authorized SCE to use TeMix's Retail Automated Transactive Energy System (RATES) platform for a three year (2022-2024) dynamic pricing pilot (Pilot) in SCE's territory and granted SCE's request for a budget of $2.5 million. The Pilot is intended to assist in assessing the costs and benefits of real-time rates, including required infrastructure, manufacturer interest, and customer impacts. The Pilot will be administered by SCE under its Demand Response (DR) Emerging Markets and Technology program, authorized in D.17-12-003.

The TeMix proposal is consistent with ED staff's Unified, Universal, Dynamic Economic (UNIDE) pricing roadmap, which was originally proposed by Energy Division (and presented in a May 25 workshop).[1] The Pilot will use the RATES™ platform developed by TeMix,[2] a software platform piloted by the California Energy Commission (CEC) Electric Program Investment Charge (EPIC) grant EPC-15-054 in SCE's territory. TeMix proposed using the same platform for implementing a three-year dynamic rate pilot.

In OP 63 of the Decision, CPUC required SCE to submit a Tier 2 AL to address the following Pilot elements: (1) scope, (2) partners, (3) shadow bill implementation, (4) dates, and (5) tariff design.

SCE included the following details of the Pilot elements in AL 4684-E, which was filed on January 5, 2022:

1. **Pilot Scope**: The Pilot will combine real time pricing design and transactional subscription elements from both the RATES and UNIDE tariff concepts. The Pilot will also investigate how customer-based distributed energy resources can act as both flexible assets and grid interactive resources when these new pricing signals are transmitted to end use customers. So that these hypotheses are fully examined, the Pilot metrics will be structured to develop a series of empirical analyses to assess the costs and benefits of real-time dynamic rate communications, with the ultimate objectives of transferring the research investments from the 2016 CEC EPIC RATES pilot into flexible customer demand side opportunities that can accelerate solutions for system reliability for the summers of 2022 and 2023.

   The Pilot will include eligible SCE retail customers as participants in the first phase. SCE will examine and pursue opportunities to identify and enroll residential, commercial, and industrial customers as appropriate with smart enabling price-responsive end-uses including

[1] D.21-12-015, Attachment 1, p. 10.
[2] *See* TeMix Opening Testimony at 1-2 and SCE Reply Testimony at 8-10.

electric vehicle charging, behind-the-meter batteries, and controllable loads that may have the enabling software to interface with TeMix. Due to the accelerated Pilot schedule, and the urgency to meet summer 2022 reliability needs, SCE intends to work with automated service providers (ASPs) that may have existing SCE customers available with installed communicating enabling technologies that are compatible with the TeMix RATES software messaging platform. This aggregated approach for customer enrollment through ASP engagement is expected to reduce the cost for individual customer outreach and enrollment processes, thereby expediting the fulfillment of the schedule milestones as indicated in the project schedule. SCE expects that customer enrollment may be a continuous process, and will be phased to ensure that there are minimal gaps in the data analysis and to capture any changes in customer participation over the term of the study.[3]

2. **Pilot Partners:** SCE will execute a service contract with TeMix to use the TeMix platform software service. The Pilot will use the TeMix RATES™ platform architecture, as piloted through a CEC EPIC grant in SCE's service territory starting in 2018 with over 100 participating residential customers.[4]

   SCE will also work with other stakeholders such as current ASPs, major electric vehicle (EV) manufacturers and/or smart charger service providers, solar/battery aggregators or service providers, and others with the capability to directly receive price tenders (binding offers to buy/sell future energy quantities at a specified price) from the TeMix RATES platform to optimize load flexibility (such as EV and storage charging and discharging schedules).

   SCE will coordinate with Electric Power Research Institute (EPRI) to examine opportunities to engage various customer groups to receive the TeMix signals similar to what EPRI has done through existing CEC-EPIC research projects.

   SCE also intends to collaborate with Lawrence Berkeley National Laboratory (LBNL) to leverage LBNL's research with the California Load Flexibility Research and Development Hub (CalFlexHub).[5] CalFlexHub was established by the CEC to conduct applied research and development and technology demonstration and deployment projects that develop and increase the use and market adoption of advanced flexible demand technologies and strategies as electric grid resources and facilitate integration of distributed energy resources. This collaboration is intended to allow SCE to coordinate price messaging protocols and develop an expeditious pathway for alternative messaging transport services that may result in additional customer eligibility for the Pilot (e.g., underserved rural areas and disadvantaged communities lacking Wi-Fi access).

   In addition, there are other technology and software providers who already manage groups of SCE customers for demand management services and other value streams. These providers and other ASPs will be engaged to collaborate with SCE and TeMix and will be included in the project team as providers and advisors. Additionally, SCE will work to engage other innovative partners who have expressed interest in collaborating in the Pilot. SCE expects that these partners can provide consulting and technical services in the areas of market and grid operations, licenses for automated service platforms, economic reviews and system

[3] *See* pp. 2-7 of SCE AL 4684-E.
[4] *See* CEC EPIC grant EPC-15-054.
[5] *See* CEC EPIC grant GFO-19-309.

impact analyses (e.g., avoided cost calculations), and the estimation of load shift impacts and energy reduction savings. To that end, SCE will form two technical advisory committees (TACs): (1) an internal TAC to expedite coordination for execution of the Pilot and share real time learnings with the SCE project team; and (2) an external TAC to oversee the Pilot's design, deployment, and execution as well as assess evaluations and make recommendations to ensure that the Pilot is on track to meet its goals.[6]

3. **Shadow Bill Implementation**: While on the Pilot, customers will continue to be billed in accordance with their Otherwise Applicable Tariff (OAT). Concurrently, TeMix will configure the platform to calculate and provide monthly bill amounts based on the hourly price signals provided to customers participating in the Pilot. Any customer savings recognized from the hourly price signals compared to the customer's OAT will be provided to the customer on at least an annual basis.[7]

4. **Pilot Dates**: The Pilot's three-year timeline is defined in OP 63 of the Decision. SCE provided an illustrative timeline and said that the Pilot timeline is under development and may be subject to change.[8]

5. **Pilot Tariff Design**: SCE proposes to implement this Pilot without establishing a pilot tariff schedule because the Pilot will assess "the monthly bill impacts of the Pilot dynamic rate in comparison to a customer's otherwise applicable tariff." The subscription transactive price, which includes a customer-specific baseline energy quantity billed at an OAT to reduce bill/revenue volatility, will be further analyzed and developed in the Pilot. This dynamic price can be calibrated to reduce cost shifts while stabilizing utility revenues and customer bills. By using the appropriate mix of generation and delivery price signals for both day-ahead and/or real-time prices, the dynamic price tariff should align demand side management with capacity planning and other operational constraints that span the wholesale and retail delivery systems. TeMix will provide the technology platform, assist SCE in calibrating the price parameters, and assist in developing the subscription portion of the price for each customer. No tariff schedule is needed for this Pilot because customers will be billed based on their current SCE rate schedule. SCE will not implement billing system enhancements and participating customers will receive a shadow bill on the dynamic price rate.

SBUA Protest

On January 25, 2022, Small Business Utility Advocates (SBUA) submitted a protest of AL 4684-E and requested Commission staff to direct SCE to file a supplemental to the AL to address the following concerns:

1. **AL 4684-E does not explain how SCE will study the enhancement of system reliability**. In its protest, SBUA stated that SCE does not explain how it will develop definitions and metrics to measure system utilization, or how SCE will demonstrate that those measurements will reasonably assess system reliability impacts. SBUA also stated that the prior RATES pilot allocated 60 percent of generation capacity costs to bulk generation and

[6] *See* pp. 7-9 of SCE AL 4684-E.
[7] Id. at 9.
[8] *See* Figure 5 on pp. 9 of SCE AL 4684-E.

remaining 40 percent to three-hour ramp generation, and that SCE's AL did not have a discussion of the allocation of generation capacity costs.

SBUA stated that it is participating in an MGCC Study that is expected to propose a method to measure the scarcity of generation capacity on a day-ahead hourly basis in order to allocate MGCCs accordingly. This MGCC Study is being performed in partnership with PG&E, the Public Advocates Office, and other parties in compliance with D.21-11-017 (in A.20-10-011). A recent settlement in PG&E's Phase 2 General Rate Case (A.19-11-019) also proposes to use of those same methods for piloting certain residential and commercial rates. SBUA suggested that this study may result in the development of "evidence-based generation scarcity pricing curves."[9]

SBUA further stated that "there is little evidence that the proposed pilot will actually study the use of dynamic rates to enhance system reliability, as directed by CPUC."[10]

2. **The AL does not explain how non-marginal costs will be recovered**. In its protest, SBUA stated that dynamic pricing should be based on marginal cost rates. However, a substantial portion of SCE's rates are not marginal costs, but are allocated using the Equal Percent of Marginal Cost (EPMC) "scalar" method. If hourly rates are also increased to collect EPMC costs, then customers will receive incorrect pricing signals. For example, if the "correct" hourly cost during a period of resource scarcity is $2 per MWh and the EPMC factor is 2.0, then a customer would be scaled up to $4 per MWh. In addition to over-incentivizing load reduction, this methodology would also send an effective price signal for battery storage of $4 per MWh, which would far exceed the price available to battery storage operators dispatched through the CAISO. SBUA pointed to the use of a revenue neutral adder adopted by PG&E in D.21-11-017 and the settlement in PG&E's Phase 2 GRC (A.12-11-019), noting that "SCE's relative silence on how it views this issue suggests that the outcome of this pilot would not lead to a potential design for a widely-available dynamic rate."[11]

3. **AL 4684-E does not clearly describe eligibility requirements, which should be open to broad participation.** In its protest, SBUA stated that SCE does not clearly state what eligibility requirements will be included in the pilot scope. SBUA also stated that it is also unclear whether the pilot will be limited to SCE's bundled customers. Costs for SCE's demand response programs are recovered in distribution rates. As a consequence, SBUA asserts that SCE's pilot should include provisions for making dynamic rates available to customers of all LSEs on SCE's system. However, this will be challenging, as the LSE sets the generation charge component of the customer's bill.[12]

4. **The $2.5 million budget is not justified.** In its protest, SBUA stated that the SCE AL does not provide any details regarding how the authorized budget of $2.5 million is to be spent. SBUA also objected to the SCE AL's description of customer incentives, which SBUA states were neither estimated by SCE in its Reply Testimony, nor approved by CPUC.[13]

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[9] See pp. 2 of SBUA Protest.
[10] Id. at 3.
[11] *Id.*
[12] *Id.*
[13] *Id*. at 4.

5. **The AL does not discuss the evaluations.** SBUA stated that while SCE is not required to discuss the mid-term and final evaluations required by the Decision, "it is surprising that the AL provides no substantive discussion of the evaluation," and that, "SCE will find it challenging to demonstrate the costs and benefits of real-time rates if the rates are not well-aligned with system costs and without clarity on how the shadow pricing relates to each component of the customer's otherwise applicable tariff"[14]

ENEL X Protest

On January 25, 2022, Enel X North America, Inc. (Enel X) submitted a protest of AL 4684-E on the grounds that the Pilot described by SCE is not sufficiently detailed to comply and achieve the goals set for the Pilot by the Decision. Enel X requested that the CPUC direct SCE to file a supplemental advice letter prior to the launch of the Pilot to provide further additional details:[15]

1. **For Pilot Scope**:
    a. Specify the rate classes or schedules that would be eligible for the Phase 2 RATES Pilot;
    b. Specify whether the total number of Pilot participants would be capped, either across the Pilot or for specific rate classes;
    c. Specify whether Pilot eligibility is limited by interconnection permit, export-compensation permit, Demand Response (DR) program participation, or other factors;
    d. Clarify whether the Pilot is intended to be limited to SCE bundled customers, or whether unbundled CCA or Direct Access customers could also participate;
    e. Clarify whether SCE intends to extend the Pilot RATES offering beyond the 2022-2024 term authorized in D.21-12-015, alluded to as "Phase 1;" and
    f. Specify how many distribution circuits will be included in the Pilot.
2. **For Pilot partners**: Describe how SCE intends to conduct Marketing and Outreach activities to enroll Pilot participants.
3. **For Shadow Bill implementation**: Specify whether Pilot participants will need to make a payment to SCE if their total RATES bills are higher than the Otherwise Applicable Tariff, or whether the Pilot will include a form of bill protection.
4. **For Pilot tariff design**:
    a. Specify the six-step "UNIDE" rate design and methodology that will be used as the basis for Pilot participation;
    b. Specify how the Pilot subscription profile would be created, level of temporal granularity in the subscription, whether customers or Automation Service Providers (ASPs) would have control over the subscription amount, whether the subscription profile would be updated over time, and how associated subscription rate(s) would be set; and

[14] See pp. 4 of SBUA Protest
[15] See pp. 2 of Enel X Protest

c. Specify whether SCE intends to adjust elements of the RATES tariff for different customer classes, to achieve revenue neutrality for a class-average customer from each class

SCE Reply to SBUA and ENEL X Protests

In its reply to the SBUA and ENEL X protests, SCE argued that the SBUA and ENEL protests do not provide a basis under General Order 96-B, Rule 7.4.2 for rejecting the Advice Letter. SCE stated that neither party argued that SCE failed to discuss each of the elements that the Decision directed SCE to address, and the Decision does not direct SCE to address the additional matters that these parties assert should be discussed in a supplemental advice letter. As such, there are no "material errors or omissions" in the Advice Letter that would warrant its rejection, and none of the other protest grounds identified by Rule 7.4.2 is applicable.[16]

SCE replied to the concerns raised in SBUA's protest as follows:

1. **AL 4684-E does not explain how SCE will study the enhancement of system reliability.** SCE stated that it will be conducting comprehensive studies that assess the costs and benefits of real-time rates, including required infrastructure, and impacts to system reliability. SCE stated that these studies will evaluate flexible load management that is enabled by automation that allows customers to more actively participate in programs governed by dynamic electricity tariffs and thereby contribute to system reliability.[17]

2. **The AL does not explain how non-marginal costs will be recovered**. SCE noted that various theories recommend different approaches to the recovery of non-marginal costs, and because there is no one-size-fits-all approach to the recovery of non-marginal costs, SCE may explore, through the Pilot, options for the recovery of such costs that range from a fixed charge approach to blended approaches that tailor the recovery of non-marginal costs in the dynamic price rate.[18]

3. **AL 4684-E does not clearly describe eligibility requirements, which should be open to broad participation.** SCE noted that a number of Pilot eligibility factors need to be considered when enrolling participants. SCE expects to include a broad selection of bundled customers in the Pilot, and that the actual number of customers may be limited by the budgetary constraints of shadow bill payments for customer participation costs. These and other factors are currently under review, and SCE is in discussions with ASPs and TeMix to focus on key eligible customer groups that can participate in the Pilot by May 1, 2022.[19]

4. **The $2.5 million budget is not justified.** SCE noted that SBUA's contention that the Advice Letter does not justify the proposed $2.5 million budget lacks merit because the

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[16] See pp. 2 of SCE Reply
[17] See pp. 3 of SCE Reply
[18] See pp. 3 of SCE Reply
[19] See pp. 3 of SCE Reply

Decision already approved this budget.[20] SCE provided clarification that expenditures of this budget are currently in the process of being defined through negotiations with various parties, including TeMix, providing services in support of the Pilot. Other costs such as shadow bill preparation and payments, UNIDE facilities platform integration with ASPs, meter data and SCADA interface with SCE, project management, M&V, and other related activities are still being developed. SCE noted that the budget authorized for the Pilot is reasonable and will mitigate potential impact to participating ratepayers.[21]

5. **The AL does not discuss the evaluations.** SCE noted that the Decision does not require SCE to address evaluation in the Advice Letter and that SBUA's criticism provides no basis for CPUC to reject the Advice Letter. SCE provided clarification that the Pilot works on the broadly accepted principle that positive and contributory load response to an adequately designed price signal presents a low-cost alternative to deploying additional capacity on the system, be it for peak load or excess supply. The Pilot will thus focus on conducting evaluation studies to assess the load responsiveness to real-time rates, including required infrastructure, manufacturer interest, and customer impacts.[22]

SCE replied to the concerns raised in Enel X's protest as follows:

1. **Pilot scope**. SCE argued that ENEL's contention that the Advice Letter fails to provide sufficient detail about the Pilot's scope is incorrect, as the Advice Letter addresses scope at length in compliance with the Decision. SCE also provided additional clarification regarding participant eligibility and noted that although there is no specific cap on the number of participants, the totals will be limited based on a customer's technological compatibility and estimated costs of shadow billing payments based on the participant mix. SCE also noted that participant eligibility is limited to SCE bundled service customers so that those energy costs can be tracked via a shadow bill. SCE expects that the scope of customers enrolled in this phase of the Pilot may include an aggregation of multiple circuits.

2. **Pilot partners**. SCE argued that the Advice Letter addresses Pilot partners at length, in compliance with the Decision. SCE clarified that it intends to enroll participants through ASPs rather than through direct marketing and outreach to minimize enrollment delays and marketing costs to meet the Pilot's start date of May 1, 2022.

3. **Shadow bill**. SCE clarified that the Pilot and shadow bill implementation will not increase any rate or change, cause the withdrawal of service, or conflict with any other schedule or rule. The shadow bill process is designed to provide compensation for any incremental electricity costs that may be incurred as a result of customers participating in this Pilot while being billed on their OAT. There will be no additional charges to customers that may incur higher bills compared to their OAT.

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[20] See D.21-12-015, p. 96 "(We grant SCE authorization to use TeMix's RATES platform for a three-year (2022-2024) dynamic pricing pilot in SCE's territory, and grant SCE its requested $2.5 million for the pilot."); see also id., OP 60.
[21] See pp. 4 of SCE Reply
[22] See pp. 4 of SCE Reply

4. **Pilot tariff design**. SCE noted that it will be implementing the Pilot without establishing a unique or separate tariff schedule for participants, as those customers will remain on their OAT. The dynamic price signals provided to the ASPs and subsequent customers will be developed by TeMix, through the technology platform under contract to SCE. TeMix will develop the UNIDE/RATES Subscription Transactive Rate (STR) for the Pilot, which will use the day-ahead Hourly CAISO Locational Prices (LMPs) as well as the day-of 15-minute and 5-minute LMPs. Leading up to the Pilot's projected May 1, 2022 start date, SCE and TeMix will be developing the initial specification of the STR for the Pilot.

SCE Supplemental AL 4684-E-A

To provide further information regarding Pilot elements and to address Energy Division questions regarding: (1) Formula of Price Curves and Rationale for Shape Chosen, (2) Inflection Points for Curves and Rationale for those Inflection Points, (3) Revenue Targets for Each of the Component Curves, (4) Illustrative Prices, (5) Addressing "Revenue Neutrality", SCE filed Supplemental AL 4684-E-A on April 25, 2022, and included the following details:

1. **Formula for Price Curves and Rational for Shape Chosen**. SCE's chosen quadratic price curve was used as a means to recover fixed costs along the entire duration of the load curve as opposed to the typical applications of concentrated fixed cost recovery used in standardized TOU rate design. Concentrated recovery of fixed costs using a flat-adder threshold basis can cause steep cross-hour price differentials that are almost surely bypassed by resources that are acutely flexible and can create compounding effects on cross-hour load impacts on the grid. SCE believes that the formulas can be iterated upon but stressed that the continuity of recovery along the entire duration of the load curve.

2. **Inflection Points for Curves and Rationale for those Inflection Points**. SCE's inflection points were selected to enable fixed cost price signals for both Peak Load and Minimum Load conditions. The inflection points also provide a capacity signal that helps mitigate renewable curtailment by providing price-sensitive sink-resources a negative capacity price to soak-up excess renewable supply while maintaining some correlation to how the system experiences load through the course of the year.

3. **Revenue Targets for Each of the Component Price Curves.** Revenue targets will be assessed based on the revenue components authorized by the Commission for each revenue component included in the customer's OAT.

4. **Illustrative Prices.** SCE provided its confidential Illustrative Pricing Model to Energy Division on April 8, 2022, as a data request response.

5. **Addressing "Revenue Neutrality"**. The customer's bill under the Dynamic Price Plus Subscription offering would approximate the customer's bill under the OAT, assuming the customer does not change from a pre-determined baseline of electricity usage. Revenue neutrality for the subscription portion of the customer's bill is achieved through the revenue neutral design of the OAT. Revenue neutrality for the dynamic price portion of the customer's bill is achieved by scaling the raw marginal cost curves by the Equal Percent Marginal Cost (EPMC) scalar for each revenue component from SCE's GRC. Non-bypassable costs and other costs associated with State and Commission programs and

policies will be included as a flat rate adder that equals the corresponding rate components currently contained in the customer's OAT and will be applied to each hour of the dynamic price curve. Grid related distribution costs as determined in SCE's GRC will be included as a flat rate (cents/kWh) in the total dynamic rate. Transmission-related costs will continue to be assessed based on the billing determinants as described in the customer's OAT and will be excluded from the Dynamic Price curve.

Discussion

After reviewing SCE AL 4684-E and Supplementary AL 4684-E-A, Energy Division finds SBUA's requests to require SCE to clarify details outside of the Pilot elements is not required pursuant to OP 63 of the Decision. The issues raised by SBUA, namely (1) enhancement of system reliability, (2) recovery of non-marginal costs, (3) eligibility requirements, (4) pilot budget, and (5) pilot evaluations, were not issues that CPUC required SCE to address in its advice letter, and are not proper grounds for protest under General Order (GO) 96-B, General Rule (Rule) 7.4.2. GO 96-B, Rule 7.4.2 provides that a protest to an advice letter may rest on grounds that: (1) the utility did not properly serve or give notice of the advice letter; (2) the relief requested would violate, or is not authorized by, statute or Commission order; (3) the analysis, calculations, or data in the advice letter contain material errors or omissions; (4) the relief requested is pending before the Commission in a formal proceeding; (5) the relief requested is inappropriate for the advice letter process; and/or (6) the relief requested is unjust, unreasonable, or discriminatory. SBUA has not identified any "material errors or omissions" in the advice letter that would warrant its rejection, nor sustained any contention that the advice letter fails to comply with the Decision. As such, Energy Division rejects SBUA's protest pursuant to Rule 7.6.1 of Commission GO 96-B.

Energy Division also finds Enel X's protest does not provide a basis for rejecting the SCE AL 4684-E under Rule 7.4.2 as the advice letter and supplemental advice letter discusses each of the elements that the Decision directed SCE to address. Since Enel X identifies no "material errors or omissions" in the advice letter, there are no grounds that warrant its rejection.

Energy Division finds that SCE's discussion of the Pilot price design offered in the supplemental AL 4684-E-A provides additional details regarding the formulation and design principles of the dynamic prices and will enable eligible customers and service providers to evaluate the benefits of participating in the Pilot.

Disposition

Energy Division hereby approves Advice Letter 4684-E and Supplemental Advice Letter 4684-E-A, submitted by Southern California Edison Company.

SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL® Company

Shinjini C. Menon
Managing Director, State Regulatory Operations

January 5, 2022

ADVICE 4684-E
(U 338-E)

PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA
ENERGY DIVISION

SUBJECT: Southern California Edison Company's Dynamic Rate Pilot Pursuant to Decision 21-12-015

PURPOSE

In compliance with Ordering Paragraphs (OPs) 59, 60, and 63 of Decision (D.) 21-12-015 (the Decision), Southern California Edison Company (SCE) hereby submits this advice letter (AL) for its Dynamic Rate Pilot (the Pilot). The purpose of this AL is to describe the scope, partners, shadow bill implementation, dates, and tariff design for the Pilot. SCE is requesting approval, in compliance with the Decision, for Pilot activities to start no later than May 1, 2022.

BACKGROUND

On November 19, 2020, the California Public Utilities Commission (Commission) initiated Rulemaking (R.)20-11-003 to establish policies, processes, and rules to ensure reliable electric service in California in the event of an extreme weather event in 2021.

On July 30, 2021, Governor Newsom signed an emergency proclamation to "free up energy supply to meet demand during extreme heat events and wildfires that are becoming more intense and to expedite deployment of clean energy resources this year and next year."[1] The Governor's emergency proclamation directed all energy agencies, including the Commission, to take steps to achieve energy stability during this emergency. In response to the Governor's emergency proclamation, on August 2, 2021, the assigned Administrative Law Judge initiated Phase 2 of R.20-11-003. After receiving testimony, briefs, and comments on a proposed decision from the parties, the

[1] See Governor Newsom's Press Release at https://www.gov.ca.gov/2021/07/30/governor-newsom-signs-emergency-proclamation-to-expedite-clean-energy-projects-and-relieve-demand-on-the-electrical-grid-during-extreme-weather-events-this-summer-as-climate-crisis-threatens-western-s/ and the Proclamation of a State of Emergency at https://www.gov.ca.gov/wp-content/uploads/2021/07/Energy-Emergency-Proc-7-30-21.pdf.

Commission on December 6, 2021 issued the Decision, which directs the IOUs to take actions to prepare for potential extreme weather in the summers of 2022 and 2023.

In accordance with OPs 59 and 60 and Attachment 1 of the Decision, SCE is authorized to conduct the Pilot to study how price responsive pilot projects can enhance system reliability in 2022 and 2023. OP 63 directs SCE to submit a Tier 2 Advice Letter within 30 days of the issuance of the Decision that includes, but is not limited to, the following elements: (1) pilot scope, (2) pilot partners, (3) shadow bill implementation, (4) pilot dates, and (5) pilot tariff design.[2] This AL is submitted to meet the requirements of OP 63 and addresses each of these five elements.

Discussion

In OP 59 and Attachment 1 of the Decision, the Commission authorized SCE to use TeMix's Retail Automated Transactive Energy System (RATES) platform for a three-year (2022-2024) dynamic pricing pilot in SCE's territory and granted SCE its request for a budget of $2.5 million for the Pilot. The Pilot is intended to assist in assessing the costs and benefits of real-time rates, including required infrastructure, manufacturer interest, and customer impacts. The Pilot will be administered by SCE under its Demand Response (DR) Emerging Markets and Technology program, authorized in D.17-12-003.

1. *Pilot Scope*

The TeMix proposal as cited in the Decision offered to support the unified, universal, dynamic economic (UNIDE) staff roadmap vision, which was originally proposed by the Commission's Energy Division (and demonstrated in a May 25 workshop).[3] The Pilot will use the RATES™ platform developed by TeMix,[4] a software platform piloted by the California Energy Commission (CEC) Electric Program Investment Charge (EPIC) grant EPC-15-054 and demonstrated in SCE's territory. This same platform is available for implementing the UNIDE concept as a pilot. Figure 1 illustrates the system architecture of the original TeMix RATES pilot conducted from 2017 through 2020.

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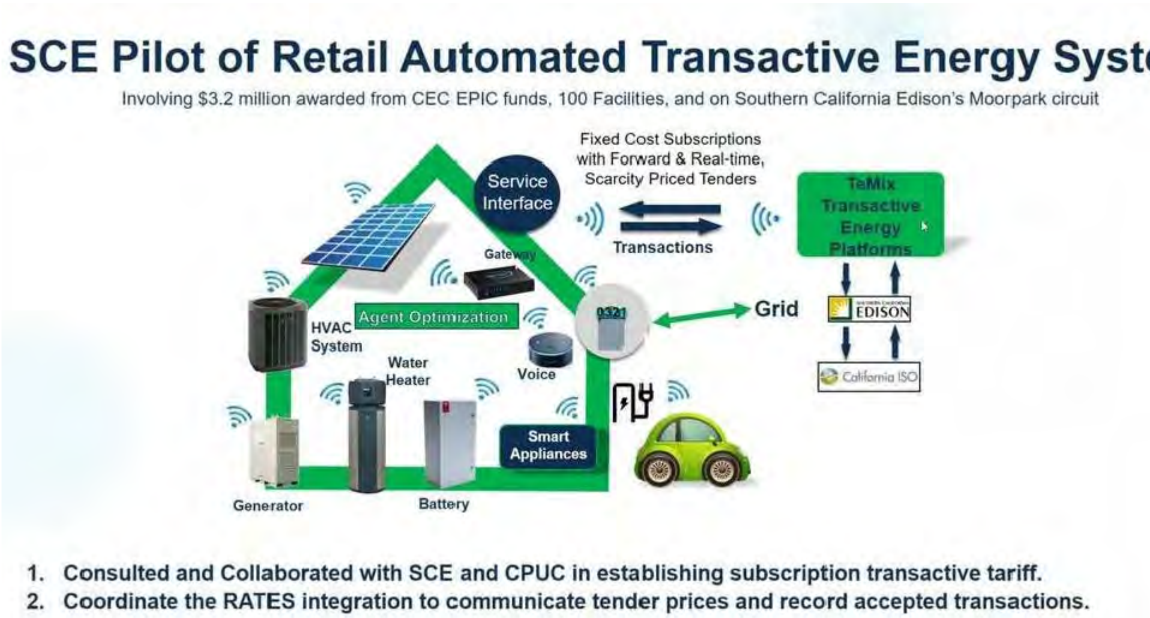
[2] D.21-12-015, OP 59; OP 63; Attachment 1, p. 12 ("SCE will submit a Tier 2 Advice Letter no later than 30 days after this decision that includes, but is not limited to, the following elements: (1) pilot scope, (2) pilot partners, (3) shadow bill implementation, (4) pilot dates, and (5) pilot tariff design.").

[3] D.21-12-015, Attachment 1, p. 10.

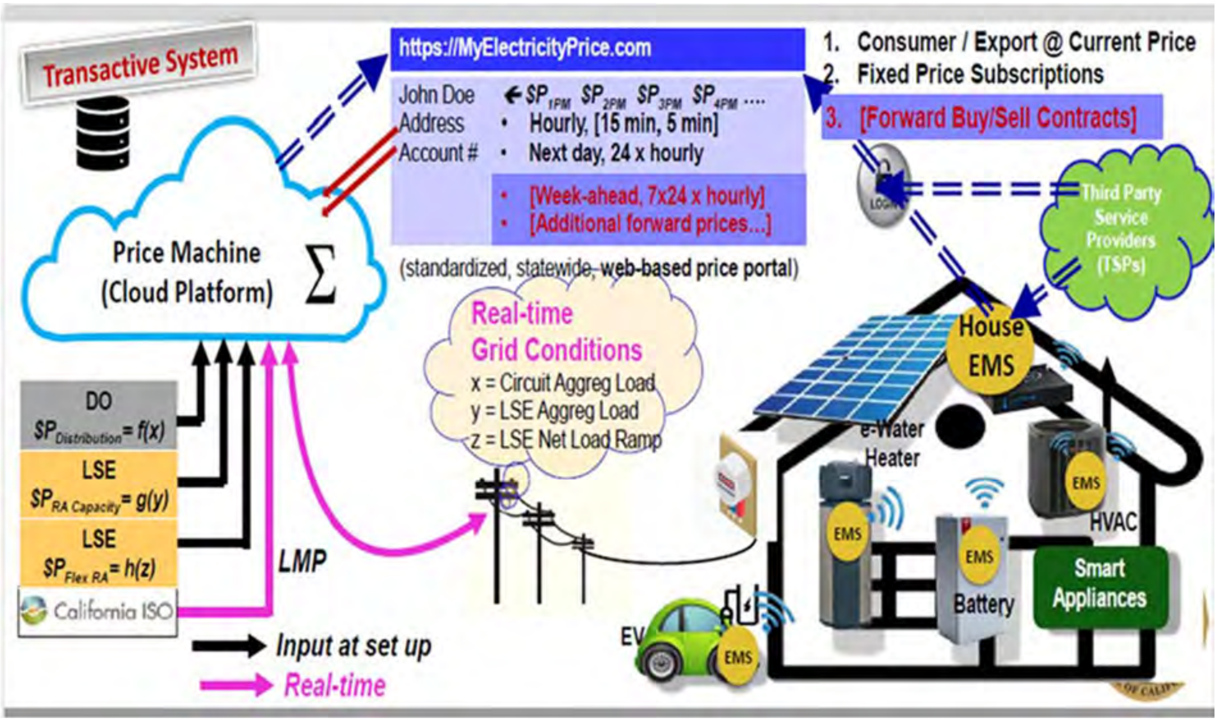
[4] TeMix Opening Testimony at 1-2; SCE Reply Testimony at 8-10.

Figure 1



The original TeMix RATES pilot sponsored by the CEC in 2016 can now be leveraged to develop economic options for both transactive price models and real time pricing with other parties and stakeholders, and to demonstrate how new forms of distributed energy resources can act as both customer assets and grid interactive resources. This "follow up" approach will allow SCE to develop transactive price models and real time pricing to meet the objectives of the Pilot. As such, SCE's Pilot will follow the TeMix platform and RATES tariff design, and will be a three-year (2022-2024) effort to examine the efficacy of the UNIDE roadmap using the RATES system architechture. An overview of the advanced UNIDE concept as proposed by the Energy Division is illustrated in Figure 2.

Figure 2



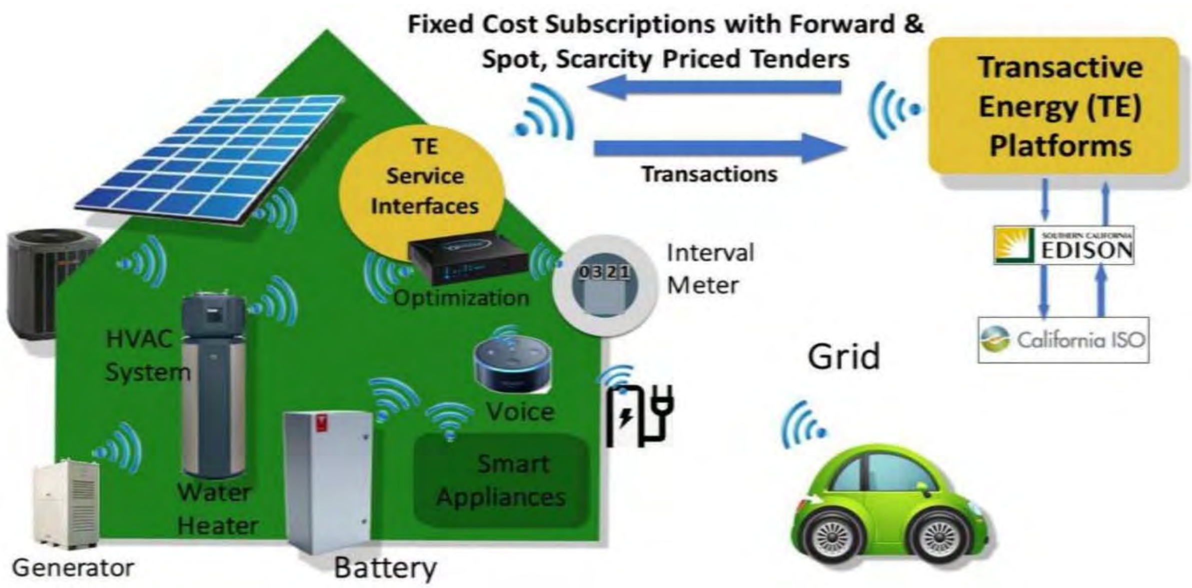
The Pilot will combine real time pricing design and transactional subscription elements from both the RATES and UNIDE tariff concepts. This is a prudent approach to enhancing and scaling up a system wide demand flexibility approach to improve system reliability and enhance customer benefits. The Pilot will also investigate how customer-based distributed energy resources can act as both flexible assets and grid interactive resources when these new pricing signals are transmitted to end use customers as proposed in the UNIDE model. So that these hypotheses are fully examined, the Pilot metrics will be structured to develop a series of empirical analyses to assess the costs and benefits of real-time dynamic rate communications, with the ultimate objectives of transferring the research investments from the 2016 CEC EPIC RATES pilot into flexible customer demand side opportunities that can accelerate solutions for system reliability for the summers of 2022 and 2023.

The key operational tasks of the Pilot will be to automate the creation of dynamic prices for the generation and delivery components of a transactive tariff, and present these composite dynamic hourly prices via an internet-based secure pathway to be accessed by retail customers, wholesale market particpants, and automated services platforms for distributed energy resources (DERs). Customers and their end use devices would be connected to the TeMix cloud platform to receive price tenders either directly, via local management, or from aggregated management signals from third-party automated services platform clouds via Internet/Wifi/LTE to the secure receivers at the customer site.

Figure 3 provides an illustration of the cloud based transport architecture is proposed for the Pilot based on the previous RATES transactive energy platform and demonstrates how it would interact with residential customers. In this illustration, appliances and devices such as electric HVAC heat pumps, electric vehicles, electric water heating devices, both heat pump and resistance, pool pumps, and smart speakers and residential energy management systems (EMS) have the potential to provide load flexibility. Other customer sectors besides single family residential could be enrolled in the Pilot, including multi-family, small business, institutional accounts, water agencies, process treatment facilities, large refrigeration, and commercial building energy management systems (including those with thermal storage systems).

To facilitate the objectives of the research hypotheses with "real world" assessments and impacts from a wide range of electrical end uses, the Pilot will include eligible SCE retail customers as participants in the first phase. SCE will examine and pursue opportunities to identify and enroll residential, commercial, and industrial customers as appropriate with smart enabling price-responsive end-uses. These end-uses include electric vehicle charging, behind-the-meter batteries, and controllable loads that may have the enabling software to interface with TeMix. Due to the accelerated Pilot schedule, as shown in Figure 5, and the urgency to meet summer 2022 reliaibity needs, SCE intends to work with automated service providers (ASPs) that may have existing SCE customers available with installed communicating enabling technologies that are compatible with the TeMix UNIDE software messaging platform.

Figure 3



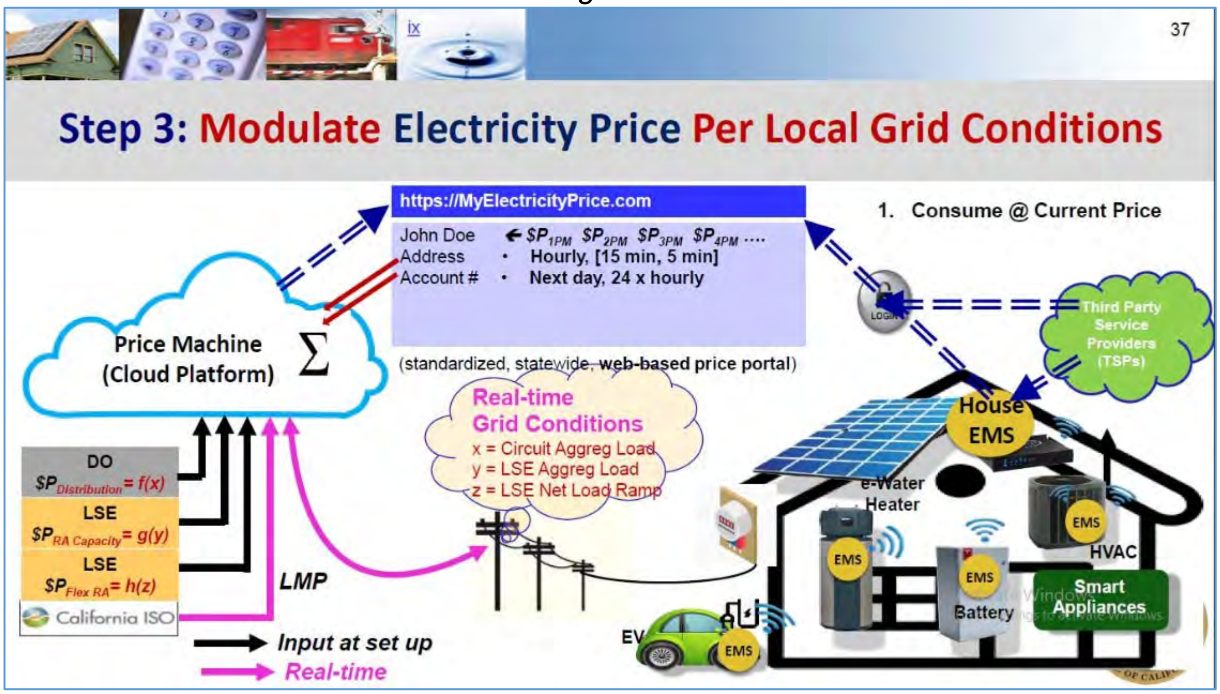
SCE and TeMix have successfully collaborated on RATES and other research activities with a wide range of automated service interfaces (API) service providers that have demonstrated secure communications for energy management products and services. These include APIs from a number of service providers that are compatible with the TeMix messaging service. The ASPs in many cases have already equipped their customers with the capability to automatically manage the electrical end use operations of customer facilities (single family homes, multi-family residences, large commercial offices, industrial facilities such as water services and refrigeration warehouses). Many of the managed services provided by ASPs include the optimization of end use loads such as air conditioning, process operations, behind the meter (BTM) solar paired with storage through smart inverter APIs, and electric vehicle managed charging and fleet services. These customer sectors and others will be approached for their availability to respond to the Pilot dynamic UNIDE price signals to achieve the flexible rate responsiveness desired to demonstate the efficacy of the Pilot and to ultimately enhance customer savings.

This aggregated approach for customer enrollment through ASP engagement would reduce the cost for individual customer outreach and enrollment processes thereby expediting the fulfillment of the schedule milestones as indicated in the project schedule in Figure 5. SCE expects that customer enrollment may be a continuous process, and will be phased to ensure that there are minimal gaps in the data analysis and to capture any changes in customer participation over the term of the study. TeMix will configure the Pilot UNIDE Platform and work with ASPs to accept enrollments of customers and their flexible devices through the applicable APIs. The platform will also be configured for the SCE distribution circuits needed for the Pilot and their specific (pNode) interface. The TeMix platform already demonstrated that it has interfaces to the CAISO that should be sufficient to start by May 1, 2022.

As noted earlier, the Decision requires that the design of SCE's Dynamic Rate Pilot be based on the 6-step UNIDE roadmap. Step 3 of the roadmap calls for implementing "scarcity price functions" designed to recover more fixed cost (of generation and distribution capacity) when system utilization is higher. As the illustration of the system architecture (included in the roadmap) shows in Figure 4, system utilization is represented by time-dependent independent variables ("x", "y", "z" in lower left of the diagram) that represent time-dependent load conditions on the grid.

During this pilot, SCE, through its Grid Operation and Strategy teams, will examine how the dependent real time grid and aggregated circuit load conditions derived from its distribution grid SCADA systems can provide the inputs to the scarcity pricing functions to generate the time-dependent hourly capacity charges (for both generation and distribution components).

Figure 4



TeMix and SCE have worked together during the RATES pilot. This experience will allow SCE and TeMix to collaborate closely to identify how the granularity, latency, and accuracy of these inputs can be provided to facilitate the summer 2022 timeline for the Pilot. The SCE internal teams will examine the SCADA real time data availability and develop an implementation plan that addresses the expectations in the Decision as discussed earlier. TeMix will work with SCE to provision the currently available data sources and methods to measure or estimate actual and forecasted loads on specific circuits involved in the Pilot. In addition, TeMix will also provide an API that will enable SCE to transfer the available circuit data to their platform in a cyber-secure manner.

2. *Pilot Partners*

To implement the Pilot, SCE will immediately execute a service contract with TeMix to use the TeMix platform software service. The Pilot will use the TeMix RATES™ platform architecture, as piloted through a CEC EPIC grant[5] in SCE's service territory starting in 2018 with over 100 participating residential customers. TeMix proposes for the Pilot to provide this software services platform for a period of three years or longer, with the option for extended services as needed. The platform will transmit dynamic tariff prices securely to participating SCE retail customers during the Pilot and will also record these UNIDE tender transactions for settlement purposes. The service is securely hosted by TeMix on the Microsoft Azure™ cloud, and operational "24/7," 365

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[5] See CEC EPIC grant EPC-15-054.

days per year. According to TeMix, this platform will be operational for the Pilot implementation in Summer of 2022.

SCE will also work with other stakeholders such as current ASPs, major electric vehicle (EV) manufacturers and/or smart charger service providers, solar/battery aggregators or service providers, and others with the capability to directly receive the UNIDE tenders from TeMix and optimize (on behalf of the customer) end use flexibility strategies (such as EV and storage charging and discharging schedules). TeMix will provide optimization agents for use by the vendors to assess their applicability for eligibility, security, and compatability with current APIs (reducing the need for software development).

Currently the Electric Power Research Institute (EPRI) is conducting a number of CEC EPIC research projects that use a similar secure communications platform (OpenADR) and have previously worked with both the CEC and TeMix on research projects to faciliate flexibility and responsiveness to dynamic test signals. The customer sectors in prior research included industrial (refrigerated warehouses and water/wastewater facilities) and large commercial office parks and institutional customers (hospitals, state facilities, etc). SCE will coordinate with EPRI and examine opportunities to enage these and other customer groups to receive the TeMix signals similar to what EPRI has done through OpenADR.

SCE also intends to collaborate with Lawence Berkeley National Laboratory (LBNL) to leverage LBNL's research with the CalFlexHub. This collaboration will allow SCE to coordinate price messaging protocols and develop an expeditious pathway for alternative messaging transport services that may result in additional customer eligibility for the Pilot (e.g., underserved rural areas and disadvantaged communites lacking Wi-Fi access). The researchers at LBNL have previously worked under contract to EPRI and SCE on conducting market studies and technical assessments of real time secure demand response and dynamic pricing communications and new forms of enabling customer technologies. This research can inform the development and design of the Pilot.

In addition, there are other technology and software providers who already manage groups of SCE customers for demand management services and other value streams. These providers and other ASPs will be engaged to collaborate with SCE and TeMix and will be included in the project team as providers and advisors. Additonally, SCE will work to engage other innovative partners who have expressed interest in collaborating in the Pilot. SCE expects that these partners can provide consulting and technical services in the areas of market and grid operations, licenses for automated service platforms, economic reviews and system impact analyses (e.g., avoided cost calculations), and the estimation of load shift impacts and energy reduction savings.

To that end, SCE will form two technical advisory committees (TACs): (1) an internal TAC to expedite coordination for execution of the Pilot and share real time learnings with the SCE project team; and (2) an external TAC to oversee the Pilot's design, deployment, and execution as well as assess evaluations and make recommendations to ensure that the Pilot is on track to meet its goals.

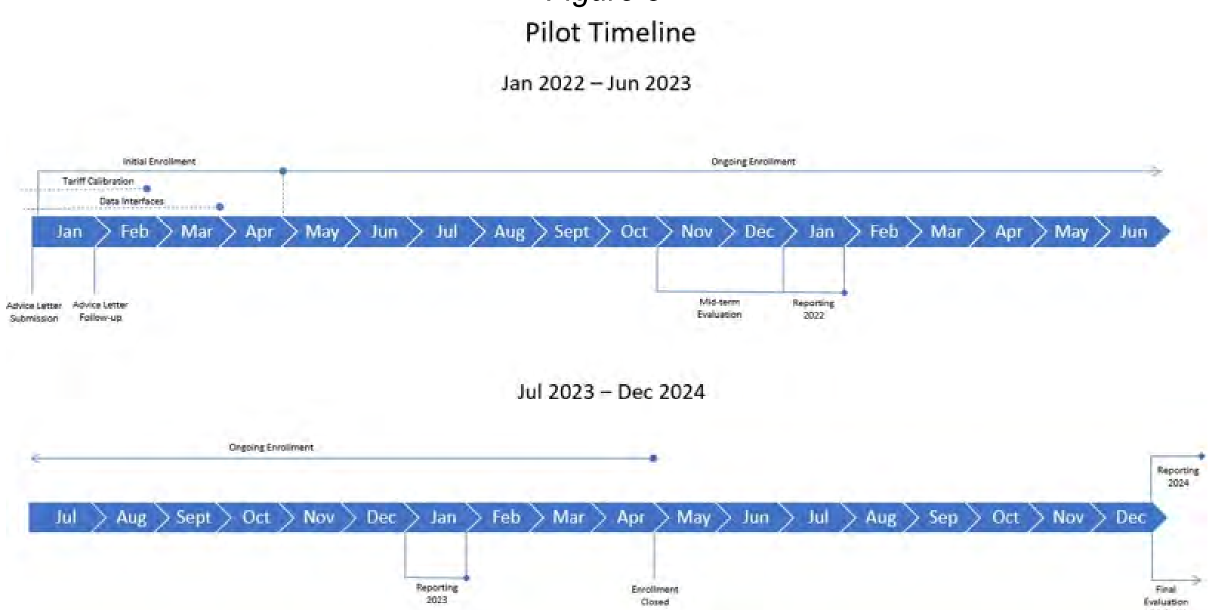
3. Shadow Bill Implementation

While on the Pilot, customers will remain on and continue to be billed in accordance with their Otherwise Applicable Tariff (OAT). Concurrently, TeMix will configure the platform to calculate and provide monthly bill amounts based on the hourly price signals provided to customers participating in the Pilot. Any customer savings recognized from the hourly price signals compared to the customer's OAT will be provided to the customer on at least an annual basis.

4. Pilot Dates

As shown in Figure 5, the three year Pilot timeline is defined in OP 63 of the Decision. This Pilot timeline is under development and may be subject to change.

Figure 5



5. Pilot Tariff Design

SCE proposes to implement this Pilot without establishing a pilot tariff schedule because the Pilot will assess "the monthly bill impacts of the Pilot dynamic rate in comparison to a customer's otherwise applicable tariff."[6] Per the Decision, the subscription transactive price, a core element of the UNIDE roadmap, will be further analyzed and developed in the Pilot. This dynamic price can be calibrated to reduce cost shifts while stabilizing utility revenues and customer bills. By using the appropriate

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[6] D.21-12-015, OP 62, p. 180.

mix of generation and delivery price signals for both day-ahead and/or real-time prices, the dynamic price tariff should align demand side management with capacity planning and other operational constraints that span the wholesale and retail delivery systems. TeMix will provide the technology platform, assist SCE in calibrating the price parameters, and assist in developing the subscription portion of the price for each customer. No tariff schedule is needed for this Pilot because customers will be billed based on their current SCE Rate Schedule. SCE will not implement billing system enhancements and participating customers will receive a shadow bill on the dynamic price rate.

This AL will not increase any rate or change, cause the withdrawal of service, or conflict with any other schedule or rule.

TIER DESIGNATION

Pursuant to OP 63 and Attachment 1, page 12 of the Decision, this advice letter is submitted with a Tier 2 designation.

EFFECTIVE DATE

This advice letter will become effective on February 4, 2022, the 30th calendar day after the date submitted.

NOTICE

Anyone wishing to protest this advice letter may do so by letter via U.S. Mail, facsimile, or electronically, any of which must be received no later than 20 days after the date of this advice letter. Protests should be submitted to:

CPUC, Energy Division
Attention: Tariff Unit
505 Van Ness Avenue
San Francisco, California 94102
E-mail: EDTariffUnit@cpuc.ca.gov

Copies should also be mailed to the attention of the Director, Energy Division, Room 4004 (same address above).

In addition, protests and all other correspondence regarding this advice letter should also be sent by letter and transmitted via facsimile or electronically to the attention of:

Shinjini C. Menon
Managing Director, State Regulatory Operations
Southern California Edison Company
8631 Rush Street
Rosemead, California 91770
Telephone (626) 302-3377
Facsimile: (626) 302-6396
E-mail: AdviceTariffManager@sce.com

Tara S. Kaushik
Managing Director, Regulatory Relations
c/o Karyn Gansecki
Southern California Edison Company
601 Van Ness Avenue, Suite 2030
San Francisco, California 94102
Facsimile: (415) 929-5544
E-mail: Karyn.Gansecki@sce.com

There are no restrictions on who may submit a protest, but the protest shall set forth specifically the grounds upon which it is based and must be received by the deadline shown above.

In accordance with General Rule 4 of GO 96-B, SCE is serving copies of this advice letter to the interested parties shown on the attached GO 96-B, R.20-11-003, A.17-01-012, et al., R.13-09-011 service lists. Address change requests to the GO 96-B service list should be directed by electronic mail to AdviceTariffManager@sce.com or at (626) 302-4039. For changes to all other service lists, please contact the Commission's Process Office at (415) 703 2021 or by electronic mail at Process_Office@cpuc.ca.gov.

Further, in accordance with Public Utilities Code Section 491, notice to the public is hereby given by submitting and keeping the advice letter at SCE's corporate headquarters. To view other SCE advice letters submitted with the Commission, log on to SCE's web site at https://www.sce.com/wps/portal/home/regulatory/advice-letters.

For questions, please contact Kellvin Anaya at (909) 274-3438 or by electronic mail at Kellvin.Anaya@sce.com.

Southern California Edison Company

/s/ Shinjini C. Menon
Shinjini C. Menon

SCM:ka:jm

California Public Utilities Commission

ADVICE LETTER SUMMARY

ENERGY UTILITY

MUST BE COMPLETED BY UTILITY (Attach additional pages as needed)

Company name/CPUC Utility No.: Southern California Edison Company (U 338-E)

Utility type:

☑ ELC ☐ GAS ☐ WATER

☐ PLC ☐ HEAT

Contact Person: Darrah Morgan
Phone #: (626) 302-2086
E-mail: AdviceTariffManager@sce.com
E-mail Disposition Notice to: AdviceTariffManager@sce.com

EXPLANATION OF UTILITY TYPE

ELC = Electric GAS = Gas WATER = Water
PLC = Pipeline HEAT = Heat

(Date Submitted / Received Stamp by CPUC)

Advice Letter (AL) #: 4684-E

Tier Designation: 2

Subject of AL:

Southern California Edison Company's Dynamic Rate Pilot Pursuant to Decision 21-12-015

Keywords (choose from CPUC listing): Compliance

AL Type: ☐ Monthly ☐ Quarterly ☐ Annual ☑ One-Time ☐ Other:

If AL submitted in compliance with a Commission order, indicate relevant Decision/Resolution #:
Decision 21-12-015

Does AL replace a withdrawn or rejected AL? If so, identify the prior AL:

Summarize differences between the AL and the prior withdrawn or rejected AL:

Confidential treatment requested? ☐ Yes ☑ No

If yes, specification of confidential information:
Confidential information will be made available to appropriate parties who execute a nondisclosure agreement. Name and contact information to request nondisclosure agreement/access to confidential information:

Resolution required? ☐ Yes ☑ No

Requested effective date: 2/4/22

No. of tariff sheets: -0-

Estimated system annual revenue effect (%):

Estimated system average rate effect (%):

When rates are affected by AL, include attachment in AL showing average rate effects on customer classes (residential, small commercial, large C/I, agricultural, lighting).

Tariff schedules affected: N/A

Service affected and changes proposed[1]:

Pending advice letters that revise the same tariff sheets: None

[1]Discuss in AL if more space is needed.

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Protests and all other correspondence regarding this AL are due no later than 20 days after the date of this submittal, unless otherwise authorized by the Commission, and shall be sent to:

CPUC, Energy Division Attention: Tariff Unit 505 Van Ness Avenue San Francisco, CA 94102 Email: EDTariffUnit@cpuc.ca.gov	Name: Shinjini C. Menon Title: Managing Director, State Regulatory Operations Utility Name: Southern California Edison Company Address: 8631 Rush Street City: Rosemead State: California Zip: 91770 Telephone (xxx) xxx-xxxx: (626) 302-3377 Facsimile (xxx) xxx-xxxx: (626) 302-6396 Email: advicetariffmanager@sce.com
	Name: Tara S. Kaushik c/o Karyn Gansecki Title: Managing Director, Regulatory Relations Utility Name: Southern California Edison Company Address: 601 Van Ness Avenue, Suite 2030 City: San Francisco State: California Zip: 94102 Telephone (xxx) xxx-xxxx: Facsimile (xxx) xxx-xxxx: (415) 929-5544 Email: karyn.gansecki@sce.com

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ENERGY Advice Letter Keywords

Affiliate	Direct Access	Preliminary Statement
Agreements	Disconnect Service	Procurement
Agriculture	ECAC / Energy Cost Adjustment	Qualifying Facility
Avoided Cost	EOR / Enhanced Oil Recovery	Rebates
Balancing Account	Energy Charge	Refunds
Baseline	Energy Efficiency	Reliability
Bilingual	Establish Service	Re-MAT/Bio-MAT
Billings	Expand Service Area	Revenue Allocation
Bioenergy	Forms	Rule 21
Brokerage Fees	Franchise Fee / User Tax	Rules
CARE	G.O. 131-D	Section 851
CPUC Reimbursement Fee	GRC / General Rate Case	Self Generation
Capacity	Hazardous Waste	Service Area Map
Cogeneration	Increase Rates	Service Outage
Compliance	Interruptible Service	Solar
Conditions of Service	Interutility Transportation	Standby Service
Connection	LIEE / Low-Income Energy Efficiency	Storage
Conservation	LIRA / Low-Income Ratepayer Assistance	Street Lights
Consolidate Tariffs	Late Payment Charge	Surcharges
Contracts	Line Extensions	Tariffs
Core	Memorandum Account	Taxes
Credit	Metered Energy Efficiency	Text Changes
Curtailable Service	Metering	Transformer
Customer Charge	Mobile Home Parks	Transition Cost
Customer Owned Generation	Name Change	Transmission Lines
Decrease Rates	Non-Core	Transportation Electrification
Demand Charge	Non-firm Service Contracts	Transportation Rates
Demand Side Fund	Nuclear	Undergrounding
Demand Side Management	Oil Pipelines	Voltage Discount
Demand Side Response	PBR / Performance Based Ratemaking	Wind Power
Deposits	Portfolio	Withdrawal of Service
Depreciation	Power Lines	

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SOUTHERN CALIFORNIA EDISON®
An EDISON INTERNATIONAL® Company

Shinjini C. Menon
Managing Director, State Regulatory Operations

April 25, 2022

ADVICE 4684-E-A
(U 338-E)

PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA
ENERGY DIVISION

SUBJECT: Supplemental to Tier 2 Advice Letter for Southern California Edison Company's Dynamic Rate Pilot Pursuant to Decision 21-12-015

PURPOSE

Southern California Edison Company (SCE) submits this supplemental advice letter (AL) to provide additional information on its Dynamic Rate Pilot (the Pilot), initially described in Advice 4684-E filed January 5, 2022 in compliance with Decision (D.) 21-12-015 (the Decision).

The purpose of this supplemental AL is to provide additional information requested by California Public Utilities Commission (Commission) staff on (1) Formula of Price Curves and Rationale for Shape Chosen, (2) Inflection Points for Curves and Rationale for those Inflection Points, (3) Revenue Targets for Each of the Component Curves, (4) Illustrative Prices, (5) Addressing "Revenue Neutrality."

SCE requests approval, in compliance with the Decision, for Pilot activities to start no later than May 1, 2022. This advice letter supplements in part and does not change the substance of the original AL 4684-E.

BACKGROUND

The Commission issued the Decision on December 6, 2021. Ordering Paragraph (OP) 59, OP 60, and Attachment 1 of the Decision authorized SCE to conduct the Pilot to study how price responsive pilot projects can enhance system reliability in 2022 and 2023. In compliance with OP 63 of the Decision, SCE submitted Advice 4684-E to address the Pilot's scope, partners, shadow bill implementation, dates, and tariff design. At the request of the Commission's Energy Division, SCE is filing this supplemental AL to provide additional details on the Pilot's design.

Discussion

SCE began work to implement the Pilot shortly after the Decision was issued, including weekly discussions regarding the Pilot design elements and operational requirements with TeMix, Inc. (TeMix). In addition, SCE has approached and discussed the Pilot with a wide range of Automated Service Providers (ASPs) in order to enroll residential, commercial, and industrial customers with smart enabling price-responsive end-uses, such as electric vehicle charging, behind-the-meter batteries, and controllable loads. The transactive platform services contract with TeMix is in the final stages of procurement, as are the service contracts with several ASPs. Internal processes for the development of the transactive rate design elements, the shadow bill strategy, ASP software integration, daily local grid level forecasting, and meter data transfers are near finalization and will soon be ready for beta testing prior to full Pilot operation.

SCE provides the following additional information regarding the implementation of the Pilot.

1. **Formula of Price Curves and Rationale for Shape Chosen**

   SCE's chosen quadratic price curve is intended to recover fixed costs along the entire duration of the load curve, as opposed to the typical applications of concentrated fixed cost recovery used in standardized TOU rate design. Concentrated recovery of fixed costs using a flat-adder threshold basis can cause steep cross-hour price differentials that are likely to be bypassed by resources that are acutely flexible and can create compounding effects on cross-hour load impacts on the grid. SCE believes that the formulaic definition of these dynamic price curves can be refined through iterative cycles and regression analysis on the causal effects of price on load determinants and/or customer responsiveness. However, SCE believes that the continuity of recovery along the entire duration of the load curve is an important element that should be considered in the determination of a price function for long-run fixed cost recovery.

2. **Inflection Points for Curves and Rationale for those Inflection Points**

   SCE's Inflection points were selected to enable fixed cost price signals for both Peak Load and Min Load conditions. The inflection point is selected as load basis when heat rates sink to some measure of system P-Mins during times of renewable over-supply and when non-renewable resources may need to continue to perform in times of increasing supply of renewable resources. The inflection points also provide a capacity signal that helps mitigate renewable curtailment by providing price-sensitive sink-resources a negative capacity price to soak-up excess renewable supply while maintaining some correlation to how the system experiences load through the course of the year.

3. **Revenue Targets for Each of the Component Curves**

   Revenue Targets will be assessed based on the revenue components authorized by the Commission for each revenue component included in the customer's otherwise applicable tariff (OAT).

4. **Illustrative Prices**

   SCE provided its confidential Illustrative Pricing Model to Energy Division on April 8, 2022 as a data request response.

5. **Addressing "Revenue Neutrality"**

   The customer's bill under the Dynamic price plus Subscription offering would approximate the customer's bill under the OAT, assuming the customer does not change from a pre-determined baseline of electricity usage. Revenue neutrality for the subscription portion of the customer's bill is achieved through the revenue-neutral design of the OAT. Revenue neutrality for the dynamic price portion of the customer's bill is achieved by scaling the raw marginal cost curves by the Equal Percent Marginal Cost (EPMC) scalar for each revenue component from SCE's GRC. Non-bypassable costs and other costs associated with the State and Commission's programs and policies will be included as a flat rate adder that equals the corresponding rate components currently contained in the customer's OAT, and will be applied to each hour of the dynamic price curve. Grid-related distribution costs as determined in SCE's GRC will be included as a flat rate (cents/KWh) in the total dynamic rate. Transmission-related costs will continue to be assessed based on the billing determinants as described in the customer's OAT and will be excluded from the Dynamic Price curve.

PROTESTS

SCE asks that the Commission, pursuant to GO 96-B, General Rule 7.5.1, maintain the original protest period designated in Advice 4684-E and not reopen the protest period.

TIER DESIGNATION

This supplemental advice letter is submitted with a Tier 2 designation, the same tier designation as AL 4684-E.

EFFECTIVE DATE

SCE respectfully requests this supplemental advice letter become effective concurrent with original Advice 4684-E, on February 4, 2022.

NOTICE

In accordance with General Rule 4 of GO 96-B, SCE is serving copies of this advice filing to the interested parties shown on the attached GO 96-B, R.20-11-003, A.17-01-012, et al., R.13-09-011 service lists. Address change requests to the GO 96-B service list should be directed by electronic mail to AdviceTariffManager@sce.com or at (626) 302 4039. For changes to all other service lists, please contact the Commission's Process Office at (415) 703 2021 or by electronic mail at Process_Office@cpuc.ca.gov.

Further, in accordance with Public Utilities Code Section 491, notice to the public is hereby given by filing and keeping the advice letter at SCE's corporate headquarters. To view other SCE advice letters submitted with the Commission, log on to SCE's web site at https://www.sce.com/wps/portal/home/regulatory/advice-letters.

For questions, please contact Patrick Nandy by electronic mail at Patrick.Nandy@sce.com.

Southern California Edison Company

/s/ Shinjini C. Menon
Shinjini C. Menon

SCM:pn:jm

ADVICE LETTER SUMMARY
ENERGY UTILITY

MUST BE COMPLETED BY UTILITY (Attach additional pages as needed)

Company name/CPUC Utility No.: Southern California Edison Company (U 338-E)

Utility type:
- [x] ELC
- [ ] GAS
- [ ] WATER
- [ ] PLC
- [ ] HEAT

Contact Person: Darrah Morgan
Phone #: (626) 302-2086
E-mail: AdviceTariffManager@sce.com
E-mail Disposition Notice to: AdviceTariffManager@sce.com

EXPLANATION OF UTILITY TYPE
ELC = Electric   GAS = Gas   WATER = Water
PLC = Pipeline   HEAT = Heat

(Date Submitted / Received Stamp by CPUC)

Advice Letter (AL) #: 4684-E Tier Designation: 2

Subject of AL:

Southern California Edison Company's Dynamic Rate Pilot Pursuant to Decision 21-12-015

Keywords (choose from CPUC listing): Compliance

AL Type: [ ] Monthly [ ] Quarterly [ ] Annual [x] One-Time [ ] Other:

If AL submitted in compliance with a Commission order, indicate relevant Decision/Resolution #:
Decision 21-12-015

Does AL replace a withdrawn or rejected AL? If so, identify the prior AL:

Summarize differences between the AL and the prior withdrawn or rejected AL:

Confidential treatment requested? [ ] Yes [x] No

If yes, specification of confidential information:
Confidential information will be made available to appropriate parties who execute a nondisclosure agreement. Name and contact information to request nondisclosure agreement/ access to confidential information:

Resolution required? [ ] Yes [x] No

Requested effective date: 2/4/22 No. of tariff sheets: -0-

Estimated system annual revenue effect (%):

Estimated system average rate effect (%):

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Tariff schedules affected: N/A

Service affected and changes proposed[1]:

Pending advice letters that revise the same tariff sheets: None

[1] Discuss in AL if more space is needed.

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Protests and correspondence regarding this AL are to be sent via email and are due no later than 20 days after the date of this submittal, unless otherwise authorized by the Commission, and shall be sent to:

California Public Utilities Commission
Energy Division Tariff Unit Email:
EDTariffUnit@cpuc.ca.gov

Contact Name: Shinjini C. Menon
Title: Managing Director, State Regulatory Operations
Utility/Entity Name: Southern California Edison Company

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CPUC
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505 Van Ness Avenue
San Francisco, CA 94102

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ENERGY Advice Letter Keywords

Affiliate	Direct Access	Preliminary Statement
Agreements	Disconnect Service	Procurement
Agriculture	ECAC / Energy Cost Adjustment	Qualifying Facility
Avoided Cost	EOR / Enhanced Oil Recovery	Rebates
Balancing Account	Energy Charge	Refunds
Baseline	Energy Efficiency	Reliability
Bilingual	Establish Service	Re-MAT/Bio-MAT
Billings	Expand Service Area	Revenue Allocation
Bioenergy	Forms	Rule 21
Brokerage Fees	Franchise Fee / User Tax	Rules
CARE	G.O. 131-D	Section 851
CPUC Reimbursement Fee	GRC / General Rate Case	Self Generation
Capacity	Hazardous Waste	Service Area Map
Cogeneration	Increase Rates	Service Outage
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Conservation	LIRA / Low-Income Ratepayer Assistance	Street Lights
Consolidate Tariffs	Late Payment Charge	Surcharges
Contracts	Line Extensions	Tariffs
Core	Memorandum Account	Taxes
Credit	Metered Energy Efficiency	Text Changes
Curtailable Service	Metering	Transformer
Customer Charge	Mobile Home Parks	Transition Cost
Customer Owned Generation	Name Change	Transmission Lines
Decrease Rates	Non-Core	Transportation Electrification
Demand Charge	Non-firm Service Contracts	Transportation Rates
Demand Side Fund	Nuclear	Undergrounding
Demand Side Management	Oil Pipelines	Voltage Discount
Demand Side Response	PBR / Performance Based Ratemaking	Wind Power
Deposits	Portfolio	Withdrawal of Service
Depreciation	Power Lines	

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Final Evaluation of Valley Clean Energy's Agricultural Pumping Dynamic Rate Pilot

Daniel G. Hansen
Michael Ty Clark

April 17, 2025

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EXECUTIVE SUMMARY

Power outages in August 2020 led the California Public Utilities Commission (Commission) to open a proceeding to consider actions in preparation for potential extreme weather in the summers of 2022 and 2023. The resulting Decision D.21-12-015 (the Decision) adopted a range of supply- and demand-side measures to address this issue, including two dynamic rate pilots to be implemented during a three-year period from 2022 through 2024. The Decision required mid-term and final evaluations of each pilot. This document represents the final evaluation of Valley Clean Energy's (VCE's) agricultural pumping dynamic rate pilot (AgFIT, or the Pilot).

The objective of the AgFIT Pilot was to test the interest and ability of agricultural customers in VCE's service territory to respond to hourly price signals. The primary question was whether they would choose to respond when provided a CalFUSE-based hourly price signal supported by well pump automation and customer support.

The Decision contains the following requirements for the evaluations:

1. The response of agricultural loads to prices.
2. The monthly bill impacts of the pilot dynamic rate in comparison to a customer's otherwise applicable tariff (OAT).
3. An evaluation of the recovery of generation and resource adequacy (RA) costs for customers on the pilot tariff.
4. An evaluation of the recovery of delivery costs for customers on the pilot tariff.

<u>Pricing and Billing Methods</u>

The dynamic prices consist of two components: a generation rate component corresponding to the services provided by VCE; and a distribution rate component for the services provided by PG&E. The Pilot pricing methodology was changed on May 1, 2023 and May 1, 2024. In the evaluation, we refer to the first pricing method as AgFIT 1.0, the second method as AgFIT 2.0, and the third method as AgFIT 2.1. The primary difference between the AgFIT 1.0 versus the 2.0 and 2.1 pricing methods is the means of linking AgFIT pricing to OAT revenue levels:

- AgFIT 1.0 uses a fixed-quantity subscription priced at OAT levels;
- AgFIT 2.0 and 2.1 replace the fixed-quantity subscription with an adder to the dynamic prices, calculated such that the average dynamic price is equal to the average seasonal OAT price paid by customers on the rate schedule.

In addition, at the same time AgFIT 2.0 was implemented, the method used to recover non-marginal generation costs was changed in a manner that resulted in reduced intra-day price variability.

According to the Decision, the shadow bill approach was adopted "to address PG&E's and CLECA's objections about the revenue neutrality of the VCE Pilot rate." Under this method, the customer continues to pay for its current usage at the OAT rates (e.g., Schedule AG-C), which did not require changes to PG&E's billing systems for the Pilot. For each month and service account (pump), the difference between the OAT bill and the AgFIT charges is recorded. At the end of a period of time[1], the monthly credits or debits are added up for each service account to determine whether a credit is paid to the customer. For any given service account, the customer is eligible to receive a credit if the sum of the AgFIT charges is less than the sum of the OAT bills. In contrast, if the sum of the AgFIT charges is greater than the sum of the OAT bills, then the customer is not responsible for paying an additional amount beyond their OAT bills for that service account.

Participant Summary

The customers enrolled in the Pilot are a mix of small, medium, and large agricultural customers that employ irrigation pumps to water different types of crops. The Pilot does not have a limit on the number of customers if the aggregate peak load of Pilot customers does not exceed 5 MW. Most enrolled Pilot customers have multiple pumps (service accounts). There were two customers with a combined total of 17 pumps in September 2022. By September 2023, the enrollment count increased to five customers with a combined total of 33 pumps. In September 2024, seven customers were enrolled with a total of 60 pumps.

Key Findings

- Customers face constraints that may limit their ability to respond to prices.
    - Agricultural pumping customers face a number of operational constraints that can vary seasonally and with weather conditions (e.g., causing them to need to run in all hours, not need to pump at all, or need to have minimum run times) that may affect their ability to shift or reduce load at any given time. While the load can sometimes be highly responsive, one should not assume that a high percentage of the pumping load will be curtailed in response to a specific high-price event.
- Automating pump operations helped customers respond to prices.
- Customers appeared to benefit from scheduling pumping via dynamic transactions (i.e., purchasing the electricity prior to the date on which the usage occurs).
    - Customers appeared to be effective in their use of pump scheduling, obtaining a lower average price per kWh than they would have paid if they'd purchased all usage at settlement prices. However, two-thirds of usage during the Pilot was purchased at settlement prices, so scheduled pumping was not the dominant behavior for most customers.
- Customers need more frequent billing feedback to understand the benefits. Shadow billing was challenging to implement, and customers did not receive monthly shadow bills. As a result, customers were not receiving timely feedback

[1] The expectation at the beginning of the Pilot was that credit calculations would be based on 12 months of billing data. In practice, the number of months used to calculate credits varied over the course of the Pilot.

on their performance during the Pilot, which could have affected their performance.

- Interviewed customers had positive views of the Pilot but had some reservations about whether they would adopt it as a permanent rate. They reported that managing usage under dynamic pricing is time consuming.
- The shadow bill credit method, with bill protection, affected Pilot results and how they ought to be interpreted.
    - The presence or absence of an AgFIT credit is not necessarily indicative of whether the customer benefited from Pilot participation.
    - Due to the Pilot's design, customers continued to receive and pay their regular OAT bills. We found evidence that at least some customers continued to pay attention to OAT price signals while participating in the Pilot, and as a result, we were unable to conduct a valid evaluation of customer response to Pilot prices alone.
- The change to one-part pricing under AgFIT 2.0 and 2.1 addressed an issue in AgFIT 1.0's two-part pricing but had other consequences.
    - A motivation for changing from two-part pricing to one-part pricing (in May 2023) was to avoid subscription prices that were based on historical loads that did not reflect pumping needs in the Pilot period, which can affect a customer's ability to earn a credit. The one-part pricing method used in the 2023 and 2024 growing seasons addressed this issue by removing subscriptions and instead adjusting the dynamic prices to match the average rate paid on the pump's rate schedule.
    - The price adjustment method used in AgFIT 2.0 and 2.1 can produce structural benefiters and non-benefiters because of the adjustment to the rate schedule average rate (rather than the pump's own average OAT rate).[2] Note that the presence of structural benefiters is common feature of voluntary rates (e.g., customers with flatter load profiles experience a lower bill after changing from a flat to a TOU rate, even prior to having any price response) and is therefore not necessarily a reason to avoid using the AgFIT 2.0 and 2.1 pricing methods.[3]
    - The price averaging used to develop AgFIT 2.0 and 2.1 prices leads to pricing distortions in the days around price spikes that could be systematically arbitraged by customers.[4] While there is no evidence that customers engaged

[2] A "structural benefiter" is a customer that has lower AgFIT charges than its OAT bill without changing its usage level or pattern.

[3] Subscription pricing can produce a similar structural benefiter effect. For example, if a pump's subscription is based on a usage profile with a high load factor (i.e., comparatively constant usage across hours) but has less need for pumping in the Pilot period (thus resulting in a lower load factor usage profile), the customer will benefit from the low subscription price even if they don't alter their pumping plans in response to hourly prices.

[4] For example, a customer could systematically benefit by scheduling pumping for future days after experiencing a day with especially high prices, regardless of whether they expect to need to pump on those days. If they end up pumping, the purchased energy would tend to cost less than if they had purchased it at settlement prices and if they do not end up pumping, they would tend to benefit by selling the purchased energy at higher settlement prices.

in this form of arbitrage during the Pilot, the moving-average pricing method should not be used in future rate offerings to prevent the possibility of it happening.

    - Because of the limited experience under AgFIT 1.0 pricing and the difficulty in accounting for differences in conditions across growing seasons (e.g., variation in precipitation levels or crop rotations), we did not compare outcomes across the pricing methods.

- Customers pay more attention to hourly prices when they vary more from day to day and hour to hour.
    - Price variability was lower in 2024 than in 2023, which corresponded to less scheduling of pumping and reduced benefits from scheduling.

1 INTRODUCTION AND PURPOSE OF THE STUDY

Power outages in August 2020 led the California Public Utilities Commission (Commission) to open a proceeding to consider actions in preparation for potential extreme weather in the summers of 2022 and 2023. The resulting Decision D.21-12-015 (the Decision) adopted a range of supply- and demand-side measures to address this issue, including two dynamic rate pilots to be implemented during a three-year period from 2022 through 2024. The Decision required mid-term and final evaluations of each pilot. This document represents the final evaluation of Valley Clean Energy's (VCE's) agricultural pumping dynamic rate pilot (AgFIT, or the Pilot).[5]

The agricultural sector accounts for 18 percent of VCE's total annual load and 16 percent of its peak demand (i.e., 35 MW out of 215 MW of peak demand).[6] The Pilot allows VCE to enroll agricultural pumping customers up to a 5 MW aggregated peak load cap, enabling up to 15 percent of its agricultural load to shift in response to changing market conditions.

The objective of the AgFIT Pilot was to test the interest and ability of agricultural customers in VCE's service territory to respond to hourly price signals. The primary question was whether they would choose to respond when provided a CalFUSE-based hourly price signal supported by well pump automation[7] and customer support.

The core element of the Pilot is to present participants with dynamic prices to assist in meeting the following goals:

- Reduce grid infrastructure costs and greenhouse gas emissions.
- Improve reliability and integration of renewables.
- Facilitate greater integration and fair compensation of distributed energy resources.[8]

The Decision states that the Pilot "provides an opportunity to assess the potential of a dynamic retail rate approach to incentivizing load shift" and that "[i]f loads do respond to the dynamic prices, then the Pilot will have achieved the intended purpose of shifting load to enhance system reliability."[9]

[5] The other dynamic pricing pilot approved in the Decision was implemented by Southern California Edison.

[6] Opening Prepared Testimony of Gordon Samuel on Behalf of Valley Clean Energy, Rulemaking 20-11-003, September 1, 2021, p. 1.

[7] In the context of the Pilot, "automation" means customers have the ability to remotely control irrigation equipment through manual decision making. There is no automated control of pumping in response to prices. Human beings decide when to run irrigation pumps, sometimes after taking into consideration hourly electricity prices.

[8] CPUC Decision 21-12-015, p. 86.

[9] CPUC Decision 21-12-015, p. 91.

The Decision contains the following requirements for the evaluations[10]:

1. The response of agricultural loads to prices.
2. The monthly bill impacts of the pilot dynamic rate in comparison to a customer's otherwise applicable tariff (OAT).
3. An evaluation of the recovery of generation and resource adequacy (RA) costs for customers on the pilot tariff.
4. An evaluation of the recovery of delivery costs for customers on the pilot tariff.

The report is organized as follows. Section 2 contains a description of the Pilot; Section 3 provides a summary of customer interviews. Section 4 contains our evaluation of customer load response; Section 5 contains the Pilot and OAT bill comparisons; Section 6 discusses Pilot cost recovery issues; Section 7 contains stakeholder comments on the Pilot; and Section 8 provides a summary and conclusions.

2 DESCRIPTION OF THE DYNAMIC PRICING PILOT

AgFIT has three key design elements in place to accomplish its goals:

1. Dynamic price signals, including the ability to schedule pumping at locked-in hourly prices up to seven days in advance, that incentivize load shifting to provide operational benefits and customer bill savings.

2. Automation incentives up to $200 per kW of shiftable load for remote control of irrigation systems.

3. Targeted marketing, education, and outreach (ME&O) and customer support.

In this section, we describe how dynamic prices were implemented in AgFIT, how the pricing method has changed over the course of the Pilot, and the shadow bill methodology. We then illustrate the prices observed to date and present information about the Pilot participants.

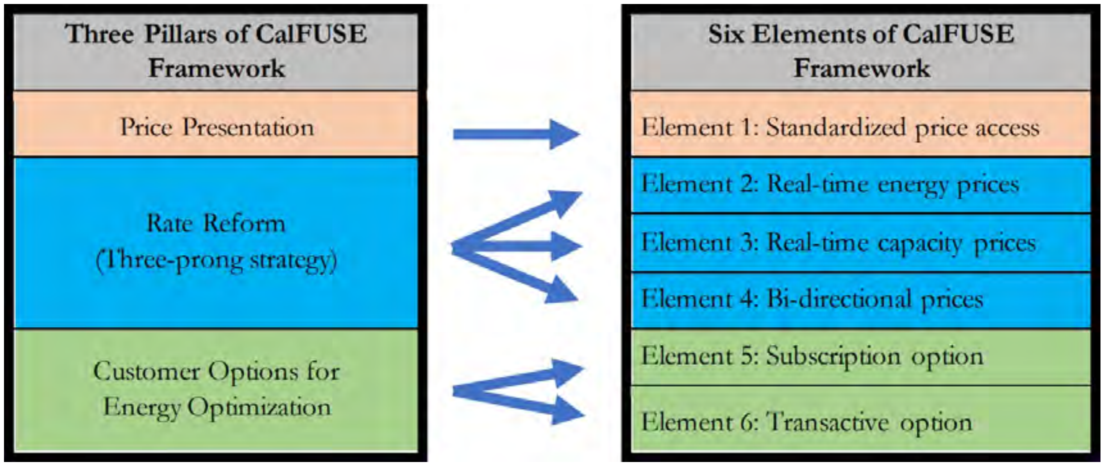
2.1 Pricing Method Description

The dynamic elements of published prices consist of two components: a generation rate component corresponding to the services provided by VCE; and a distribution rate component for the services provided by PG&E. VCE selected TeMix as the vendor to

[10] CPUC Decision 21-12-015, p. 94. There is a fifth requirement, as follows: "In the case that VCE incorporates binding forecast projections, the evaluation should also include an assessment of this element." However, VCE implemented "binding forecast projections" for all Pilot customers (i.e., there was no control group of customers presented with price forecasts with no opportunity to lock them in), so this requirement is met through the analysis of the response of agricultural loads to prices.

provide its proprietary cloud-hosted TeMix Platform™ that operates 24/7 to support the six steps of the CalFUSE framework itemized in Figure 2.1 below.[11]

Figure 2.1: CalFUSE Framework



A key input to the TeMix distribution rate component is week-ahead hourly circuit load forecasts, which are provided by PG&E through a third-party vendor. Week-ahead generation price forecasts are provided through a different third-party vendor.

The integration and automation of pumping loads with the Pilot price signals is through the equipment and related data integration provider (Automation Service Provider, or ASP) via its proprietary software. The ASP that was selected by VCE is Polaris. In this Pilot, "automation" was optional and, when used, meant that price forecasts were available for customers to view, who could control pumps manually or via remote control technology. The Pilot did not have pumps automatically controlled by the price signals themselves.

The Pilot was funded in June 2022 and launched on August 1, 2022.[12] The two-part tariff was approved and implemented for use from the third week of August 2022 to the end of April 2023. During that period, there were two customers with a total of 19 pumps. Starting in May 2023, the Pilot pricing method was changed from a two-part design to a one-part design, with the AgFIT price development, shadow billing and transactive responsibilities performed by Polaris while TeMix continued to provide hourly tenders up to a week ahead for each circuit used by pilot participants. The first phase of the AgFIT Pilot with a subscription priced at OAT rate levels and dynamic prices reflecting marginal (and other) costs is referred to as AgFIT 1.0 (August 2022 through April 2023); and the second phase with no subscription and dynamic prices scaled to OAT rate levels is referred to as AgFIT 2.0 (beginning May 1, 2023). The AgFIT 2.1 pricing method was

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[11] The figure is taken from page 6 of the June 22, 2022 Energy Division white paper entitled "Advanced Strategies for Demand Flexibility Management and Customer DER Compensation".

[12] It is our understanding that it was an intense effort by the CPUC, VCE, PG&E, Polaris, and TeMix starting in early 2022, to get the Pilot approved, funded, contracted, and to standup all the teams to manage, deploy, configure, test, and securely operate 24/7 the multiple software platforms, cloud computing systems, pump controls, and interfaces to existing CAISO, near real-time metering, monthly billing data, and circuit forecasting and to recruit, train, and support customers to participate in the Pilot.

adopted on May 1, 2024, which is largely the same as the 2.0 pricing method but with some modifications described below.

AgFIT 1.0 Pricing

When the Pilot became active in August 2022, a two-part pricing method was employed. The customer is provided a subscription, which is a fixed quantity of energy per hour priced at OAT rates. The subscription hourly quantities (kWh) are based on the customer's usage in the same month of the previous year (2021).

The subscription price was developed by applying an escalation factor to the previous year's (2021) OAT bill. The escalation factors were fixed within a rate schedule and month based on class-average changes in bills across years. An alternative method (employed by SCE in its dynamic rate pilot) would have been to price the subscription by billing each customer's historical usage at current OAT rates. This would have done a better job of aligning the effect of rate changes with the customer's specific usage profile but would have required more time and data to implement. Therefore PG&E opted to use the simpler escalation method to allow the Pilot to proceed at an earlier date.

The subscription component of the bill serves two purposes. First, it reduces the customer's bill volatility due to dynamic prices, with the customer only paying (or being paid) those prices for usage that deviates from their subscription quantity.[13] In the extreme, a customer who uses exactly its subscription quantity during an hour will not pay the dynamic price at all. This risk mitigation can be especially important during extended periods of high dynamic prices. In addition to shielding some or all of a customer's usage from high prices, it also provides an opportunity for the customer to sell back some of its subscription at the locational dynamic prices, thus releasing energy for those who value it more.

Second, the subscription provides a means of linking the overall bill level to the OAT (and the revenue requirement assumed when the OAT for each rate class was established), thus preserving any rate class pricing differences. Because dynamic prices are intended to reflect the utility's retail locational marginal cost, in theory the deviations of the bill from the OAT-based subscription level should be matched by the avoided costs associated with the price response. However, a utility's average cost (total revenue requirement divided by total load) is almost always greater than the marginal cost. Thus, the Pilot cannot simply charge the marginal costs for all usage; it requires a mechanism to collect the non-marginal "missing money" to meet the revenue requirement, at least approximately. This was accomplished via subscription charges and adders to hourly prices based on non-marginal costs. The dynamic prices in AgFIT 1.0 recover some non-marginal costs using scarcity pricing in which more of the costs are recovered when net loads[14] or the net load ramp is high and less when they are low. The rest of the non-marginal costs such as public purpose charges and transmission charges are recovered in a flat $/kWh adder that is included in the dynamic prices.

[13] In contrast, under a "one-part" real-time pricing program, the customer pays the hourly price for all usage in the hour.

[14] Net load is the CAISO load less the solar plus wind generation. Net load ramp is a positive difference between the net load for the hour and the net load three hours earlier.

In a simple two-part pricing rate, the customer pays for deviations from their subscription quantity at hourly prices that reflect market conditions.[15] This is reflected in the simplified bill calculation for month *m* below (where *i* indexes all hours during the month):

$$\text{Two-part Pricing Bill}_m = \Sigma_i \{(P^{Sub}_i \times Q^{Sub}_i) + P^{Dyn}_i \times (Q^{Obs}_i - Q^{Sub}_i)\}$$

Table 2.1: Variables in a Two-Part Pricing Bill Calculation

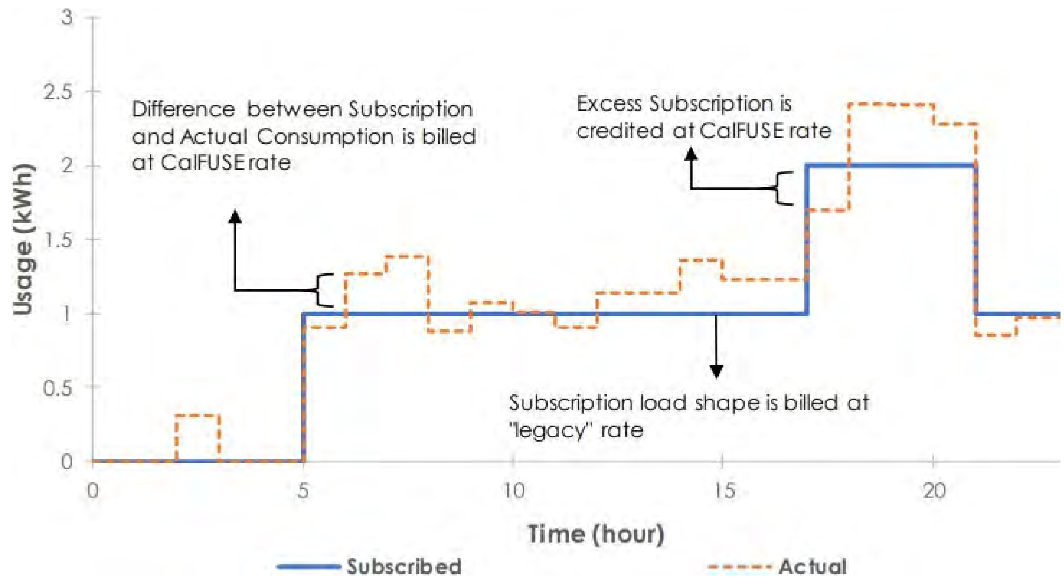
Variable	Description
P^{Sub}_i	Subscription price during time interval *i* in $/kWh
Q^{Sub}_i	Subscription quantity during time interval *i* in kWh
P^{Dyn}_i	Dynamic price during time interval *i* in $/kWh
Q^{Obs}_i	Observed (metered) usage during time interval *i* in kWh

The settlement process is illustrated in Figure 2.2 below, which is taken from the Energy Division's "Advanced Strategies for Demand Flexibility Management and Customer DER Compensation" white paper.[16] In the figure, the "CalFUSE rate" is synonymous with the dynamic settlement price used in AgFIT 1.0.

[15] These prices can be guaranteed up to seven days ahead, day-ahead, hour-ahead, or only known after the fact.

[16] "Advanced Strategies for Demand Flexibility Management and Customer DER Compensation" Energy Division White Paper, page 67: ED-White-Paper-Advanced-Strategies-for-Demand-Flexibility-Management-June-2022.pdf (dret-ca.com)

Figure 2.2: Example Showing the Subscription as a Hedging Product



In addition to the elements described above, the Pilot offers additional opportunities for customers to lock in the prices paid for scheduled load (or received for subscription amounts that will be unused) up to six days ahead of time. Specifically, each day the customer is presented with six days of hourly dynamic "tender prices". The customer can choose to schedule a pump to run or not run for any hour in that six-day window. Once scheduled, the difference between the customer's current position (i.e., the sum of customer's subscription quantity in that hour and previous transactions for that hour) and the usage scheduled for that hour is purchased or sold in a transaction at the dynamic tender price. The price and quantity are fixed and guaranteed by the transaction. The transactions are essentially adjustments to the customer's "forward contract" (i.e., the energy that has been pre-purchased) priced at the dynamic tender prices.

The final settlement for any given hour reflects the following three components:

- The subscription quantity purchased at subscription prices;
- Purchases or sales of fixed quantities of energy at dynamic tender prices; and
- The purchase or sale of the difference between the customer's metered net load and the net transacted quantity at ex-post prices.

The dynamic tender prices are set to recover the marginal energy costs, which reflect CAISO locational marginal prices (LMPs); long-run generation capacity marginal costs; long-run distribution capacity marginal costs; and other non-marginal revenue components and policy costs currently included in the approved revenue requirements of PG&E.

AgFIT 2.0 and 2.1 Pricing

The AgFIT 2.0 and 2.1 pricing methods replace the two-part pricing method described above with a one-part method that uses only dynamic tenders, i.e., subscriptions were eliminated. While the customer does not purchase a subscription at OAT-based prices, the 2.0 and 2.1 pricing methods link Pilot price levels to OAT levels by shifting the prices of the dynamic tenders from the TeMix Platform™ up or down so a pump's average price matches its rate schedule's average OAT price. In addition, the customers are allowed to purchase fixed quantities of electricity at these binding dynamic adjusted tenders up to seven days in advance; this feature is similar to AgFIT 1.0 pricing. The extension of the tenders from six to seven days in advance is unrelated to the change to AgFIT 2.0 and 2.1.

Under the AgFIT 2.0 and 2.1 "one-part" pricing programs, the customer pays the day-ahead hourly price for all of its usage in the hour unless the customer purchases two to seven days ahead at the forward adjusted dynamic prices. Any difference between the net sum of the forward transactions and the actual meter reading is automatically transacted at the day-ahead price.

The AgFIT 2.0 dynamic prices are adjusted by comparing the weekly average dynamic prices (i.e., the upcoming 168 hourly prices that would have served as the dynamic prices under AgFIT 1.0) to the seasonal average price paid per kWh for the customer's OAT. The OAT value is calculated at the rate schedule level and therefore could differ from the AgFIT customer's historical or current average OAT price. The AgFIT 2.0 rate adjustment is constant across all hours of the week, equal to the difference between the average OAT price and the average of the (unadjusted) dynamic prices. The averaging is conducted daily.

Another change to the pricing methodology occurred at the same time AgFIT 2.0 was implemented. Specifically, non-marginal generation costs that had been recovered using a dynamic scarcity price were changed to be recovered on a flat cents/kWh basis. This change is unrelated to the other methodological changes but has the effect of reducing the potential for customers to benefit from shifting usage by lowering intra-day price differences.

In contrast to AgFIT 2.0, under AgFIT 2.1 the dynamic prices are adjusted by comparing the weekly average dynamic prices for the prior and coming week (i.e., a two-week average rather than the one-week average used in AgFIT 2.0). As with AgFIT 2.0, rate adjustment is constant across all hours of the week, equal to the difference between the average OAT price and the average of the (unadjusted) dynamic prices. The averaging is conducted daily. In addition, the scarcity pricing method used in AgFIT 2.1 to allocate distribution and generation capacity costs across hours uses a sigmoidal method that replaces the quadratic method used in AgFIT 2.0. The 2.1 pricing method also introduces a threshold CAISO net load level (approximately 28 GW) below which the capacity cost assigned to the hour is zero.

Table 2.2 summarizes the differences between the AgFIT pricing methods. The primary difference is the removal of the fixed-quantity subscription in AgFIT 2.0 and 2.1 and the resulting need to implement an alternative method to recover OAT-level embedded costs (the flat adder).

Table 2.2: Comparison of AgFIT 1.0, 2.0, and 2.1

Characteristic	AgFIT 1.0	AgFIT 2.0	AgFIT 2.1
Has a subscription?	Yes	No	No
Basis for OAT-level Revenue	Fixed-quantity subscription priced at customer's historical OAT with an escalator	Flat $/kWh adder to dynamic prices based on the rate schedule's seasonal average price paid per kWh	Flat $/kWh adder to dynamic prices based on the rate schedule's seasonal average price paid per kWh
Averaging period for dynamic price adjustments	N/A	7 previous days	7 previous and 7 future days
Ability to transact for fixed quantities at a guaranteed dynamic price?[17]	Yes, up to 6 days ahead	Yes, up to 6 days ahead	Yes, up to 7 days ahead
Recovery of non-marginal generation costs[18]	Dynamic and Flat $/kWh	Flat $/kWh	Flat $/kWh
Distribution and Generation Capacity Cost Allocation Method	Quadratic	Quadratic	Sigmoidal
Effective Dates	8/2022 – 4/2023	5/2023 – 4/2024	4/2024 – 12/2024

Shadow Bill Credit Method

According to the Decision, the shadow bill approach was adopted "to address PG&E's and CLECA's objections about the revenue neutrality of the VCE Pilot rate."[19] Under this method, the customer continues to pay for its current usage at the OAT rates (e.g., Schedule AG-C), which did not require changes to PG&E's billing systems for the Pilot. For each month and service account (pump), the difference between the OAT bill and the AgFIT charges is recorded. At the end of a period of time[20], the monthly credits or debits are added up for each service account to determine whether a credit is paid to the customer. For any given service account, the customer is eligible to receive a credit if the sum of the AgFIT charges is less than the sum of the OAT bills. In contrast, if the sum of the AgFIT charges is greater than the sum of the OAT bills, the customer is not responsible for paying an additional amount beyond their OAT bills for that service account.

The equation below shows the calculation of the dynamic bill credit for service account *s* during months *m*.

$$\text{Dynamic Pilot Credit}_s = \text{MAX}\{\Sigma_m(\text{OAT Bill}_{s,m} - \text{AgFIT Charges}_{s,m}), 0\}$$

In the equation, MAX is the maximum function, Σ_m is the summation function, "OAT $\text{Bill}_{s,m}$" is service account *s*'s bill on their OAT using metered usage during month *m*, and "AgFIT Charges $_{s,m}$" is service account *s*'s AgFIT charges during month *m*.

Note that service accounts belonging to a customer are treated distinctly for these calculations. That is, a customer could earn a credit for one service account that is not offset by a debit for another.

Customer Impacts of the Shadow Bill Credit Method

It is important to understand the shadow bill credit method as we discuss customer load and bill impacts during the Pilot. While a purported benefit of AgFIT pricing is that customers no longer need to consider the OAT demand charges[21], customers who increase their billed demand will pay the higher OAT bill associated with that change versus what they would have paid prior to the Pilot. At the end of a year, they will be eligible for a credit if their total AgFIT charges are less than the total OAT bill. This methodology may lead participants to view the Pilot negatively in real time (i.e., because they pay higher OAT bills relative to pre-Pilot months even as they are responding to dynamic prices). Perhaps more importantly, if the Pilot pricing method does not present the customer with sufficient opportunities to save each month (e.g., due to a lack of dynamic price variation), the customer could end up paying more by having ignored the OAT price signals.

Conversely, a customer who reduces their OAT bill relative to pre-Pilot levels by responding to dynamic prices may not receive a shadow bill credit even though responding to the Pilot prices benefited them. For example, if dynamic prices are consistently high during the OAT's Peak pricing period, the customer may decrease its OAT billed demand by responding to dynamic prices which could result in reducing the OAT bill to a level lower than the AgFIT charges.[22] This is important to keep in mind when we examine bill impacts in Section 5. A customer who does not receive a Pilot credit still may have saved money relative to pre-Pilot levels. There is evidence to suggest at least some of the customers understood these concepts (i.e., the importance of continuing to pay attention to OAT prices during the Pilot), though there was likely variation in the level of understanding.

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[17] The change allowing customers to transact seven days ahead instead of six occurred at the time AgFIT 2.1 pricing was adopted but is not otherwise related to the removal of fixed-quantity subscription pricing.

[18] This change occurred at the time AgFIT 2.0 pricing was adopted but is not otherwise related to the removal of the subscription.

[19] CPUC Decision 21-12-015, p. 91.

[20] The three credit periods used in the Pilot were August 2022 to April 2022, May 2023 to September 2023, and October 2023 to December 2024.

[21] VCE's web page promoting AgFIT lists the following among the program benefits: "There are no penalties, no demand charges, and no clawbacks." https://valleycleanenergy.org/programs/a-flexible-irrigation-pilot-program-for-agriculture/

[22] The customer could have responded to the OAT prices to reduce their bills by the same amount. But perhaps the customer would be more engaged with and able to respond to OAT and dynamic prices during the Pilot, and thus their savings are due to paying attention more than the dynamic prices or shadow billing process.

2.2 Observed Dynamic Prices

Figures 2.3 through 2.5 illustrate the average hourly "last rate" (the day-ahead dynamic tender price) by month of the growing season (May through September) in each year of the Pilot. The blue bars reflect the average daily price (i.e., the simple average across 24 hours), while the orange dots reflect the maximum hourly price, and the yellow dots reflect the minimum hourly price on each date. In each case, the prices reflect the average across customers enrolled at that time.

Figure 2.3 shows high maximum prices in early September 2022 surrounded by more moderate prices. Note that this figure shows data beginning in mid-August (corresponding to the beginning of the customer participation in the Pilot), whereas the subsequent figures show data beginning in May.

Figure 2.3: Average and Maximum Daily Day-Ahead Prices, 2022 Growing Season

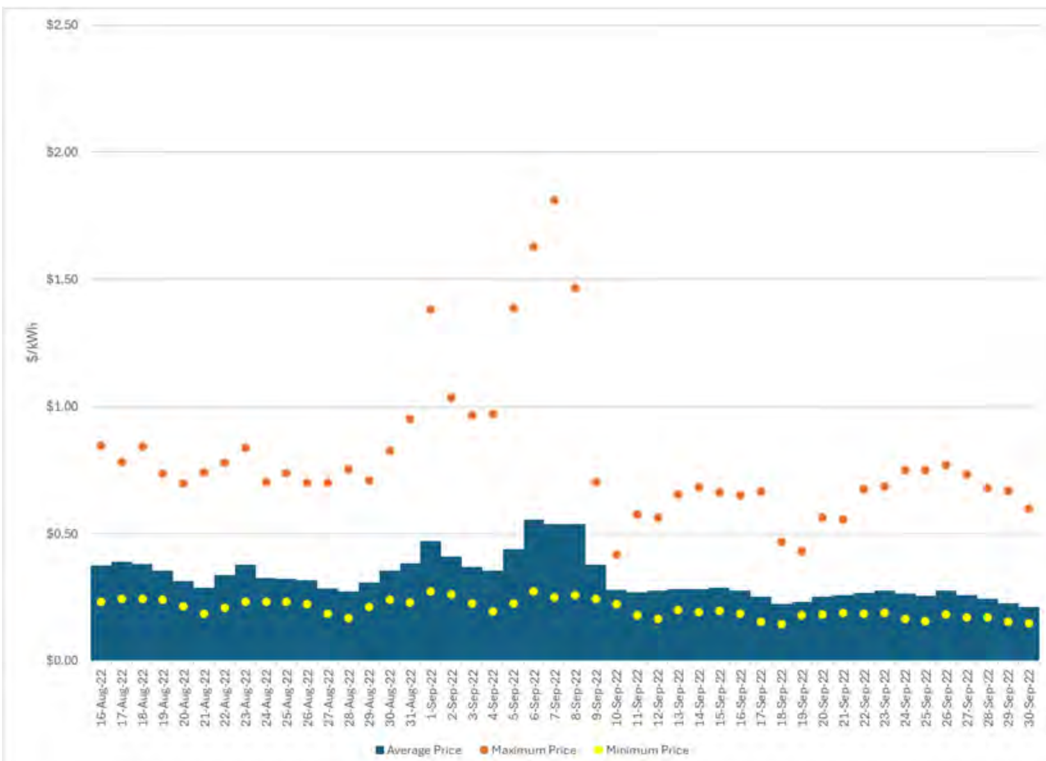


Figure 2.4 shows that the highest prices of the 2023 growing season occurred in mid-August. Moderate prices were in effect from May into July and again in September, with July having some slightly higher price days.

Figure 2.4: Average and Maximum Daily Day-Ahead Prices, 2023 Growing Season

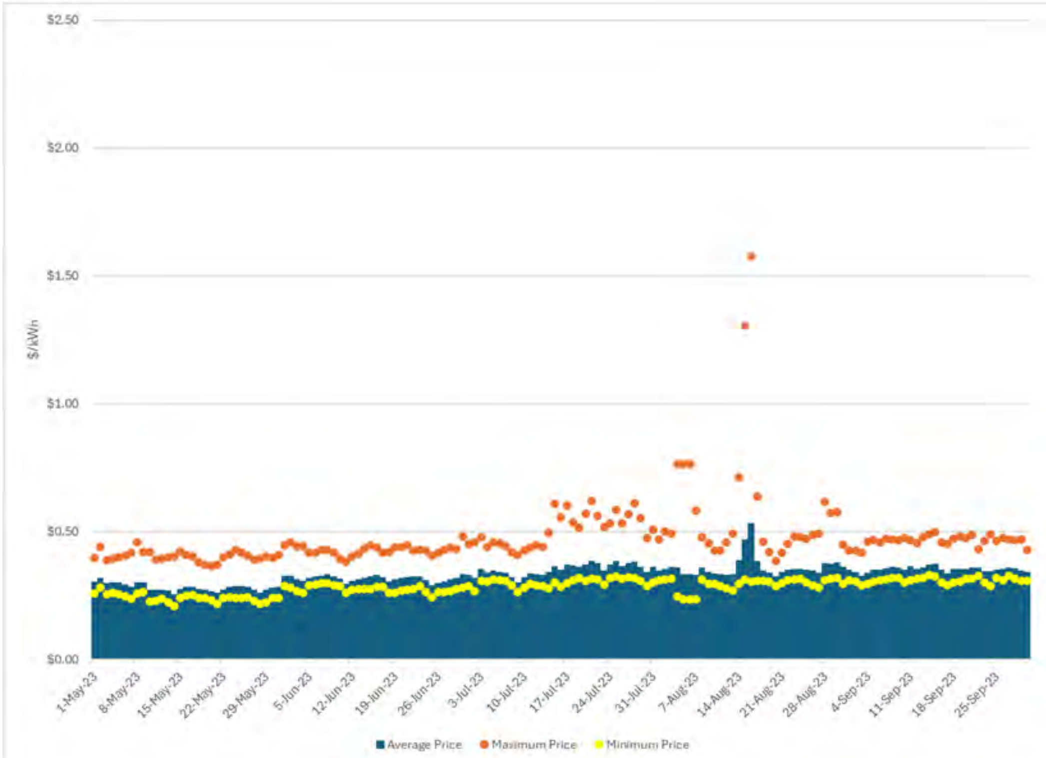
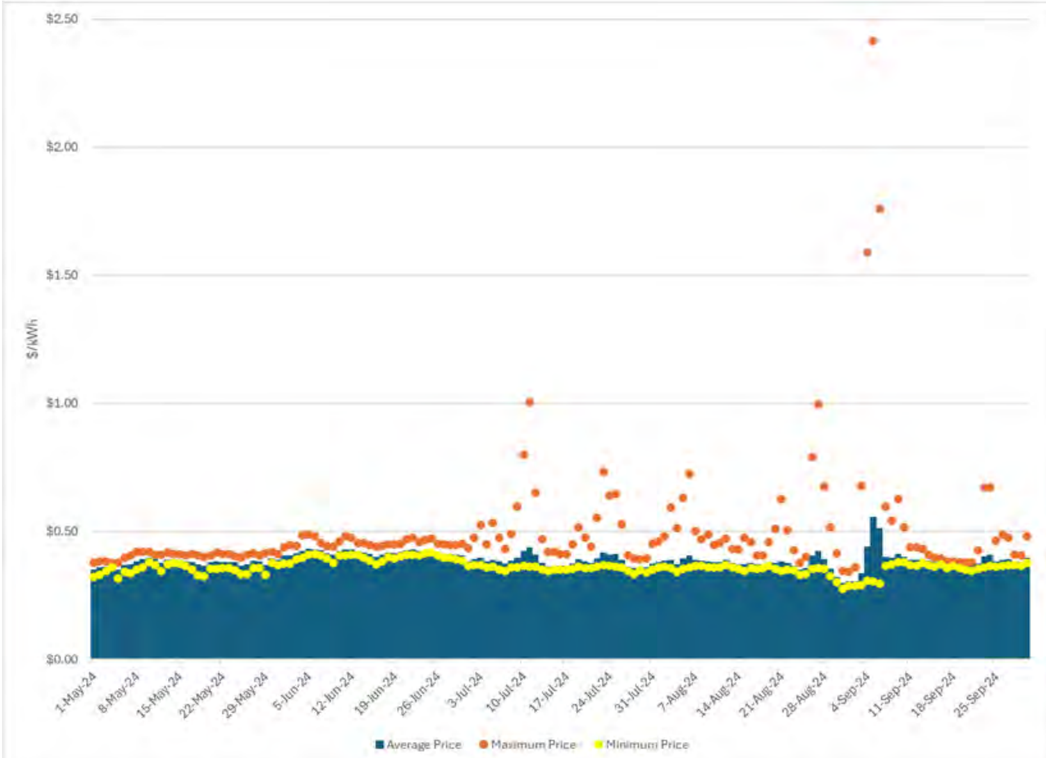


Figure 2.5 shows that the highest prices of the entire Pilot occurred on September 5, 2024, with somewhat high price spikes occurring on the two neighboring dates. More moderate price spikes (around $1 per kWh) occurred on July 11 and August 27, 2024. The difference between the highest and lowest daily prices is lower in 2024 than 2023 (averaging $0.19 per kWh in 2023 and $0.14 per kWh in 2024).

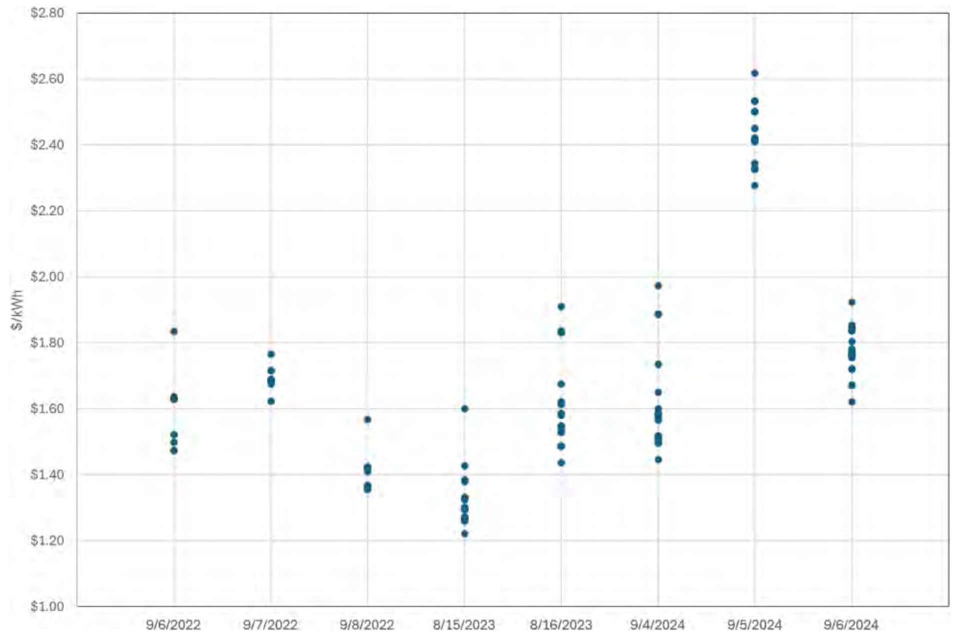
Figure 2.5: Average and Maximum Daily Day-Ahead Prices, 2024 Growing Season



The figures above reflect average prices across enrolled customers. However, the price can vary across customers due to location (i.e., because of differences in loads across circuits and the pNODE price) and because of the pump's OAT rate, which serves as the basis for hourly price adjustments in 2023 and 2024. The next figure explores how prices vary across customers.

Figure 2.6 shows the variation in prices across customers during the highest-priced hours. We selected the eight highest-priced hours and graphed the prices on each date. For example, on September 5, 2024, which had the highest prices overall, the pump-specific prices ranged from $2.28 to $2.62 per kWh. On average, the prices differed by $0.34 per kWh from lowest to highest on each date, with the largest difference ($0.53 per kWh) occurring on September 4, 2024. This shows that high-price hours applied to all customers, even though the exact magnitude of the price varied across customers.

Figure 2.6: Price Distribution Across Pumps on High-Price Days



The next set of figures shows the average hourly price profile for different time periods. We use a box-whisker format[23] to provide an indication of the variability around the typical price profile.

Figure 2.7 shows the hourly distribution of day-ahead dynamic tender prices for AgFIT 2.0 (May through September 2023). As expected, prices increase during evening hours. The variance on the upper bound is also largest during the early evening hours, peaking from 6 to 8 p.m. The morning hours exhibit lower prices and a reduced range relative to the evening hours.

[23] A box-whisker plot illustrates different elements regarding the distribution of prices. The shaded box area represents prices that fall within the 25th and 75th percentile of observations (i.e., the interquartile range). The horizontal line within the box indicates the median price. The "whiskers" represent the lower and upper bounds of prices that are not considered outliers – i.e., not more than 1.5 times the interquartile range away from the upper and lower bounds of the interquartile range.

Figure 2.7: Distribution of Hourly Day-Ahead Dynamic Prices, May-Sep 2023

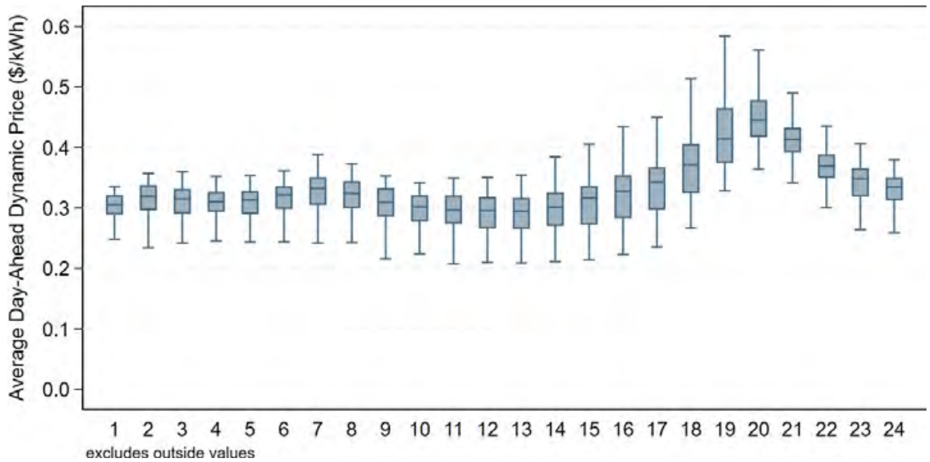


Figure 2.8 shows the same information for the 2024 growing season. While the highest-priced hours are still from 6 to 8 p.m., the overall price profile is both flatter and with less variability around the median values.

Figure 2.8: Distribution of Hourly Day-Ahead Dynamic Prices, May-Sep 2024

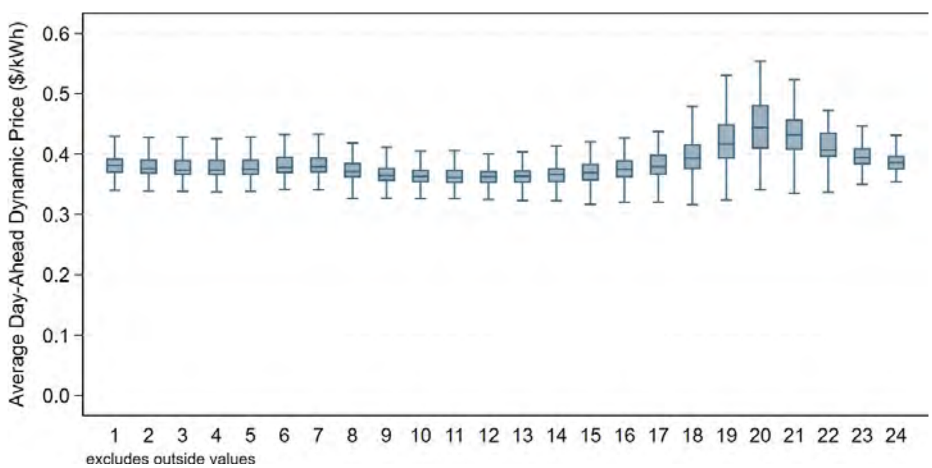


Figure 2.9 compares the distribution of hourly day-ahead dynamic tender prices between August 2022, which employed AgFIT 1.0 pricing, and August 2023, which employed AgFIT 2.0 pricing. The August 2023 AgFIT 2.0 prices are higher than August 2022 AgFIT 1.0 prices during the morning hours but lower during evening hours. The overall result is less intra-day price variation under AgFIT 2.0, resulting in a lower peak to off-peak period price differential relative to AgFIT 1.0. While the pricing method changed across the two periods, other factors also affected the price level and pattern. For example, the CAISO locational marginal prices (LMP) that serve as an input to the AgFIT prices were generally lower in 2023 than 2022, with lower price differentials. Figure 2.10 illustrates the

distribution of CAISO LMPs for August 2022 and 2023.[24] (Please note the change in the y-axis scale relative to Figure 2.9 when making comparisons.)

Figure 2.9: Distribution of Hourly Day-Ahead Dynamic Prices, August 2022 vs 2023

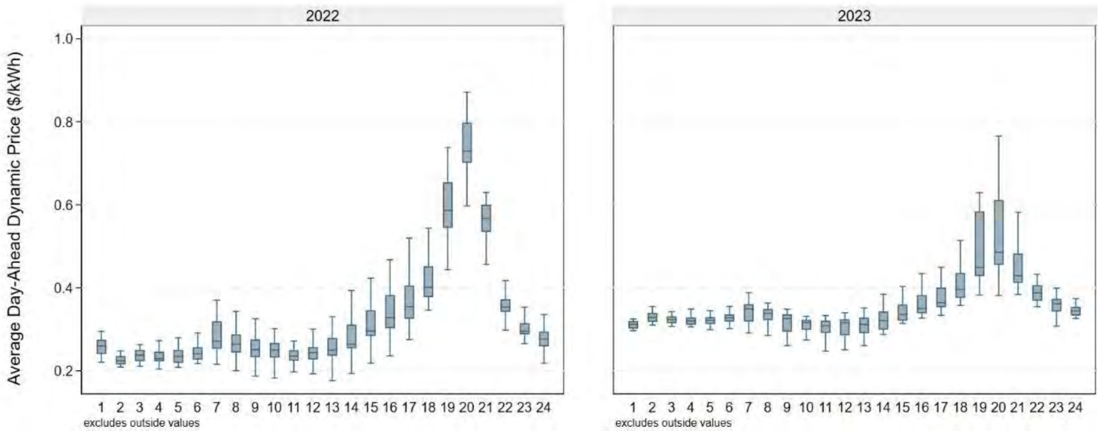


Figure 2.10: Distribution of Hourly CAISO LMPs, August 2022 vs 2023

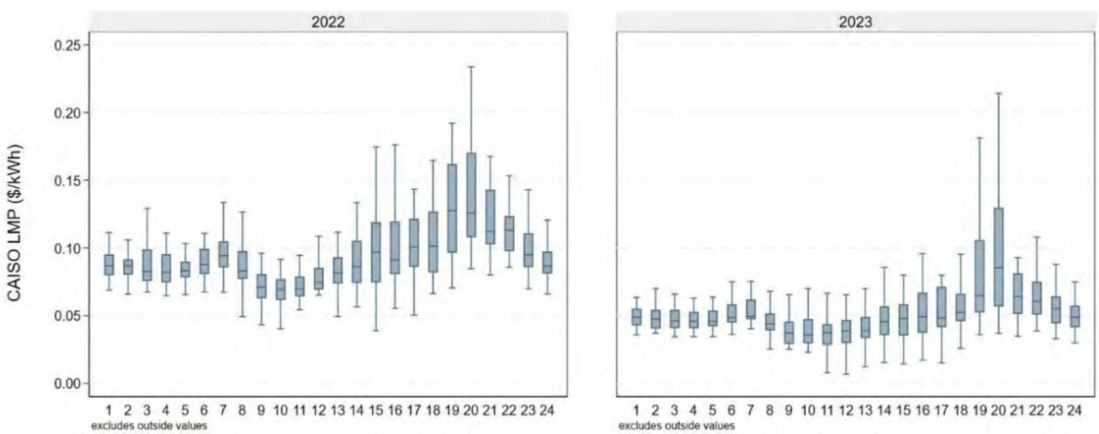
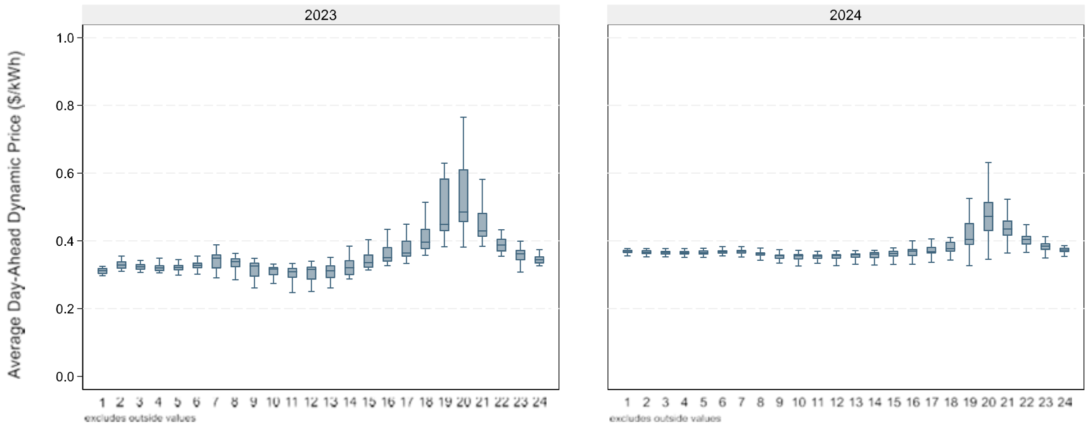


Figure 2.11 uses the same format as Figure 2.9 to compare prices in August 2023 and 2024. The insights from the entire growing season hold when looking only at August: the price profile in 2024 was flatter and less volatile than it was in 2023, further differentiating it from the prices in 2022 (when two-part pricing was in effect).

[24] Specifically, the figure summarizes hourly real-time market prices for the Aggregated Pricing Node PGAE.

Figure 2.11: Distribution of Hourly Day-Ahead Dynamic Prices, August 2023 vs 2024



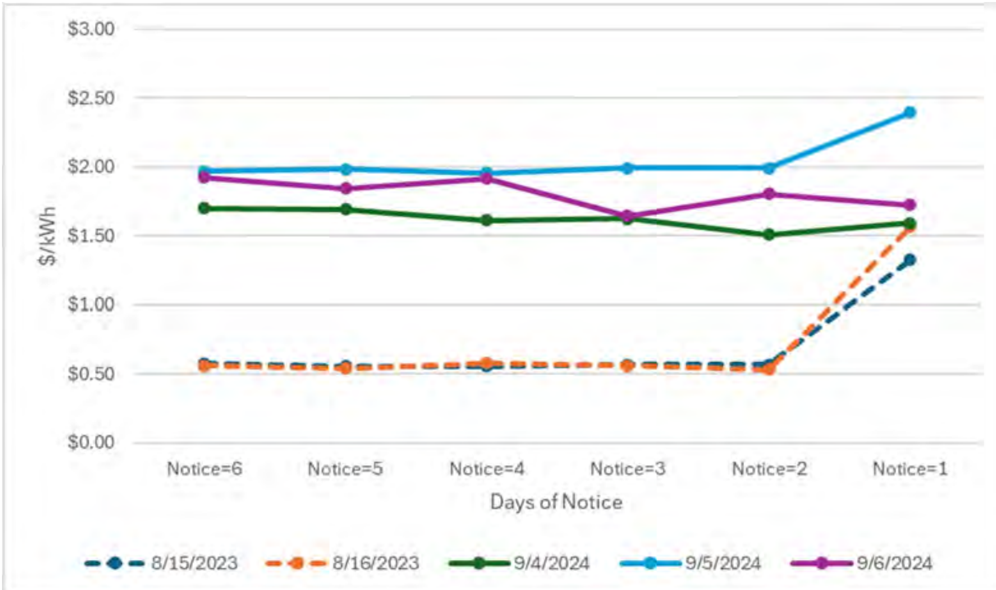
While the discussion above focuses on day-ahead dynamic prices, customers were provided dynamic price tenders up to seven days ahead of time. It may be instructive to illustrate how the tenders for the highest priced hours changed over time.

Figure 2.12 shows the tenders across notice levels for five high-priced hours during 2023 and 2024, with the 2023 days represented by dashed lines.[25] The figure shows a notable difference in the evolution of prices across notice levels across years. In 2023, the price spike only showed up one day ahead of delivery. In contrast, the 2024 prices were somewhat high across all notice levels, though there was some variation across them.

Our understanding is that the third-party vendor used to provide forecasts prior to the day-ahead (when CAISO market prices are used) changed in 2024, perhaps leading to an improvement in forecasting constrained conditions more than one day ahead of delivery.

[25] The figure shows prices averaged across the customers enrolled in the Pilot at the time.

Figure 2.12: Price Evolution for Select Days in 2023 and 2024



A potential implication of the figure is that prior to 2024, customers who planned pump activity two or more days in advance (and did not revisit their decision later) may not have been aware of when prices were at their highest. Our interviews confirmed that at least some customers were not aware that high-price hours occurred in 2022 and 2023.

2.3 Participant Summary

The customers enrolled in the Pilot are a mix of small, medium, and large agricultural customers that employ irrigation pumps to water different types of crops. The Pilot does not have a limit on the number of customers if the aggregate peak load of Pilot customers does not exceed 5 MW. Most enrolled Pilot customers have multiple pumps (service accounts). Figure 2.13 depicts the number of customers and pumps enrolled in the Pilot. There were two customers with a combined total of 17 pumps in September 2022. By September 2023, the enrollment count increased to five customers with a combined total of 33 pumps. In September 2024, seven customers were enrolled with a total of 60 pumps.[26]

[26] The figure shows the count of pumps with usage in that month, which is sometimes less than the number of enrolled pumps.

Figure 2.13: Enrollment Customer and Pump Counts

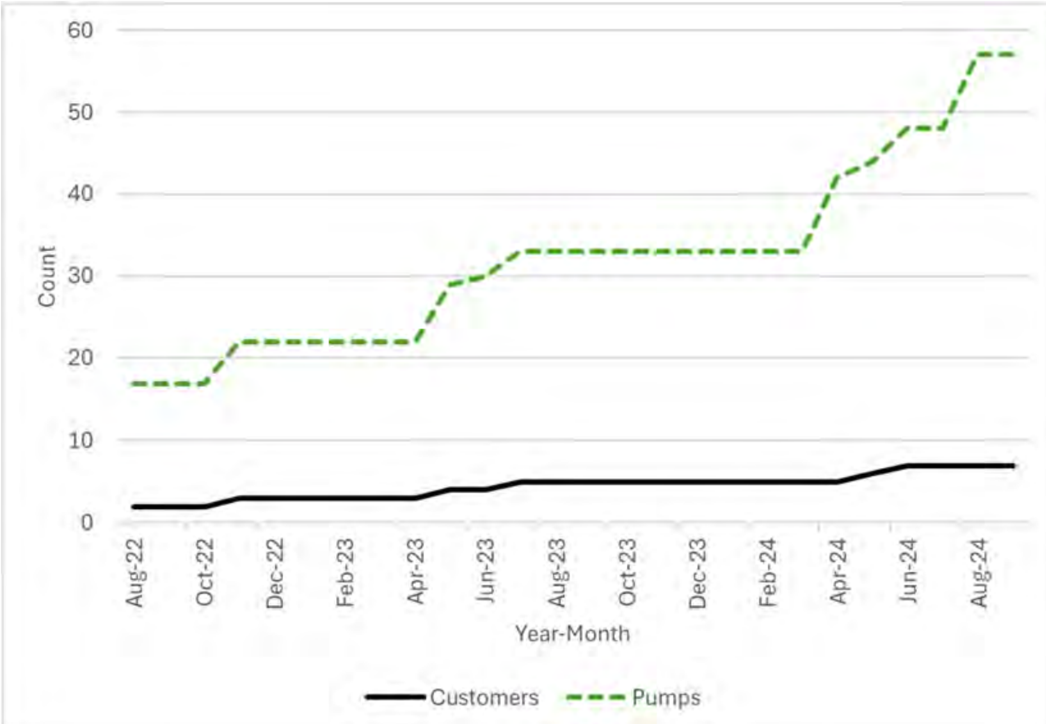


Table 2.3 provides characteristics information for each enrolled Pilot customer, including their start date, number of pumps, and usage. Note that we have anonymized the customer names in the interest of confidentiality. The two largest customers account for 62% of the enrolled pumps and 70% of the enrolled load (by PLUM kW).[27]

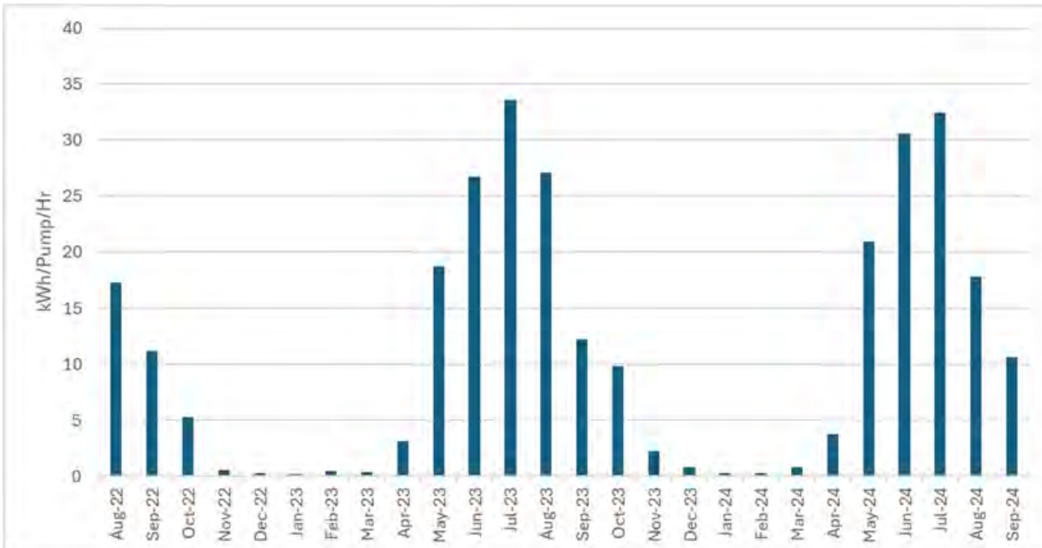
Table 2.3: Pilot Customer Characteristics

Customer	Start Date	# Pumps	# NEM Pumps	PLUM kW	NCP Max kW
C-001	8/1/2022	21	10	1,482	1,875
C-002	8/1/2022	9	3	362	463
C-003	11/11/2022	16	0	1,040	1,661
C-004	7/27/2023	9	0	420	426
C-005	5/27/2023	2	0	146	166
C-006	5/1/2024	2	0	106	115
C-007	6/10/2024	1	0	53	4
Total		**60**	**13**	**3,609**	**4,711**

[27] The "NCP Max kW" value indicates the non-coincident peak (NCP) for each pump, summed across pumps within each customer. Therefore, the total NCP Max kW value will not equal the maximum demand for the Pilot's aggregate load. The "PLUM kW" value uses the Peak Load Under Management (PLUM) methodology, calculated as the average load of each pump after removing hours when the pump is not running. The PLUM values can change over time. This is the measure that VCE used to track the kW enrolled in the Pilot.

Agricultural pumping loads vary by season. Figure 2.14 depicts the average usage per pump for each month.[28] Energy use ramps up during May, is comparatively high from June through August, and then declines during September. April and October appear to be shoulder periods when relatively little pumping is employed. Customer energy use is minimal from November through March.

Figure 2.14: Program Average Monthly Usage by Pump



Figures 2.15 through 2.23 show the average hourly usage from May through September for each customer, with separate profiles by year and enrollment status. Each profile represents the total across the applicable pumps (enrolled and not enrolled by year). The dashed lines reflect pre-Pilot (unenrolled) loads, and the solid lines represent enrolled loads. Note that not all combinations of enrollment status and year are available for every customer (e.g., some customers have no enrolled pumps in 2022 or 2023, and no customers have enrolled pumps in 2021). These figures provide an illustration of typical usage patterns under Pilot and pre-Pilot pricing. One feature to look for in each figure is the extent to which the customer appears to be managing peak-period usage in response to OAT demand charges. As we will describe below, two customers are notable in this regard.

Customer C-001's pumps are divided into two figures. Figure 2.15 shows the pumps that were actively managed by the customer, while Figure 2.16 shows three pumps that were not managed to Pilot prices, according to our interview with the customer. Figure 2.15 shows that the pre-Pilot load profiles were flat across the hours of the day, except for 2022. In Section 4.2, we will describe how the "notch" from hours-ending 18 to 20 likely reflects the use of automation to respond to OAT TOU incentives. The Pilot load profiles show less usage during (and near) peak-period hours, though the "notching" seen in the 2022 pre-Pilot loads is not present.

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[28] Because the composition of customers changes over time, the average usage per pump between months is not directly comparable in this figure.

Figure 2.15: Average Hourly Usage by Year and Enrollment Status, C-001 Managed

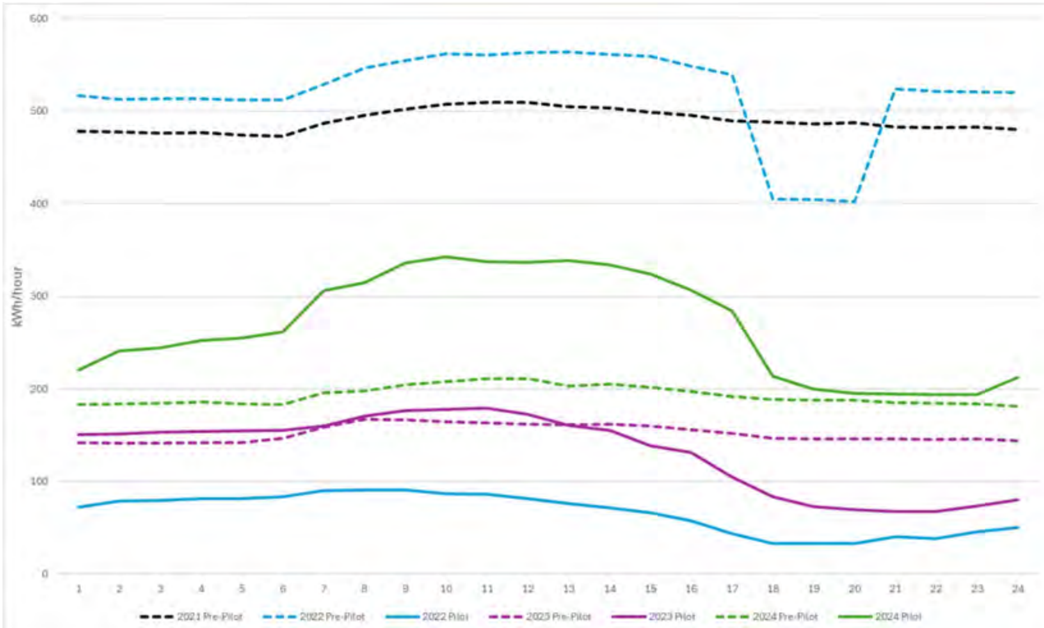


Figure 2.16 shows the load profiles for three pumps that customer C-001 was not managing to Pilot prices.[29] The figure reflects this, with no large differences in profiles by enrollment status.

[29] Customer C-001 had six pumps that had difficulty getting automation installed. The customer intended to respond to prices with these pumps at the time of enrollment, but the lack of automation did not allow it.

Figure 2.16: Average Hourly Usage by Year and Enrollment Status, C-001 Not Managed

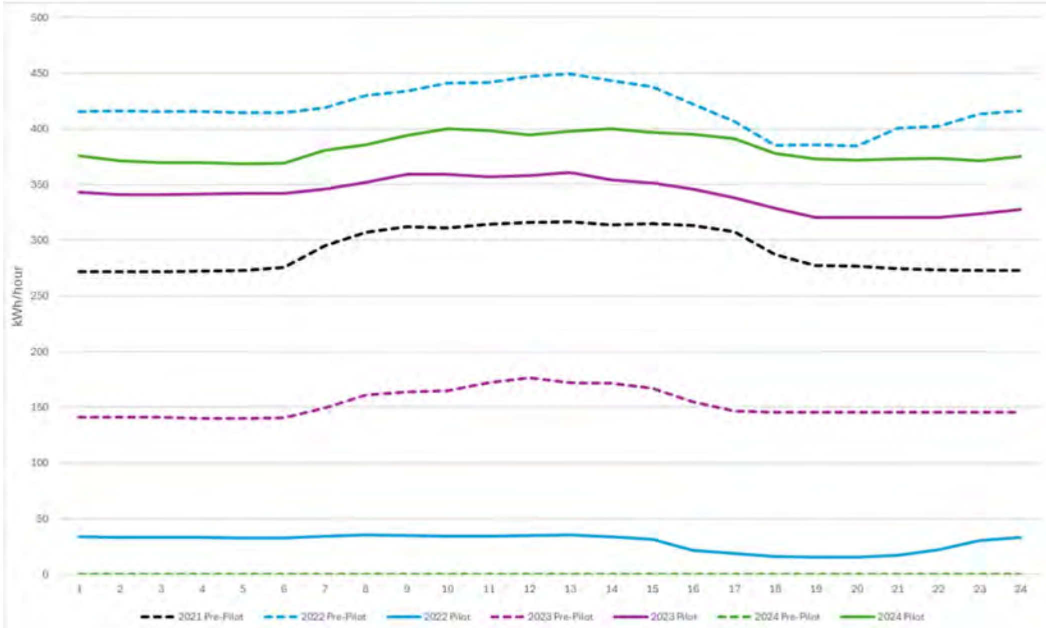


Figure 2.17 shows that customer C-002 also had the peak-period notch in the 2022 pre-Pilot load profile. This will also be described further in Section 4.2. Compared to the 2021 pre-Pilot load profile, the Pilot load profiles show relatively less usage during the higher-cost hours of the day (around HE 18 to 20), perhaps indicating price response.

Figure 2.17: Average Hourly Usage by Year and Enrollment Status, C-002

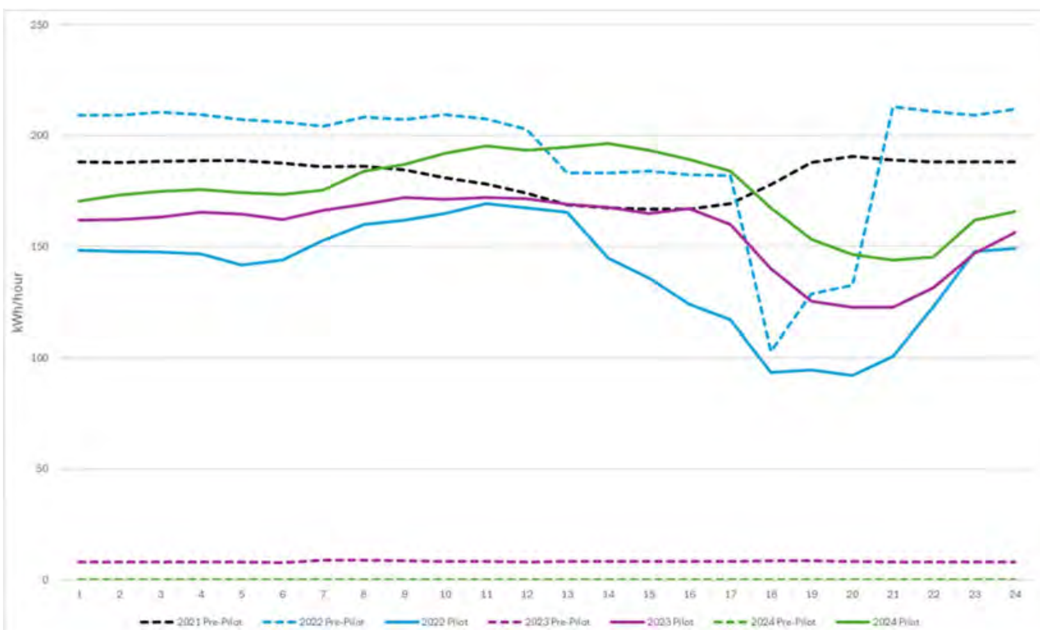


Figure 2.18 shows that customer C-003 manages peak-period usage regardless of whether they are on the Pilot. This has an important implication for analyses of their price responsiveness, which is that it is more likely to occur during off-peak hours. That is, the

customer responds to the OAT rate's demand charge during peak hours on an everyday basis, regardless of the dynamic price levels. However, they may be more responsive to variations in off-peak dynamic prices.[30]

Figure 2.18: Average Hourly Usage by Year and Enrollment Status, C-003

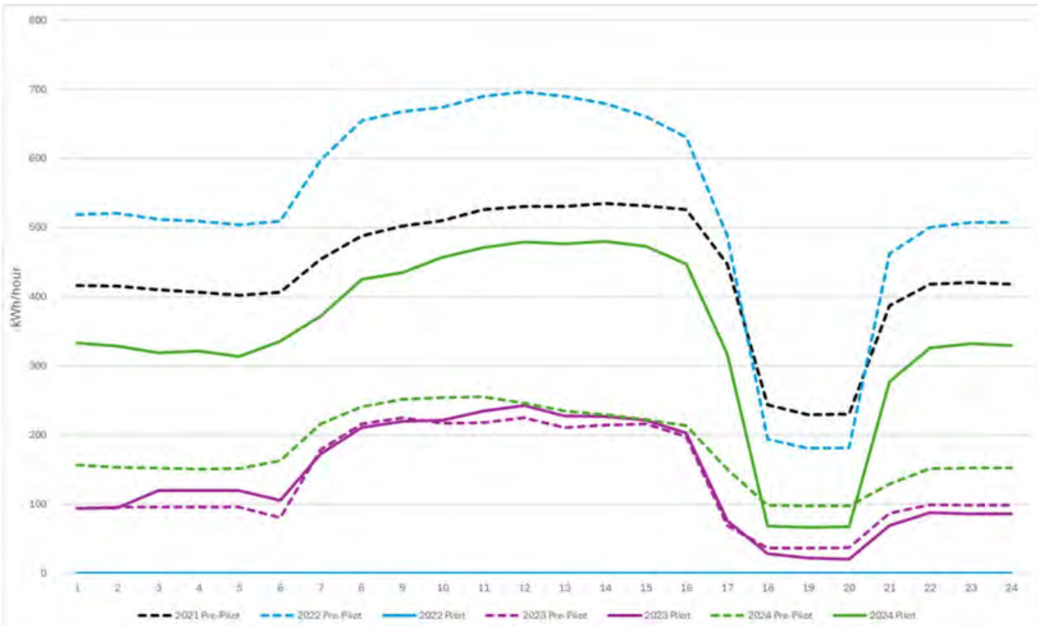


Figure 2.19 shows some evidence of customer C-004 managing peak-period demands (most notably in the 2021 pre-Pilot usage profile), but in general usage appears to be more concentrated in the daytime hours.

[30] Note that the pumps reflected in this figure are served on Schedule AG-C, which has a high summer Peak-period demand charge that gives the customer a strong incentive to avoid using during that pricing period.

Figure 2.19: Average Hourly Usage by Year and Enrollment Status, C-004

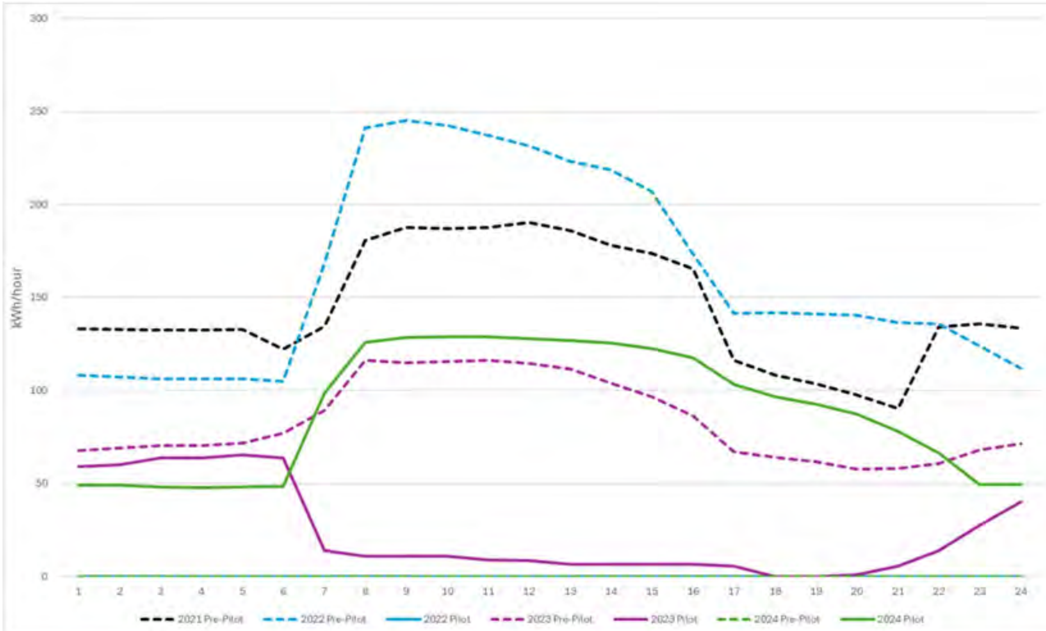


Figure 2.20 shows the usage profiles for the pump that customer C-005 actively managed. The most important point to note is that the customer never used energy from HE 17 to 21 during 2023 and 2024. During our interview, the customer said they continued to respond to OAT demand charges, but did play close attention to dynamic prices in other hours. We will find some evidence of this in our price response analyses.

Figure 2.20: Average Hourly Usage by Year and Enrollment Status, C-005 Managed

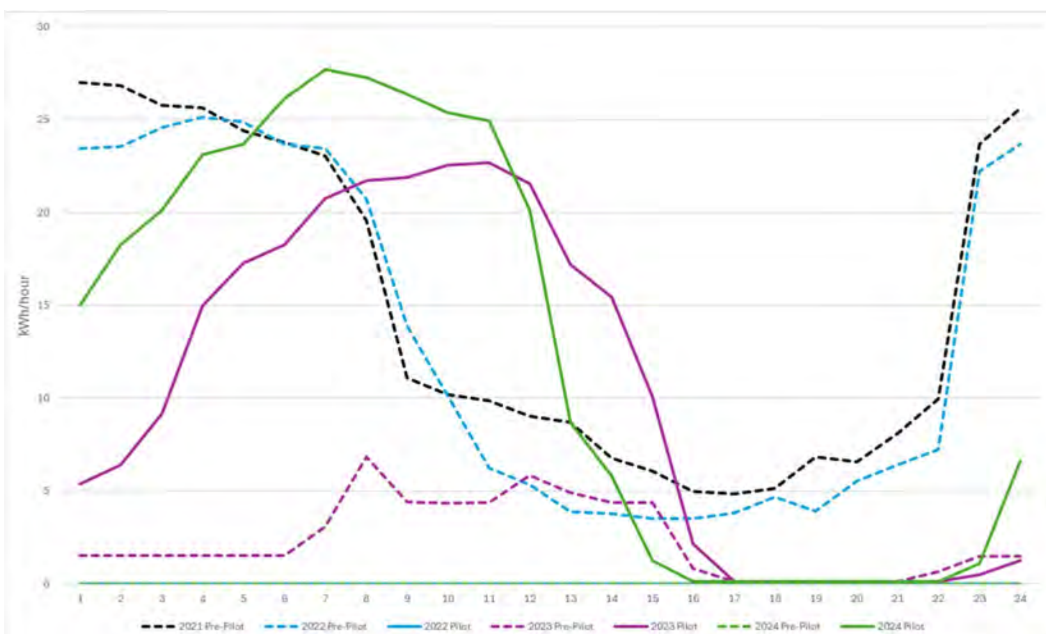


Figure 2.21 shows the usage profiles for the pump that customer C-005 leased to another Pilot participant. According to customer C-005 in our interview, the customer managing

this pump was not actively responding to dynamic prices. According to information conveyed by Polaris, the pump was rarely needed during the Pilot due to high surface water allocations. The relatively flat Pilot load profiles reflect the lack of price response, though the overall load level during Pilot years is low relative to pre-Pilot usage in 2021, supporting Polaris's information that pumping needs were not very high for this pump while it was enrolled in the Pilot.

Figure 2.21: Average Hourly Usage by Year and Enrollment Status, C-005 Leased

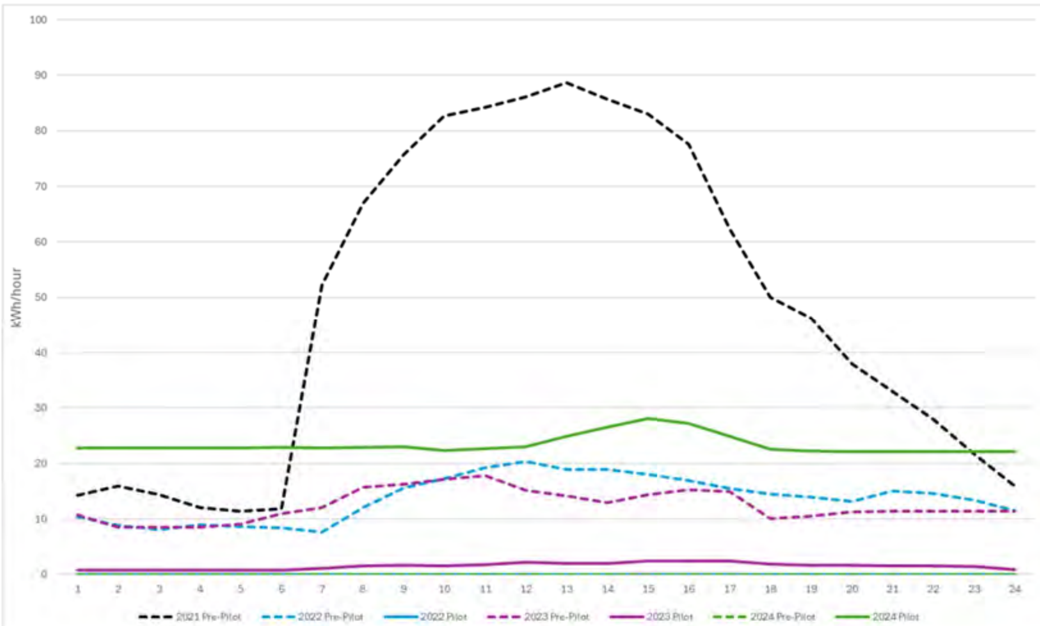


Figure 2.22 shows the usage profiles for customer C-006. The load profile during the Pilot period seems fundamentally different from the pre-Pilot loads. Given that some low-priced hours (e.g., HE 1-6) have lower usage during the Pilot, the shape differences may reflect differences in pumping needs across years rather than a response to Pilot prices.

Figure 2.22: Average Hourly Usage by Year and Enrollment Status, C-006

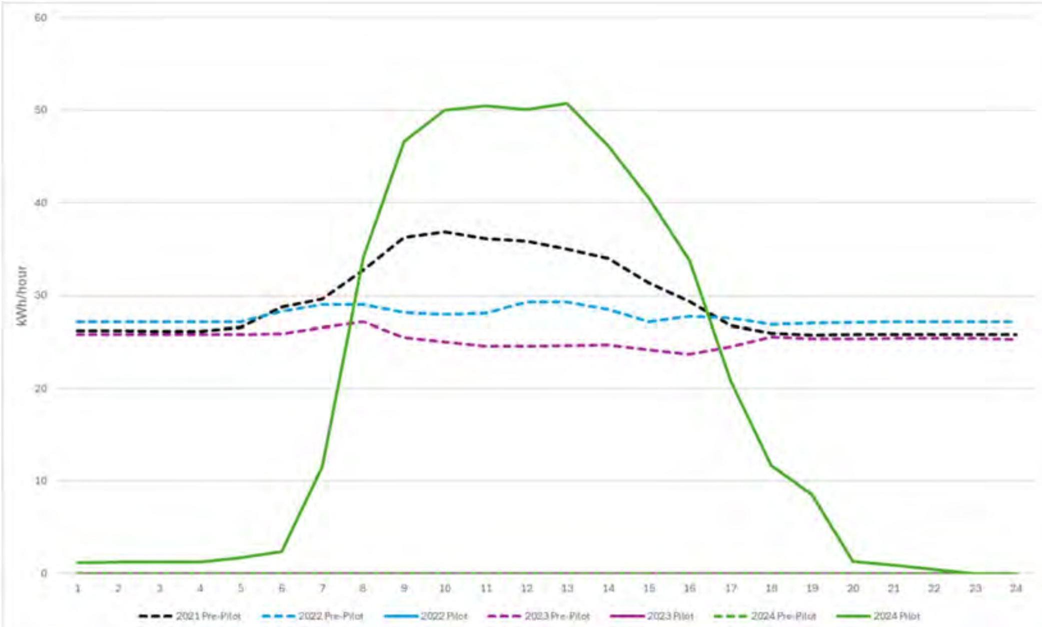
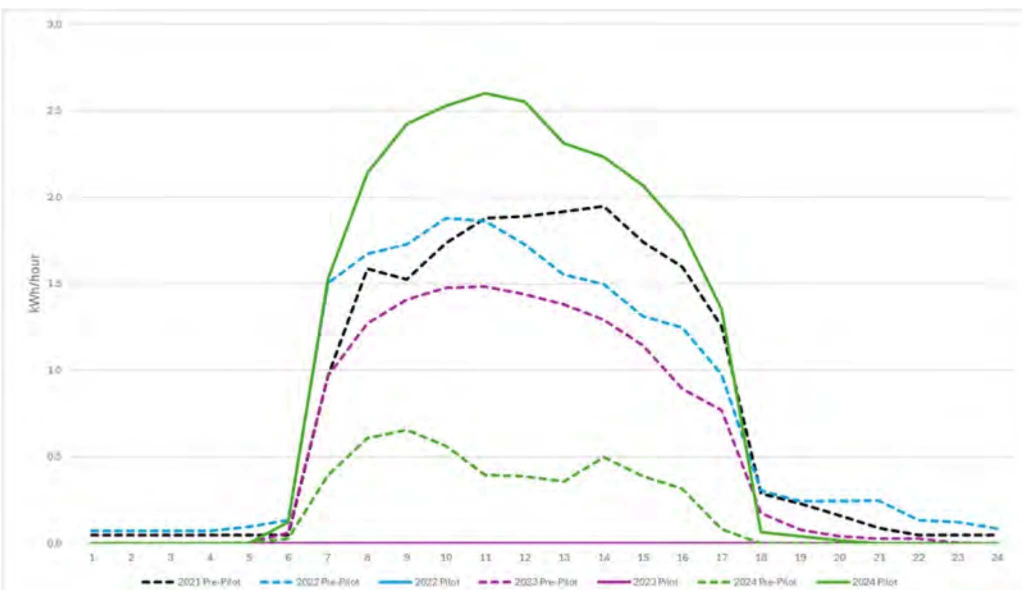


Figure 2.23 shows the usage profiles for customer C-007. Note that the load level is very low for this customer compared to other enrolled customers, peaking around 2.5 kWh/hour. The load shape is consistent across years and enrollment statuses, with pumping concentrated from HE 7-17, though the overall usage level varies.

Figure 2.23: Average Hourly Usage by Year and Enrollment Status, C-007



3 PARTICIPANT INTERVIEWS

Pilot participants were interviewed on two occasions during the Pilot. The first two customers to participate in the Pilot were interviewed by Polaris following the 2022 growing season. In August 2024, three customers participating during AgFIT 2.0 were interviewed.[31] The two sets of interviews are described in the sub-sections below.

3.1 Participant Interviews Following the 2022 Growing Season

Polaris provided us with video interviews of the two customers enrolled during AgFIT 1.0: customers C-001 and C-002. The interviews took place on December 15, 2022; therefore, the discussions focused on usage differences in 2022 versus 2021 due to installed automation technology more than due to dynamic pricing. There was only a limited period when customers were actively pumping and under AgFIT 1.0 pricing. Nevertheless, we summarize parts of the interview here since it provided insights into views regarding technology as well as factors that affect pumping behavior.

Customer C-001 had nine pumps installed during the AgFIT 1.0 summer period. While reviewing reductions during the TOU peak period for the months May through September in 2022, customer C-001 mentioned that the automation technology was the biggest factor contributing to the reduction. Higher prices were also a factor but not as much as the automation because by that point they had only received prices for a short period of time (August and September 2022) for a few of their pumps. Before having automation technology installed, customer C-001 knew when the TOU peak period was; however, it was difficult to avoid the peak period because it required sending out an employee to shut off the pump at the beginning and turn it back on at the end. Labor availability and additional overtime costs thus increased the costs to avoid the peak period.

During the interview, customer C-001 discussed pumping less in 2022 than the previous year. They indicated that the amount of surface water wasn't the cause of the difference, but crop rotation was. For example, the amount of TOU response is dependent on the crop type because specific crops need more water; therefore, the pump's response to TOU pricing is not as steep. In discussing the upcoming year (2023 at the time), customer C-001 indicated that the coming year's crops would require more irrigation.

Customer C-002 had eight pumps on the Pilot during the 2022 period. Customer C-002 indicated that in 2021, before installing automation technology, they would run their pumps regardless of the TOU peak period because of the labor challenges associated with changing employees in and out. In general pump usage was less in 2022 than in 2021 but there was also a TOU peak period reduction because of the automation. Customer C-002 suggested that the reduced usage in 2022 was due to having more control over when pumping was dispatched.[32] The automation technology allowed the ability to track

[31] We attempted to interview all five customers who participated in AgFIT 2.0 but were only able to schedule interviews with three of them.
[32] Customer C-002 indicated that crop rotation and surface water levels wouldn't have been the cause of the reduction.

pumps without having to send laborers out to the locations. This ability helped reduce errors due to not knowing whether the pump was incorrectly on/off.

Similar to the customer C-001 interview, customer C-002 indicated that the automation technology was convenient for employees to not have to go turn pumps on/off. TOU without automation was inconvenient and not worth the savings to avoid the peak period because of the additional labor costs. Customer C-002 indicated that there can be a negative side to the automation technology, that is, employees can become comfortable with the technology and assume it is working without checking it.

Customer C-002 mentioned some things that were instructive regarding how they respond to dynamic pricing and the platform. First, they indicated that they wanted the scheduling platform to have the ability to view weeks Monday through Sunday to better match their planning period.[33] Second, customer C-002 indicated that while some pumps run all the time, their plan was still to avoid specific high price thresholds (e.g., $0.30/kWh). However, if overall price levels increased, the customer's price threshold would also increase if there was a need to get a certain number of pumping hours – in other words, the price threshold was essentially a way to get the pumps to run during the lowest-priced hours while still pumping the required hours per week. This provides evidence that price thresholds are used by the customer to manage price responsiveness.

3.2 Participant Interviews During the 2024 Growing Season

Three customers were interviewed in August 2024: C-001, C-003, and C-005. A presentation was provided to the customer prior to the interview to help guide the discussion. It included the following elements:

- Comparisons of average hourly usage in 2022 and 2023: facilitated discussions of differences in usage across hours and years.
- Pump scheduling decisions: encourage customers to describe when/how they scheduled pumping.
- Effects of Pilot technology and pricing: discuss whether/how operations were affected by automation and/or dynamic pricing.
- Review usage on the highest-priced days in 2023 (August 15-16) to explore customer awareness of and response to high prices.
- Show shadow bill credits during AgFIT 2.0 and ask about alignment with the customer's expectations.
- Conclude with open-ended questions about their overall views of the Pilot.

The following key points emerged from the discussions:

- Pumping needs can vary significantly across years due to factors such as changing hydrological conditions or crop rotation. In addition, pumps frequently have operational constraints that could prevent the customer from responding to prices. This can include needing to run 24/7, not needing to run at all, or having

[33] This feature was added to the interface based on this feedback from the customer.

minimum run times (e.g., a minimum of six consecutive hours to meet the crop's needs).

- Automation allowed the customers to take advantage of TOU and dynamic pricing. Prior to automation, it was difficult to have people available to manually turn pumps on and off to match the TOU pricing periods. However, even with automation, some labor is required to inspect the pumps for proper operation (e.g., checking for leaks and confirming flow rates).
- One customer used automation from a vendor other than Polaris and reported no problems in using the technology in combination with Polaris's scheduling software.
- One customer noted that automation was expensive and he would not have been able to adopt it without the Pilot incentives.
- Customer scheduling behavior varied. C-001 primarily scheduled on Sunday and did not revisit prices later in the week. He tried to concentrate pumping on weekends when prices were lowest. C-003 would schedule in two blocks: Saturday through Monday and then for Monday through Friday. He was not concerned about prices changing during the week, particularly during "must-run" times. C-005 checked prices at least once a week and typically more often than that. He usually scheduled pumping on the day-of or a day ahead.
- Customers reported differences in behavior in 2023 and 2024. The lower price differentials in 2024 gave them less incentive to pay close attention to prices. One customer reported trying to take full advantage of negative prices in 2023 (even when it was not necessarily in the best interest of the trees in the orchard), but did not see negative prices in 2024.
- Customers did not recall being aware of the highest-price days in 2022 and 2023. One customer had no need for pumping at the time of a price spike and therefore he wasn't paying attention to prices. Customer C-005 was already responding to OAT demand charges by avoiding pumping during the peak-period and thus would not have been concerned about high dynamic prices in those hours.
- One customer reported that it's easier to respond in spring when there's plenty of water, but harder to be flexible later in the growing season.
- Customers wanted more frequent and comprehensive feedback. It was difficult for them to connect their actions with bill savings. It would be easier to learn what works if they received more frequent feedback.
- Two customers reported that they continued to manage usage in response to the OAT demand charge (i.e., avoiding use from 5 to 8 p.m.), while a third said he primarily looked at hourly prices but also considered OAT prices when scheduling usage.
- All three customers were generally happy with the Pilot but would like to learn more about the benefits they get from the extra work it takes to schedule usage with dynamic prices. One expressed concern that his pumps are not flexible enough to make it worthwhile in the long run and thought that the most flexible pumps (even at other farms or orchards) might be the smaller ones, with a corresponding reduction in the scale of the potential benefits of the pricing method.

- Customer C-005 has recommended the Pilot to others and likes the pricing from a conceptual perspective. However, he thinks many farmers will have less flexibility than he does, and he noted that it is easier to manage usage on a TOU rate. Pilot participation required a significant time commitment. There's complexity in dealing with prices while dealing with operational constraints.
- Customer C-003 reported that price differences need to be large enough to make shifting worthwhile.

4 EVALUATION OF LOAD RESPONSIVENESS

4.1 Overview of Methodologies and Results

In this section, we evaluate whether and how customers changed their usage while on the Pilot. Several methods are employed, including:

- Comparisons of pre-Pilot and Pilot loads;
- Comparisons of Pilot usage on high-price and comparison days; and
- Statistical analyses of changes in usage in response to dynamic prices.

The analyses are limited to months when Pilot customers have demand for pumping (August and September 2022 for AgFIT 1.0; and May through September for AgFIT 2.0 and 2.1).

The findings indicate the following:

- Comparisons of pre-Pilot to Pilot hourly usage profiles for the first two enrolled customers provide evidence of changes in typical customer usage patterns once automation is introduced, with the response occurring under both TOU and dynamic pricing.
- Comparisons of usage profiles on high-price and comparison days provide mixed evidence of larger price response on higher-priced days. In some cases, there did not appear to be usage to curtail during the high-price hours (either because the customer didn't need to pump at all that day or because they were already avoiding the TOU peak period due to the OAT demand charge). In other cases, the differences in loads across day types was consistent with price response. Some customers had load differences that were not consistent with price differences and thus were likely due to differences in pumping needs across days, unrelated to price.
- The statistical analysis, which examines customer responses to Pilot dynamic prices, found evidence that two customers responded to prices during off-peak hours, but did not respond during peak hours. This is consistent with our interviews with one of them, which indicated everyday management of peak

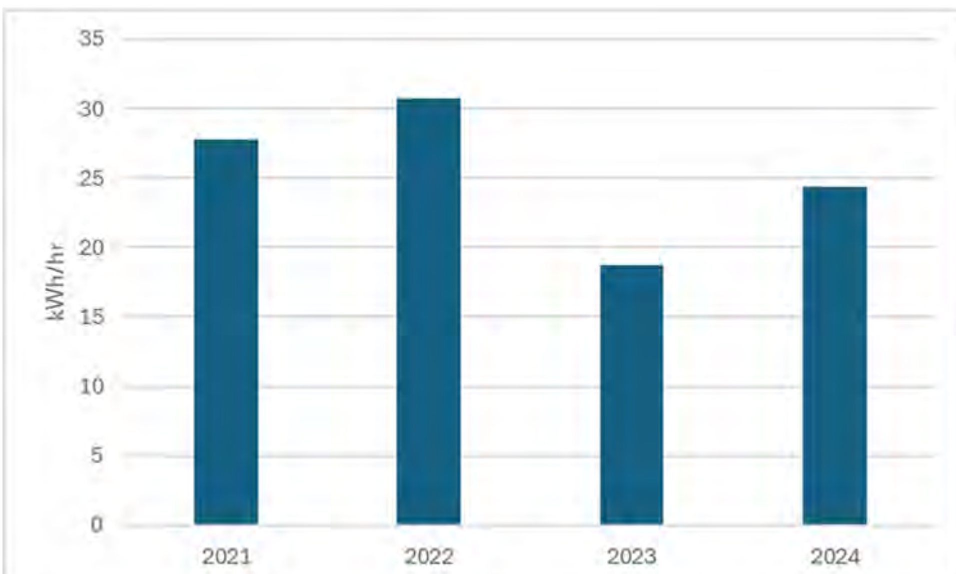
usage in response to the OAT demand charge, but response to prices in other hours.

4.2 Pre-Pilot Versus Pilot Usage Comparisons

One potential measure of the Pilot's effect is to compare typical usage profiles prior to the Pilot to those during the Pilot. However, simple comparisons of pre-Pilot and in-Pilot usage patterns are likely to be misleading when applied to agricultural pumping customers. That is, a pump's usage can vary significantly across years due to changes in hydrological conditions and crop rotations. To illustrate how overall pumping demand can vary across years, we graphed average usage per pump during the May to September growing season for the pumps that enrolled in the Pilot at some point.

Figure 4.1 shows how pumping needs varied from 2021 through 2024. All pumps are reflected in each year, with the share of enrolled load increasing from 0% in 2021 to nearly 100% in 2024 (not all pumps were enrolled for the entire summer of 2024). Customer C-003 told us that their energy needs were much higher in 2022 than 2023, requiring them to use approximately 25% more energy in 2022.[34] This is reflected in the figure, with average use per pump falling by 39% from 2022 to 2023. Because of these differences across years, we do not believe the evaluation of price response should be based on pre-Pilot vs. in-Pilot usage comparisons.

Figure 4.1: Average Usage by Pump from May to September by Year



[34] According to Polaris, the difference in usage across years is due to a very dry winter before the 2022 growing season causing: 1) more pumping to be necessary; 2) water tables to be lower so pumping required more energy; and 3) low or no surface water allocation. This contrasted with a very wet winter prior to the 2023 growing season, almost reversing the effects of the prior winter: 1) more surface water allocations leading to less reliance on well pumping; and 2) more rain leading to higher water tables so less energy to pump when the wells were needed.

That said, there is one comparison we can make that provides some anecdotal evidence of the effect of automation on TOU price response. Specifically, two Pilot customers, C-001 and C-002, had automation technology installed on pumps that were on time-of-use (TOU) pricing before being introduced to dynamic pricing.[35] This allowed us to compare how usage changed between technology and price regimes; first with no automation technology but TOU prices, second with automation technology and TOU prices, and third with automation technology but now with dynamic prices. The automation technology was installed in July 2022 while dynamic pricing went into effect in August 2022 for these customers' pumps. Therefore, the month of July between the years 2021 through 2023 can be used to compare usage under the different technology and price regimes. Again, it is important to note that other factors can affect usage levels and patterns across years, including variations in the planted crops and differences in hydrological conditions.

Figure 4.2 illustrates the average hourly usage for customer C-001's pumps that had automated technology installed before receiving dynamic prices. July usage is shown for the years 2021 through 2023. The 2021 usage (blue line) remained relatively flat throughout the day and therefore did not include a reduction during the TOU peak period (HE 18-20). The 2022 usage (orange line) represents usage when the customer's pumps had automation technology but were still under TOU pricing. There is a noticeable decrease in 2022 usage during the peak TOU period relative to 2021. The comparison between 2021 without technology and 2022 with technology is suggestive that the automation technology helped the customer respond to the TOU peak period. The 2023 usage (green line) represents when the customer's pumps had automation technology and faced AgFIT 2.0 pricing. Compared to 2022, the usage in 2023 illustrates a wider reduction around and after the TOU peak period, though at a lower magnitude. The 2023 usage pattern aligns with the AgFIT 2.0 price pattern (see Figure 2.7).[36] Therefore, the automation technology appears to also have helped the customer respond to dynamic prices.

[35] There were eleven pumps between the two customers that fall into this category.

[36] From Figure 2.7, the highest average prices occurred about an hour later than the 5-8 p.m. Ag peak period (the highest prices were HE 19-21, e.g., 6-9 PM). Likewise, the usage reductions under AgFIT 2.0 pricing were shifted later in the day compared to the TOU-based reductions. Aggregate decreases below the mid-day "baseline" (i.e., total reductions over all hours from 2 p.m. to midnight) were also greater under AgFIT 2.0 than under TOU rates.

Figure 4.2: Automation and Pricing Regime Usage, C-001

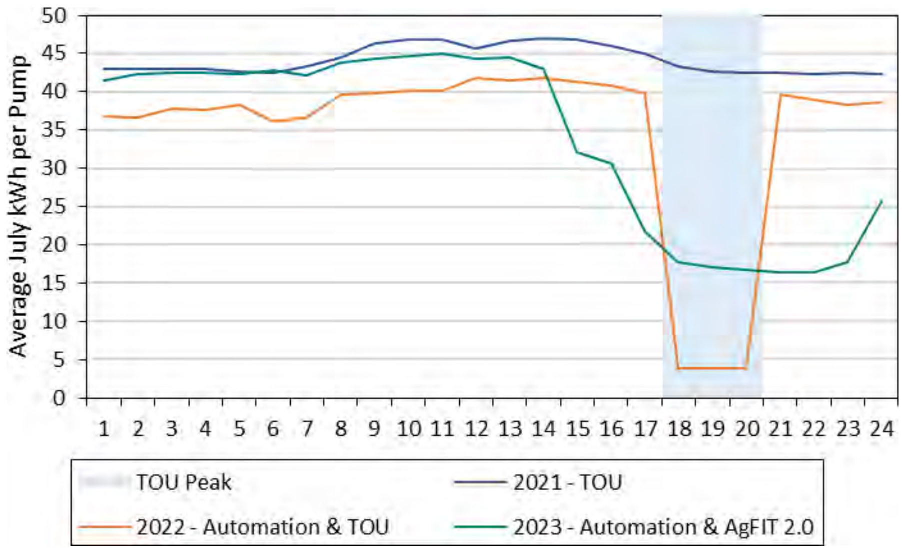
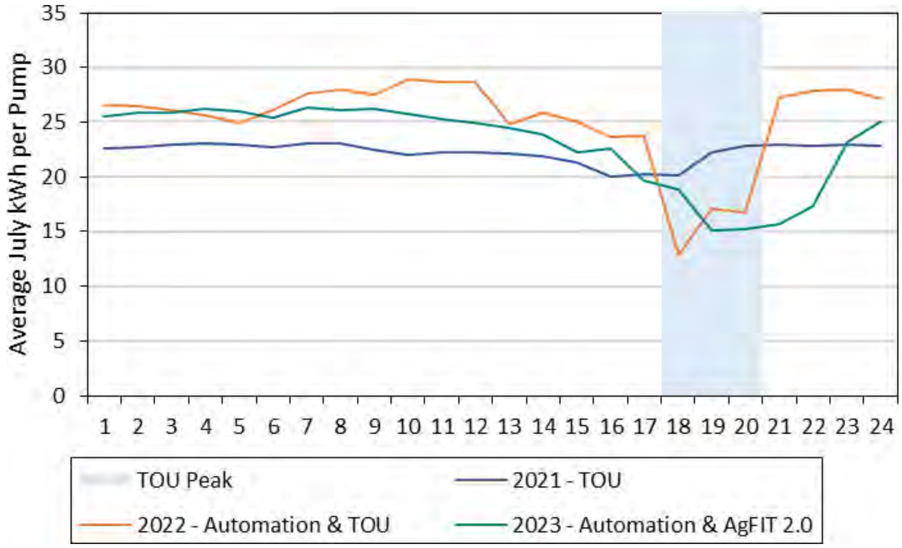


Figure 4.3 contains the same July comparisons for customer C-002's qualifying pumps. The 2021 usage without technology is relatively flat with no reduction during the TOU peak period. In contrast, the introduction of automation technology under TOU prices, reflected in the orange 2022 line, shows a reduction during the TOU peak period. The usage in 2023, when the customer faced AgFIT 2.0 prices, also exhibits a reduction during the TOU peak period but is again later, spread out in the surrounding hours, and greater in overall magnitude. The comparison between usage under the different technology and price regimes is suggestive that the automation technology was useful to enable load response to both TOU and dynamic pricing.

Figure 4.3: Automation and Pricing Regime Usage, C-002



Taken together, these comparisons provide evidence of changes in typical customer usage patterns once automation is introduced, with the response occurring under both TOU and dynamic pricing.

4.3 Comparisons by Price Day Types

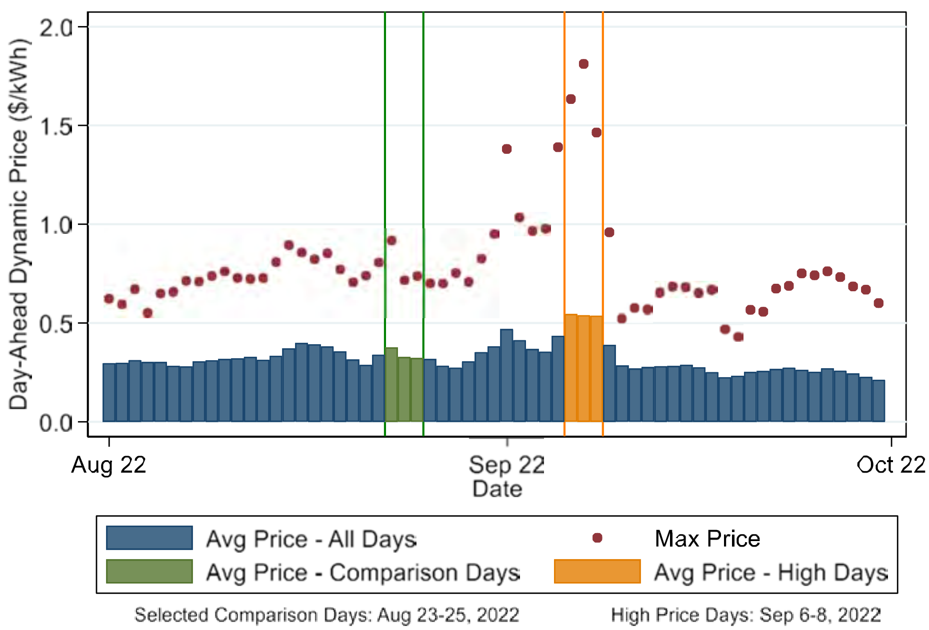
In this section we discuss results from comparisons between usage on high-price days and a set of comparison days. The analysis is completed for the August and September 2022 period when AgFIT 1.0 was in place, the May through September 2023 period when AgFIT 2.0 prices were in place, and the May through September 2024 period when AgFIT 2.1 prices were in place.

The set of comparison days is intended to serve as a counterfactual and indicate what the customer loads would have been if the dynamic prices had not increased above typical levels. Importantly, the two sets of days should be somewhat close to each other in time because the demand for pumping varies over the season. This comparison can illustrate the extent to which customer behavior changes across price day types. However, pumping needs can change across days for reasons we don't know, which affects our ability to attribute differences in usage profiles to dynamic prices.

We selected "high-priced" days as the days with the highest single-hour prices. However, it was the case that the two dates in each growing season that had the highest maximum price also had the highest average daily price. The following three figures highlight the dates selected as high-priced days and comparison days. The blue bars represent the average daily price while the red dots represent a maximum price for each date. The orange bars mark the days that have the highest average and maximum prices during each year. The selected comparison days are depicted by the green bars. Comparison days were selected to match the day of week for the high-priced days, be near the high-price dates, and have typical (rather than high) price levels.[37] As will be shown in the customer-specific hourly figures below, the two day types tend to have similar prices during the overnight and morning hours. The higher prices are limited to afternoon and evening hours.

Figure 4.4 shows the day selections for the 2022 growing season. In this case, the highest-priced days occurred near the end of the growing season. Selecting comparison days following that period would likely have included dates on which pumping was not required for some pumps. The week immediately prior to the high-priced days (September 6 through 8) also had somewhat high prices, so we selected dates during the week of August 22nd (two weeks before the highest prices occurred). For the 2023 and 2024 growing seasons (shown in Figures 4.5 and 4.6, respectively), we were able to select comparison days from the week prior to the highest-priced days. Note that pumping needs can change significantly from week to week, which limits our ability to attribute usage differences across day types to price effects.

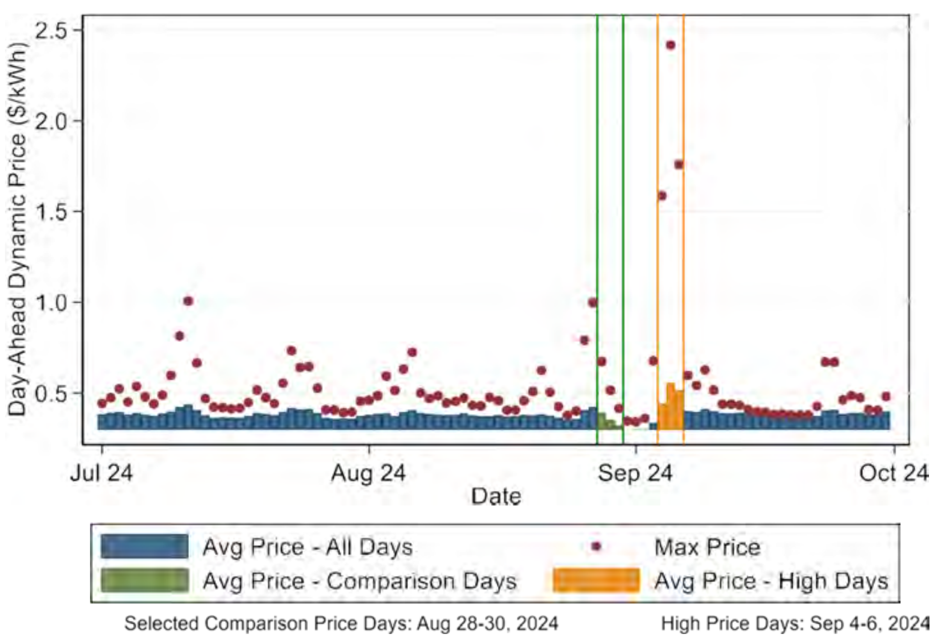
Figure 4.4: AgFIT 1.0 Daily Prices and Selected Comparison Days, August – September 2022



[37] While pumps may operate on any day of the week, limiting our comparisons to the same weekdays helps control for any factors that may change by day of week. For example, a customer primarily scheduling usage during the weekend may affect the typical amount of notice at which the customer transacts by day of week.

Figure 4.5: AgFIT 2.0 Daily Prices and Selected Comparison Days, July – September 2023

Figure 4.6: AgFIT 2.1 Daily Prices and Selected Comparison Days, July – September 2024



In the following figures, we compare average hourly prices and loads across the two day types. Each year is presented as a two-figure panel, with the top panel showing average prices and the bottom panel showing average usage. The dashed lines represent the high-priced days and the solid lines represent the comparison days, with separate figures by year. (The scales are kept constant across years to facilitate comparisons.) Appendix A presents the same information for each customer.

Figure 4.7 shows that prices for the two day types began to diverge in HE 12, with the difference being largest from HE 18 to 20. In contrast, usage differences across day types exist in nearly all hours, suggesting a difference in pumping demand across day types rather than price response (i.e., the usage difference exists even in hours with very similar prices).

Figure 4.7: High Price vs. Comparison Day Usage and Prices, All Enrolled Customers, 2022

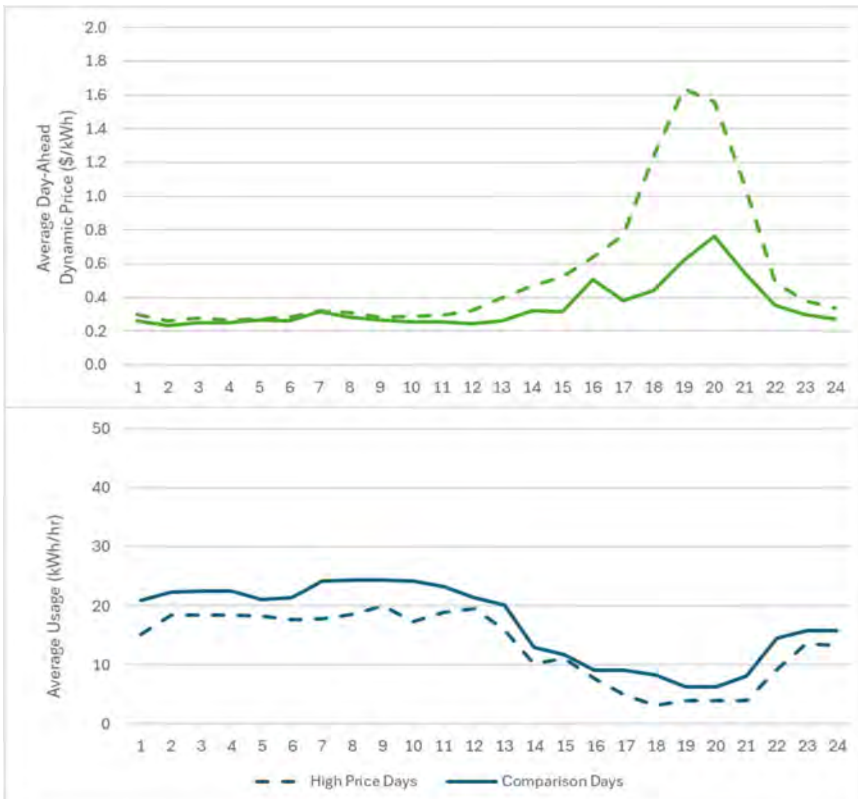


Figure 4.8 shows a similar story for 2023, with prices diverging a couple hours later than in 2022, but once again with usage differences occurring in hours with and without price differences across day types.

Figure 4.8: High Price vs. Comparison Day Usage and Prices, All Enrolled Customers, 2023

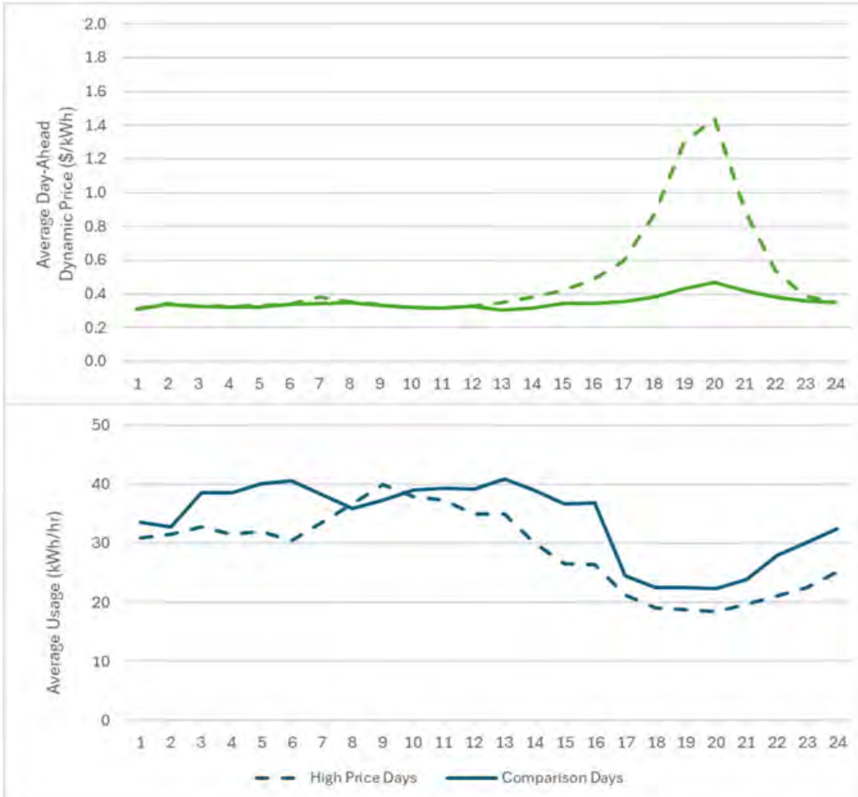
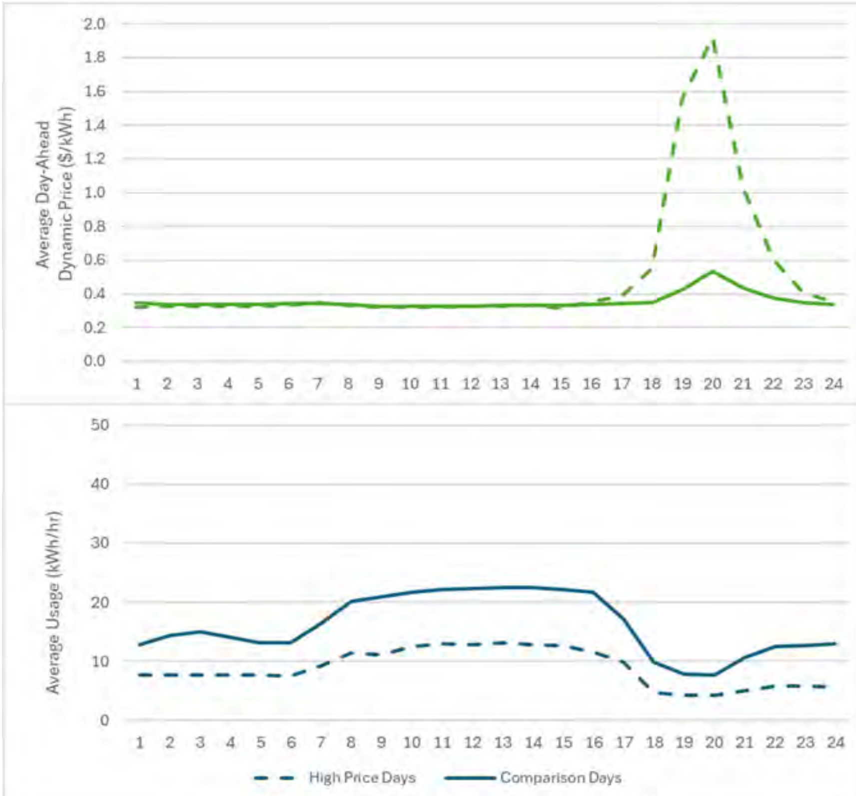


Figure 4.9 shows that 2024 differs from the earlier years by having prices remain similar across day types through more of the day, with an especially pronounced price difference in hours-ending 19 and 20 ($1.14 and $1.39 higher on the high-price days, respectively). In contrast, the usage profile reflects a downward shift across all hours on the high-price days with little additional response during the highest-priced hours (HE 19 and 20).

Figure 4.9: High Price vs. Comparison Day Usage and Prices, All Enrolled Customers, 2024



Conclusions from the Price Day Type Comparisons

A few conclusions may be drawn from the comparisons of usage across price day types. This includes insights that can be gleaned from the customer-specific figures in Appendix A.

- Because the highest-price hours tend to occur in the same hours as the TOU peak period, customers who are (rationally) still responding to OAT prices by limiting peak-period usage may not have much remaining usage to curtail during high-price days.
- Some customers may not typically have usage (unrelated to OAT response) during the highest-price hours, so further reductions in response to price spikes are not possible.
- Other operational constraints may prevent customers from responding to price spikes.
- Customers may not be aware of the price spike (which was confirmed in customer interviews) if the prices at the time of scheduling did not yet reflect constrained conditions (e.g., they scheduled on Sunday and the price spike happened on Friday, with the 5-day ahead forecast on Sunday not reflecting Friday's price spike).

4.4 Statistical Estimates of Load Impacts

4.4.1 Methodology

The statistical estimation of load impacts incorporates the full set of days in the analysis to model customer usage as a function of the hourly day-ahead dynamic tender prices. In contrast to the day-type comparisons that rely on a small set of days, the regression models are used to discover how customers' pumping behavior responds to Pilot prices over a longer period of time. The results presented below provide mixed evidence of customer response to dynamic prices. Estimates for two customers reflect response to dynamic prices during TOU off-peak hours but not peak hours. This is likely because they manage peak usage on an everyday basis to minimize their billed demand on their OAT rate.

The regression analysis uses the following specification:

$$nkW_{it} = b^{Price} \times Price_{it} + b^{kW\_MA} \times nkW\_MA_{it} + b^{Price\_MA} \times Price\_MA_{it} + b^{Dtype\_Controls} \times Dtype\_Controls_t + \sum_{h=1}^{H} (b_h^{hour} \times Hour_{h,t}) + \sum_{p=1}^{P} (b_p^{Pump} \times Pump_{p,i}) + e_{it}$$

The variables and coefficients in the equation are described in Table 4.1:

Table 4.1: Regression Variables

Symbol	Description
nkW_{it}	the demand in hour *t* for a Pilot customer pump *i* divided by the pump's maximum observed hourly usage
The various b's	the estimated parameters
$Price_{it}$	The Pilot program day-ahead price during hour *t* for pump *i*.
nkW_MA_{it}	the three-day moving average of daily usage for pump *i* during hour *t* divided by the pump's maximum observed hourly usage
$Price\_MA_{it}$	the three-day moving average of day-ahead prices for pump *i* during hour *t*
$Dtype\_Controls_t$	set of control variables for day type in hour *t.* The set includes year-month and day of week fixed effects.
$Hour_{h,t}$	an indicator variable for hour *h*, equal to one when *t* corresponds to hour *h* of a given day
$Pump_{p,t}$	an indicator variable for pump *p*, equal to one when *i* corresponds to pump *p* for a given observation
e_{it}	error term for Pilot customer in hour *t*

The dependent variable is normalized by dividing each hour's usage by the pump's maximum observed usage. This helps with the interpretation of the estimated coefficients. We model usage as a function of the day-ahead prices because they are the last prices presented to the customers before the usage hour in question. While the customer may have transacted at earlier dynamic tender prices (e.g., three days ahead) at a fixed quantity, the day-ahead price represents the customer's last transaction opportunity and the best estimate of the ex-post price used in settlement.

The estimated coefficient on price is the key parameter since it indicates the change in kWh associated with a change in price, all else equal. In other words, the price coefficient represents the extent to which the customer responds to the day-ahead dynamic prices. The three-day moving average of quantity is included to control for differences in pumping demand over the growing season.[38] The three-day moving average of the day-ahead tender price is included to control for substitution of pumping demand from previous days. For example, customers may substitute their usage from previous days to the current day if recent prices have been high, all else equal.

We include an interaction of the price variable with a peak-period indicator variable (defined as hours-ending 18 through 20). The estimated coefficient on the standalone price variable represents the customer's price responsiveness during all hours while the coefficient on the peak-interacted price variable (labeled "Price X Peak" in the table below) reflects the incremental price response during peak hours. The interaction variable allows the price responsiveness to vary by TOU pricing period, which could occur if customers respond proportionately more to higher prices (the dynamic prices tend to be highest during TOU peak hours), or response to dynamic prices during peak hours could be muted compared to other hours if customers are managing their OAT billed demand on most or all days.

The model includes additional variables to explain typical usage patterns, independent of the dynamic prices. These include hour-specific indicator variables, day-of-week indicator variables, and year-month indicator variables.

The regression model is estimated separately for each customer using all hours of the day. This allows us to control for unobservable differences between customers while also providing different estimates of price responsiveness. For customers with multiple pumps, we estimate the regression using a panel model containing all the pumps and include pump-specific fixed effects while clustering the standard errors around the pump. The models are separately estimated for the AgFIT 1.0, 2.0, and 2.1 periods.

4.4.2 Results from the Statistical Model

Table 4.2 provides the estimated price coefficients with p-values in parentheses from regression specification described in Section 4.4.1.[39] The estimates are provided for three separate time periods: August and September 2022 (AgFIT 1.0), May through September

[38] Pumping demands generally increase over the summer period. A spurious positive correlation between usage and price occurs if AgFIT prices also increase over the same period. Controlling for changes in pumping demand over time prevents confounding usage changes from increased demands with increased prices.

[39] Table B.1 in the appendix provides additional regression summary statistics, including the number of observations and R^2.

2023 (AgFIT 2.0), and May through September 2024 (AgFIT 2.1).[40] For each pricing period, we show the estimated coefficient on the standalone price variable and the price variable interacted with peak hours. The estimated coefficients can be interpreted as the percentage reduction in usage relative the pump's peak highest hourly usage in response to a $1 per kWh price change. For example, a value of -0.5 would mean that the customer decreased their usage by 50 percent of their peak hourly usage when prices increased by $1/kWh. Therefore, greater negative coefficient values suggest higher response to prices. Positive values suggest that customer increased usage when prices increased. Such estimates likely indicate omitted variable bias (a factor unknown to the analyst that affects the customer's pumping demand). Bold values indicate a p-value less than 0.05.

It is important to note that the "Price x Peak" coefficients should be interpreted as an *incremental* impact reflecting the difference between the price response during the Peak period and the response across all hours. For example, customer C-005's AgFIT 2.1 estimates are 0.703 in all hours with a Price x Peak estimate of -0.776. Therefore, the total price response during the Peak period for this customer is 0.703 + (-0.776) = -0.073.[41]

The estimates show no statistically significant price response under AgFIT 1.0. Under AgFIT 2.0, two customers (C-004 and C-005) show strong price response outside of the peak period (as represented by the -1.325 and -0.672 coefficients in bold). The offsetting peak-period interaction effect shows that there's no corresponding price response during peak hours. This may be because these customers managed peak-period usage on an everyday basis to manage billed demand on their OAT rate. The managed loads at C-001 have estimates that point toward a similar type of response, though its price coefficient falls short of being statistically significant. Customers C-004 and C-005 did not exhibit statistically significant price response during AgFIT 2.1. In our interviews with them, customer C-005 noted that the incentives to respond seemed lower in 2024 than 2023, which affected the extent of their response.

Two customers have statistically significant price estimate during AgFIT 2.1, though the signs of the estimates point toward a spurious effect. That is, the all-hours price response indicates that the customer uses more when prices increase, with the interaction estimate showing essentially no price response in the peak period (i.e., the "Price" and "Price x Peak" coefficients approximately offset one another).

[40] The AgFIT 1.0 analysis end September 20, 2022, since the average usage is relatively low afterwards due to the end of the growing season.

[41] The advantage of estimating the model in this way is that it provides a direct test of whether the Peak-period price response is statistically significantly different from the all-hours price response.

Table 4.2: Estimates of Customer Price Response

Customer	Managed?	AgFIT 1.0		AgFIT 2.0		AgFIT 2.1	
		Price	Price X Peak	Price	Price X Peak	Price	Price X Peak
C-001	No	N/A	N/A	0.455 (0.144)	-0.541 (0.182)	-0.467 (0.057)	0.340 (0.111)
	Yes	0.011 (0.860)	-0.033 (0.641)	-0.378 (0.080)	**0.438 (0.026)**	-0.122 (0.427)	0.189 (0.246)
C-002	Yes	-0.069 (0.507)	-0.069 (0.531)	0.175 (0.257)	-0.168 (0.262)	0.092 (0.376)	-0.153 (0.214)
C-003	Yes	N/A	N/A	0.024 (0.850)	-0.210 (0.122)	0.009 (0.930)	-0.060 (0.660)
C-004	Yes	N/A	N/A	**-1.325 (0.000)**	**1.253 (0.000)**	0.006 (0.959)	-0.045 (0.684)
C-005	Leased to a Customer	N/A	N/A	-0.007 (0.876)	-0.024 (0.579)	**0.703 (0.008)**	**-0.776 (0.004)**
	Yes	N/A	N/A	**-0.672 (0.000)**	**0.571 (0.000)**	-0.130 (0.168)	0.075 (0.426)
C-006	Yes	N/A	N/A	N/A	N/A	-0.140 (0.550)	0.117 (0.611)
C-007	Yes	N/A	N/A	N/A	N/A	**0.238 (0.027)**	**-0.318 (0.005)**

p-values in parentheses.

This section provides evidence that is consistent with some customers simultaneously responding to OAT and AgFIT incentives. Specifically, customers C-004 and C-005 adjusted off-peak usage levels in response to dynamic prices (at least in 2023) but appeared to manage peak-period usage every day in response to the OAT demand charge. There may be other behaviors motivated by OAT pricing that we can't discern as easily from these estimates. Ultimately, the Pilot was not designed to provide rigorous estimates of customer response to dynamic prices, which is attributable to the shadow bill credit methodology.

In addition, it is worth noting that our analysis looks at customer response vis-à-vis the day-ahead prices (used in settlement under AgFIT 2.0 and 2.1) rather than the prices the customer saw at the time they scheduled usage, which could have been up to seven days ahead. This method is employed for both practical and theoretical reasons. On a practical level, we don't know when customers made their usage decisions for a specific hour or when they looked at prices. We can observe from transactions the hours in which customers decided to pump (at least provisionally – sometimes they sell it back), but there's no record in AgFIT 2.0 and 2.1 of a customer's decision to avoid high-priced hours (i.e., there's no subscription they can sell back). This makes it difficult to assign a price other than the ex-post price to each hour.[42]

The theoretical case for using ex-post prices in the price response analysis can be illustrated via an example: if a customer transacted five days ahead at a low price but then the ex-post price was significantly higher, a decision to follow through on the pumping would save the customer money relative to pumping at ex-post prices, but it wouldn't cause system or circuit loads to decline in response to constrained conditions (as

[42] We also show in Section 6.3 that most customers purchased the majority of their usage at the ex-post price, which further supports our methods.

reflected in the high ex-post prices). Ultimately the response that's most relevant from a societal perspective is the relationship between usage and ex-post prices.[43] In Section 6, we present information showing that customers benefited from transactions (i.e., saving money relative to what they would have paid if all usage was purchased at settlement prices), which reflects awareness of and response to prices earlier than the day-ahead prices examined in this section.

5 CUSTOMER BILL IMPACTS AND CREDITS

As described in the introduction, Pilot participants continue to pay their OAT bill through the duration of the Pilot. Each month, a shadow bill is calculated representing what they would have paid under the AgFIT pricing model. At the end of a period of time, the customer is credited if their cumulative AgFIT charges are less than their cumulative OAT bill, but the customer does not pay more if the OAT bills are lower than the AgFIT charges (i.e., they have bill protection at the service account level). In this section we summarize AgFIT and OAT bills for three periods of time: AgFIT 1.0 from August 2022 through April 2023, AgFIT 2.0 from May through September 2023, and AgFIT 2.0/2.1 bills from October 2023 through September 2024.[44]

Tables 5.1, 5.2, and 5.3 provide summaries of the customer-level bill impacts by time period.[45,46] Each column represents a customer. The table shows both the simple difference between the OAT bill and the AgFIT charges (row 5) as well as the shadow billing credit (row 6), which omits pumps for which the total OAT bill is lower than the total AgFIT charges.

Across all columns and tables, the customers were eligible to receive a shadow billing credit. The total Pilot credit across all customers and years was 8.3% of the corresponding OAT bill total. Every customer earned a credit in each growing season, however not every pump received a credit in each growing season. In total, pumps were on track to receive a credit 64% of the time (counting each growing season for a pump separately). In addition, one customer (C-001) had aggregate OAT bills that were lower than their aggregate AgFIT charges in each time period. While every customer with more than two pumps benefited from the "bill protection" embedded in the shadow bill credit method, only customer C-001 had an aggregate Pilot bill that exceeded its aggregate OAT bill.

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[43] When deployed at scale, the scheduling facilitated by the Pilot would provide the market with information that would lead to market feedback loops. For example, if enough customers schedule pumping in low-priced hours offered for three days hence, subsequent pricing for that day will tend to be higher (all else equal) due to the increased demand.

[44] At the time of this writing, credits have been delivered to customers for the May to September 2023 period but not for the other periods.

[45] Table 5.3 excludes NEM accounts, which had a billing issue that was being resolved at the time of this writing.

[46] Note that the AgFIT credits in Table 5.2 represent the amounts paid to customers. It was later discovered that monthly customer charges were inadvertently excluded from the AgFIT charges. Tables 5.10 through 5.14 show the AgFIT credits adjusted for the inclusion of the customer charges.

Table 5.1: Summary of Bill Impacts, AgFIT 1.0

Row #	Result Type	C-001	C-002	C-003
1	# Pumps	9	8	5
2	MWh	156.3	250.0	43.0
3	OAT Bill	$52,311	$82,272	$30,321
4	AgFIT Bill	$54,838	$64,229	$28,390
5	OAT – AgFIT Bill	-$2,527	$18,043	$1,932
6	Pilot Billing Credit	$5,640	$20,315	$3,813
7	OAT $/kWh (Row 3/Row 2)	$0.335	$0.329	$0.705
8	AgFIT $/kWh (Row 4/Row 2)	$0.351	$0.257	$0.660
9	% Bill Difference (Row 5/Row 3)	-4.8%	21.9%	6.4%
10	Credit as % of OAT Bill (Row 6/Row 3)	10.8%	24.7%	12.6%

Table 5.2: Summary of Bill Impacts, AgFIT 2.0

Row #	Result Type	C-001	C-002	C-003	C-004	C-005
1	# Pumps	15	8	7	1	2
2	MWh	1,588.7	522.0	430.2	50.8	35.0
3	OAT Bill	$520,385	$174,129	$138,136	$19,440	$13,244
4	AgFIT Bill	$534,572	$169,085	$133,670	$13,865	$9,529
5	OAT – AgFIT Bill	-$14,187	$5,044	$4,466	$5,575	$3,715
6	Pilot Billing Credit	$25,163	$9,738	$12,926	$5,575	$3,715
7	OAT $/kWh (Row 3/Row 2)	$0.328	$0.334	$0.321	$0.383	$0.379
8	AgFIT $/kWh (Row 4/Row 2)	$0.336	$0.324	$0.311	$0.273	$0.273
9	% Bill Difference (Row 5/Row 3)	-2.7%	2.9%	3.2%	28.7%	28.0%
10	Credit as % of OAT Bill (Row 6/Row 3)	4.8%	5.6%	9.4%	28.7%	28.0%

Table 5.3: Summary of Bill Impacts, AgFIT 2.0/2.1

Row #	Result Type	C-001	C-002	C-003	C-004	C-005	C-006	C-007
1	# Pumps	10	6	16	9	2	2	1
2	MWh	741.7	518.8	1,122.0	312.3	122.4	63.4	2.4
3	OAT Bill	$271,655	$198,395	$401,931	$145,090	$54,128	$22,842	$1,016
4	AgFIT Bill	$271,758	$191,365	$360,314	$134,753	$52,088	$21,104	$275
5	OAT – AgFIT Bill	-$103	$7,030	$41,617	$10,337	$2,040	$1,738	$741
6	Pilot Billing Credit	$15,688	$10,082	$46,739	$13,312	$2,040	$1,738	$741
7	OAT $/kWh (Row 3/Row 2)	$0.366	$0.382	$0.358	$0.465	$0.442	$0.360	$0.422
8	AgFIT $/kWh (Row 4/Row 2)	$0.366	$0.369	$0.321	$0.432	$0.426	$0.333	$0.114
9	% Bill Difference (Row 5/Row 3)	0.0%	3.5%	10.4%	7.1%	3.8%	7.6%	72.9%
10	Credit as % of OAT Bill (Row 6/Row 3)	5.8%	5.1%	11.6%	9.2%	3.8%	7.6%	72.9%

The sub-sections below provide detail at the pump level by customer.

5.1.1 Bill Impacts from August 2022 through April 2023

Table 5.4 summarizes the OAT bill and AgFIT charges during the AgFIT 1.0 period for customer C-001. This period included the later portion of the 2022 growing season into the following spring. The table includes pump-specific amounts for AgFIT 1.0 billing periods that were provided to us by TeMix. The tables contain the total kWh consumed by the customer, the total OAT bill and AgFIT dollar amounts, the difference between the OAT bill and AgFIT charges, and the shadow bill credit (which is the greater of zero and the difference between the OAT bill and AgFIT charges). Four of the nine pumps had AgFIT charges that were lower than the corresponding OAT bill. The total shadow bill credit was $5,640.[47]

[47] For pump 5 the AgFIT charges were negative. This indicates that customer C-001 managed to "sell back" a significant amount of energy during high-priced periods. The relatively high average OAT price of $0.53/kWh indicates that the pump's usage profile had a low load factor and/or a high share of energy consumed in the Peak pricing period.

Table 5.4: OAT vs AgFIT Bills, AgFIT 1.0, C-001

Pump	kWh	OAT Bill	AgFIT Bill	OAT – AgFIT Bill	Pilot Credit
1	729	$719	$1,433	-$714	$0
2	30,831	$9,001	$12,267	-$3,265	$0
3	28,250	$9,482	$8,663	$818	$818
4	23,531	$6,278	$4,910	$1,369	$1,369
5	3,212	$1,692	-$45	$1,737	$1,737
6	29,187	$10,973	$11,209	-$237	$0
7	7,235	$2,995	$4,629	-$1,635	$0
8	22,389	$7,343	$9,658	-$2,316	$0
9	10,943	$3,829	$2,113	$1,716	$1,716
Total	**156,308**	**$52,311**	**$54,838**	**-$2,527**	**$5,640**

Table 5.5 shows how the total usage was divided between subscription purchases, net dynamic price (ex-ante) transactions (purchases and sales in response to tenders prior to the day of pumping), and the net ex-post transactions over the billing period. The dynamic and ex-post quantities represent the net amount after combining the purchases (i.e., buying more than their subscription quantity) and sales (selling unused subscription). For example, pump 3 had a subscription quantity of 60,684 kWh and transacted to sell a net amount of 345 kWh ahead of time, with an additional net 31,789 kWh sold at ex-post prices, reflecting significantly lower usage in the Pilot period versus the historical period used as the basis for the subscription (i.e., the corresponding months in the prior year).

Table 5.5 also adds the average price paid for these categories, thereby allowing comparisons to the average price for the OAT bill. The subscription price was higher than the average OAT price for two of the nine pumps. Differences between the subscription and OAT average prices do not necessarily indicate mispricing of the subscription. That is, the subscription price represents the customer's historical load profile, and if that load profile changes while on the Pilot, the average OAT price paid may change as well. For example, a demand-billed customer who decreased its load factor across years (leading to relatively higher demand charges) would likely experience an average OAT price per kWh that is higher than the subscription price.[48]

[48] Note that the average transaction prices for dynamic and ex-post prices are calculated as the total net charges across all purchases and sales divided by the net kWh bought or sold. Therefore, they do not necessarily reflect the average dynamic or ex-post price at the time when the energy was being bought or sold.

Table 5.5: Comparison of Subscription, Dynamic, and Ex-Post Average Net Transaction Prices Paid, AgFIT 1.0, C-001

Pump	kWh	Subscription kWh	Dynamic kWh	Ex Post kWh	OAT $/kWh	Subscription $/kWh	Dynamic $/kWh	Ex Post $/kWh
1	729	10,137	0	-9,407	$0.97	$0.32	N/A	$0.21
2	30,831	73,214	-19,332	-23,051	$0.29	$0.31	$0.34	$0.18
3	28,250	60,384	-345	-31,789	$0.34	$0.26	$3.29	$0.19
4	23,531	54,490	-16,214	-14,745	$0.27	$0.24	$0.36	$0.15
5	3,212	72,879	0	-69,668	$0.53	$0.25	N/A	$0.26
6	29,187	51,522	-2,108	-20,227	$0.38	$0.29	$0.30	$0.16
7	7,235	17,901	4,475	-15,141	$0.41	$0.27	$0.77	$0.26
8	22,389	12,371	0	10,018	$0.33	$0.42	N/A	$0.40
9	10,943	67,922	-2,804	-54,176	$0.35	$0.20	$0.28	$0.21

It might be instructive to interpret the results for customer C-001's pump 2. Table 5.4 shows that the customer paid $3,265 more on AgFIT versus its OAT bill. The information in Table 5.5 provides important context for that bill comparison. Notice that the subscription average price of $0.31 per kWh is above the current OAT average price of $0.29 per kWh. Because the subscription price reflects the customer's pre-Pilot OAT bill (with an escalator applied to account for current rate levels), this comparison indicates that the customer likely saved money on this pump relative to its pre-Pilot bills. The customer was able to benefit by selling much of the subscription it purchased at $0.31 per kWh for an average of $0.34 per kWh at dynamic prices. However, the customer also sold a substantial portion of its subscription load (23,051 kWh) at ex-post settlement prices, which were low relative to the subscription price. That is, on average the customer paid $0.31 per kWh for 23,051 kWh it later sold for an average of $0.18 per kWh.

Table 5.6 summarizes the OAT bill and AgFIT charges during the AgFIT 1.0 period for customer C-002. Five of the eight pumps had AgFIT charges that were lower than the corresponding OAT bill. The total shadow bill credit was $20,315.

Table 5.6: OAT vs AgFIT Bills, AgFIT 1.0, C-002

Pump	kWh	OAT Bill	AgFIT Bill	OAT – AgFIT Bill	Pilot Credit
1	47,075	$15,320	$6,972	$8,348	$8,348
2	20,099	$8,708	$9,009	-$301	$0
3	39,304	$12,151	$10,334	$1,818	$1,818
4	18,262	$6,444	$6,493	-$49	$0
5	34,301	$12,012	$7,689	$4,324	$4,324
6	35,844	$12,056	$9,227	$2,829	$2,829
7	26,658	$6,822	$8,745	-$1,922	$0
8	28,502	$8,758	$5,761	$2,997	$2,997
Total	**250,045**	**$82,272**	**$64,229**	**$18,043**	**$20,315**

Table 5.7 shows how the total usage was divided between subscription purchases, dynamic price transactions, and the net ex-post kWh over the billing period for customer C-002. The subscription price was higher than the average OAT price for two of the eight pumps.

Table 5.7: Comparison of Subscription, Dynamic, and Ex Post Price Paid, AgFIT 1.0, C-002

Pump	kWh	Subscription kWh	Dynamic kWh	Ex Post kWh	OAT $/kWh	Subscription $/kWh	Dynamic $/kWh	Ex Post $/kWh
1	47,075	84,474	-8,996	-28,404	$0.33	$0.23	$0.41	$0.30
2	20,099	15,319	0	4,780	$0.43	$0.48	N/A	$0.33
3	39,304	65,202	-149	-25,748	$0.31	$0.26	$11.51	$0.21
4	18,262	33,472	-2,664	-12,546	$0.35	$0.29	$0.40	$0.20
5	34,301	49,169	-4,750	-10,117	$0.35	$0.24	$0.55	$0.17
6	35,844	0	207	35,637	$0.34	N/A	$0.20	$0.25
7	26,658	22,263	-1,030	5,427	$0.26	$0.34	$0.60	$0.31
8	28,502	100,758	2,916	-75,171	$0.31	$0.21	$0.31	$0.23

Table 5.8 summarizes the OAT bill and AgFIT charges during the AgFIT 1.0 period for customer C-003. Three of the five pumps had AgFIT charges that were lower than the corresponding OAT bill. The total shadow bill credit was $3,813. Note that this customer did not become active in the Pilot until November 2022, after the 2022 growing season concluded.

Table 5.8: OAT vs AgFIT Bills, AgFIT 1.0, C-003

Pump	kWh	OAT Bill	AgFIT Bill	OAT – AgFIT Bill	Pilot Credit
1	9,947	$7,167	$7,254	-$86	$0
2	12,599	$10,763	$9,971	$792	$792
3	3,753	$1,766	-$853	$2,619	$2,619
4	4,802	$3,395	$2,993	$402	$402
5	11,913	$7,230	$9,025	-$1,795	$0
Total	**43,014**	**$30,321**	**$28,390**	**$1,932**	**$3,813**

Table 5.9 shows how the total usage was divided between subscription purchases, dynamic price transactions, and the net ex-post kWh over the billing period for customer C-003. The subscription price was never higher than the average OAT price for this customer's pumps. The customer consistently had more subscription usage than it needed during this time period.

Table 5.9: Comparison of Subscription, Dynamic, and Ex Post Price Paid, AgFIT 1.0, C-003

Pump	kWh	Subscription kWh	Dynamic kWh	Ex Post kWh	OAT $/kWh	Subscription $/kWh	Dynamic $/kWh	Ex Post $/kWh
1	9,947	58,157	-15,067	-33,143	$0.72	$0.27	$0.16	$0.18
2	12,599	39,084	-6,947	-19,538	$0.85	$0.37	$0.20	$0.18
3	3,753	82,573	-1,871	-76,948	$0.47	$0.19	$0.22	$0.21
4	4,802	10,758	-1,117	-4,839	$0.71	$0.38	$0.18	$0.23
5	11,913	47,232	-6,003	-29,316	$0.61	$0.32	$0.20	$0.17

5.1.2 Bill Impacts from May through September 2023

Tables 5.10 through 5.14 summarize the OAT bills and AgFIT charges from May through September 2023, during which the AgFIT 2.0 pricing method was in place. The tables contain the total kWh consumed by the customer, the total OAT bill and AgFIT dollar amounts, the difference between the OAT bill and AgFIT charges, and the shadow bill credit (which is the greater of zero and the difference between the OAT bill and the AgFIT charges).

During this period, the AgFIT charges inadvertently excluded monthly customer charges, and those bills served as the basis for the credits paid to customers. The rightmost column of the table shows what the credit would have been had the customer charges been included in the AgFIT charges. In aggregate across the customers and pumps, the inclusion of the customer charges reduces the credit by 5.9%.

Table 5.10 provides the comparison of OAT bill and AgFIT charges for each of customer C-001's pumps under the specified AgFIT 2.0 period. The AgFIT charges were lower than the corresponding OAT bill for eight of the fifteen pumps. Eight of the nine pumps that were also on the Pilot during AgFIT 1.0 received a shadow bill credit during AgFIT 2.0 this time period. In contrast, none of the six pumps that only participated during AgFIT 2.0 earned a credit.

Table 5.10: OAT vs AgFIT Bills, AgFIT 2.0, C-001

Pump	kWh	OAT Bill	AgFIT Bill	OAT – AgFIT Bill	Original Pilot Credit	Pilot Credit w/ Cust. Charge
1	15,373	$5,440	$4,510	$929	$929	$825
2	91,250	$31,403	$24,709	$6,694	$6,694	$6,478
3	103,705	$35,630	$32,118	$3,513	$3,513	$3,297
4	43,400	$12,940	$13,079	-$139	$0	$0
5	107,898	$33,625	$31,599	$2,026	$2,026	$1,810
6	5,360	$2,872	$1,528	$1,345	$1,345	$1,207
7	33,387	$11,082	$9,492	$1,590	$1,590	$1,374
8	61,940	$19,111	$17,534	$1,577	$1,577	$1,361
9	57,534	$22,564	$15,076	$7,489	$7,489	$7,273
10	101,950	$32,090	$34,044	-$1,954	$0	$0
11	111,114	$36,226	$37,485	-$1,260	$0	$0
12	275,280	$97,326	$110,569	-$13,243	$0	$0
13	301,210	$86,368	$100,173	-$13,804	$0	$0
14	151,671	$53,892	$59,580	-$5,688	$0	$0
15	127,587	$39,817	$43,079	-$3,262	$0	$0
Total	**1,588,660**	**$520,385**	**$534,572**	**-$14,187**	**$25,163**	**$23,625**

Table 5.11 provides the comparison of OAT bill and AgFIT charges for each of customer C-002's pumps under the specified AgFIT 2.0 period. The AgFIT charges were lower than the corresponding OAT bill for five of the eight pumps, though one of those pumps (pump 8) would not have been paid a credit had customer charges been included in the AgFIT charges. The aggregate shadow bill credit was $9,738, which would have been reduced to $9,224 had customer charges been included in the AgFIT charges.

Table 5.11: OAT vs AgFIT Bills, AgFIT 2.0, C-002

Pump	kWh	OAT Bill	AgFIT Bill	OAT – AgFIT Bill	Original Pilot Credit	Pilot Credit w/ Cust. Charge
1	99,096	$30,015	$25,233	$4,782	$4,782	$4,782
2	33,165	$13,908	$10,976	$2,932	$2,932	$2,932
3	91,988	$29,878	$28,227	$1,651	$1,651	$1,435
4	34,753	$11,040	$11,616	-$576	$0	$0
5	79,723	$23,859	$24,536	-$677	$0	$0
6	106,454	$39,406	$42,847	-$3,441	$0	$0
7	872	$502	$213	$290	$290	$75
8	75,935	$25,520	$25,437	$84	$84	$0
Total	**521,985**	**$174,129**	**$169,085**	**$5,044**	**$9,738**	**$9,224**

Table 5.12 provides the comparison of OAT bill and AgFIT charges for each of customer C-003's pumps under the specified AgFIT 2.0 period. The AgFIT charges were lower than the corresponding OAT bill for four of the seven pumps. Overall, the AgFIT charges for customer C-003 were only marginally lower than the OAT bills ($133,670 vs. $138,136), but because the "best-of" customer billing method used in the Pilot doesn't bill for AgFIT charges when the total is higher than the OAT bill for each individual pump, C-003 will end up having paid only $125,210 (the $138,136 OAT bill minus the $12,926 shadow billing credit).

Table 5.12: OAT vs AgFIT Bills, AgFIT 2.0, C-003

Pump	kWh	OAT Bill	AgFIT Bill	OAT – AgFIT Bill	Original Pilot Credit	Pilot Credit w/ Cust. Charge
1	154,466	$43,015	$47,110	-$4,095	$0	$0
2	20,682	$10,048	$5,912	$4,136	$4,136	$3,917
3	122,225	$41,841	$36,970	$4,871	$4,871	$4,652
4	4,942	$1,987	$1,273	$715	$715	$496
5	25,958	$11,814	$8,608	$3,206	$3,206	$2,987
6	55,666	$16,711	$17,515	-$804	$0	$0
7	46,306	$12,719	$16,281	-$3,562	$0	$0
Total	**430,245**	**$138,136**	**$133,670**	**$4,466**	**$12,926**	**$12,050**

Table 5.13 provides the comparison of OAT bill and AgFIT charges for customer C-004's pump under the specified AgFIT 2.0 period. The AgFIT charges were $5,575 lower than the corresponding OAT bill for the single pump.

Table 5.13: OAT vs AgFIT Bills, AgFIT 2.0, C-004

Pump	kWh	OAT Bill	AgFIT Bill	OAT – AgFIT Bill	Original Pilot Credit	Pilot Credit w/ Cust. Charge
1	50,755	$19,440	$13,865	$5,575	$5,575	$5,445

Table 5.14 provides the comparison of OAT bill and AgFIT charges for each of customer C-005's pumps under the specified AgFIT 2.0 period. The AgFIT charges were lower than the corresponding OAT bill for both pumps, with a combined shadow bill credit of $3,715.

Table 5.14: OAT vs AgFIT Bills, AgFIT 2.0, C-005

Pump	kWh	OAT Bill	AgFIT Bill	OAT – AgFIT Bill	Original Pilot Credit	Pilot Credit w/ Cust. Charge
1	4,722	$3,331	$1,854	$1,477	$1,477	$1,337
2	30,242	$9,913	$7,675	$2,238	$2,238	$2,066
Total	**34,963**	**$13,244**	**$9,529**	**$3,715**	**$3,715**	**$3,403**

Under AgFIT 2.0, some of the pumps show large differences between the average price paid under the OAT bill and AgFIT charges. For example, customer C-003's pump 2 shown in Table 5.12 has an OAT average price of $0.49 per kWh while its AgFIT charges average $0.29 per kWh. Recall that AgFIT 2.0's pricing method scales the dynamic tenders to an OAT price level and there is no separate subscription (as in AgFIT 1.0). However, the OAT bills shown in these tables reflect the customer's usage billed at its OAT rates while the class-average OAT price paid is used to scale dynamic tenders. Large differences between the OAT bill and AgFIT charges may reflect differences between the customer's load profile and the class average profile.

5.1.3 Bill Impacts from October 2023 through September 2024

Tables 5.15 through 5.21 summarize bills from October 2023 through September 2024 by customer. While this time period combines months priced under AgFIT 2.0 and 2.1, the bulk of the usage is from the 2023 growing season (May through September 2024), which was billed at AgFIT 2.1 prices.

Table 5.15 provides the comparison of OAT bill and AgFIT charges for each of customer C-001's pumps from October 2023 through September 2024. The customer is on track to receive a 5.8% credit ($15,688), while the aggregate difference between the AgFIT charges and OAT bills was slightly negative (-$103). This difference is caused by four of the pumps failing to receive a credit.

Table 5.15: OAT vs AgFIT Bills, AgFIT 2.1, C-001

Pump	kWh	OAT Bill	AgFIT Bill	OAT – AgFIT Bill	Pilot Credit
1	4,373	$3,785	$1,843	$1,942	$1,942
3	90,721	$38,390	$32,010	$6,379	$6,379
4	69,124	$22,198	$25,534	-$3,336	$0
6	57,397	$27,554	$25,739	$1,815	$1,815
7	48,798	$16,921	$17,538	-$617	$0
9	216,981	$64,644	$76,099	-$11,454	$0
11	125,180	$47,375	$44,269	$3,106	$3,106
18	14,967	$7,340	$5,129	$2,211	$2,211
20	82,777	$29,309	$29,693	-$384	$0
21	31,375	$14,139	$13,903	$236	$236
Total	**741,693**	**$271,655**	**$271,758**	**-$103**	**$15,688**

Table 5.16 provides the comparison of OAT bills and AgFIT charges for each of customer C-002's pumps. Half of the pumps did not receive a credit, thus leading the customer to benefit from the shadow billing credit methodology. The aggregate credit is 5.1% of the OAT bill, while the corresponding difference between the total OAT bill and AgFIT charges is 3.5%.

Table 5.16: OAT vs AgFIT Bills, AgFIT 2.1, C-002

Pump	kWh	OAT Bill	AgFIT Bill	OAT – AgFIT Bill	Pilot Credit
3	105,024	$41,624	$36,314	$5,309	$5,309
4	49,690	$18,588	$18,981	-$393	$0
6	145,755	$58,283	$58,614	-$331	$0
7	62,122	$24,270	$21,792	$2,478	$2,478
8	107,263	$39,349	$37,054	$2,295	$2,295
9	48,978	$16,282	$18,610	-$2,328	$0
Total	**518,832**	**$198,395**	**$191,365**	**$7,030**	**$10,082**

Two of the sixteen pumps for C-003 (shown in Table 5.17) did not receive a credit. The gap between the credit and the total bill difference is therefore smaller than it was for the two preceding customers, with a 11.6% credit and a 10.4% total bill difference.

Table 5.17: OAT vs AgFIT Bills, AgFIT 2.1, C-003

Pump	kWh	OAT Bill	AgFIT Bill	OAT – AgFIT Bill	Pilot Credit
1	232,022	$81,025	$78,200	$2,826	$2,826
2	121,799	$54,293	$38,138	$16,155	$16,155
3	143,616	$54,190	$50,190	$4,000	$4,000
4	10,789	$4,383	$3,514	$868	$868
5	107,111	$41,968	$33,077	$8,891	$8,891
6	192,073	$65,665	$65,433	$231	$231
7	86,829	$30,450	$32,335	-$1,885	$0
8	82,451	$18,467	$21,704	-$3,237	$0
9	21,175	$5,258	$4,158	$1,100	$1,100
10	2,222	$386	$135	$252	$252
11	17,200	$4,020	$2,515	$1,504	$1,504
12	33,663	$14,690	$10,614	$4,077	$4,077
13	9,318	$3,247	$2,309	$938	$938
14	44,231	$16,269	$12,567	$3,703	$3,703
15	1,594	$990	$432	$558	$558
16	15,928	$6,629	$4,994	$1,636	$1,636
Total	**1,122,020**	**$401,931**	**$360,314**	**$41,617**	**$46,739**

Six of the nine pumps for customer C-004 received a credit, as shown in Table 5.18. The aggregate credit was 9.2% of the OAT bill, while the total bill difference (total OAT – total AgFIT charges) was 7.1%.

Table 5.18: OAT vs AgFIT Bills, AgFIT 2.1, C-004

Pump	kWh	OAT Bill	AgFIT Bill	OAT – AgFIT Bill	Pilot Credit
1	51,415	$27,256	$18,724	$8,533	$8,533
2	20,727	$10,104	$9,728	$376	$376
3	41,399	$17,029	$14,436	$2,593	$2,593
4	3,358	$1,932	$1,218	$714	$714
5	25,822	$12,828	$11,938	$890	$890
6	67,308	$29,716	$31,275	-$1,559	$0
7	1,156	$835	$629	$206	$206
8	40,862	$18,342	$18,729	-$387	$0
9	60,237	$27,047	$28,077	-$1,030	$0
Total	**312,283**	**$145,090**	**$134,753**	**$10,337**	**$13,312**

Table 5.19 shows that both of customer C-005's pumps received a credit. Recall that customer C-005 only managed pump 2, with the other pump leased to another customer.

Table 5.19: OAT vs AgFIT Bills, AgFIT 2.1, C-005

Pump	kWh	OAT Bill	AgFIT Bill	OAT – AgFIT Bill	Pilot Credit
1	75,865	$36,172	$35,708	$464	$464
2	46,489	$17,956	$16,380	$1,576	$1,576
Total	**122,354**	**$54,128**	**$52,088**	**$2,040**	**$2,040**

Table 5.20 shows that both of customer C-006's pumps received a credit, totaling 7.6% of the combined OAT bills.

Table 5.20: OAT vs AgFIT Bills, AgFIT 2.1, C-006

Pump	kWh	OAT Bill	AgFIT Bill	OAT – AgFIT Bill	Pilot Credit
1	28,082	$10,573	$9,232	$1,340	$1,340
2	35,320	$12,269	$11,871	$398	$398
Total	**63,403**	**$22,842**	**$21,104**	**$1,738**	**$1,738**

Table 5.21 shows that customer C-007's sole pump received a credit of 72.9%. In the following section, we will describe a pricing error that allowed the customer to receive such a high credit.

Table 5.21: OAT vs AgFIT Bills, AgFIT 2.1, C-007

Pump	kWh	OAT Bill	AgFIT Bill	OAT – AgFIT Bill	Pilot Credit
1	2,409	$1,016	$275	$741	$741
Total	**2,409**	**$1,016**	**$275**	**$741**	**$741**

6 COST RECOVERY

The Decision requires an evaluation of the recovery of generation, resource adequacy (RA), and delivery costs by the Pilot rates. Stakeholder comments during the proceeding reflect concern that the Pilot could shift costs to other service classes. There is particular concern about the scarcity pricing concept used to allocate generation capacity, flexible capacity, and distribution capacity costs to hourly prices.[49]

We approach this issue in three ways. First, we discuss a CAISO settlement issue that creates a mismatch between changes in customer bills and changes in VCE's wholesale costs. Second, we provide an overview of cost recovery under the AgFIT 1.0 pricing method. Third, we explore potential sources of AgFIT credits, which can include response to dynamic prices, structural benefits, and dynamic price arbitrage.

6.1 AgFIT and CAISO Settlement

One theory of dynamic pricing pilots is that the providers and customers can both win if load impacts produce changes in customer bills that are closely related to changes in avoided costs. For example, customers reducing usage during an hour with high CAISO LMPs will pay less on their bill and reduce generation costs for its load serving entity (LSE). However, AgFIT embeds a disconnect between the changes in bills and changes in energy costs because VCE uses the PG&E load profile for CAISO settlement. An example will illustrate the issue. An AgFIT customer that reduces its usage by 100 kWh when the CAISO LMP is $1,000/MWh ($1 per kWh) will reduce its bill by the amount of the LMP plus the other factors included in the AgFIT dynamic price. However, VCE's wholesale power costs will not be reduced by $1/kWh times 100 kWh because the 100 kWh reduction will be "spread" across all hours of the PG&E settlement profile (in proportion to

[49] E.g., Public Advocate's Office Opening Comments to the Proposed Phase 2 Decision at page 9, November 10, 2021.

the usage by hour in that profile). The reduction in VCE's CAISO energy costs will therefore be 100 kWh times the day's load weighted average LMP (where the load weights come from PG&E's settlement profile). As a result, in this example VCE will pay the customer more for its load reduction than it receives in energy cost savings from CAISO.[50]

Our understanding is that the use of PG&E's settlement profile is a common practice among Community Choice Aggregators (CCAs) such as VCE because PG&E's profile is less variable due to the large number of customers included in it. That is, using PG&E's settlement profile is perceived to be less risky for the CCAs. However, if dynamic pricing programs are going to scale to a significant share of a CCA's load, it seems that the settlement disconnect will need to be addressed.[51] Note that this settlement "mismatch" concern is not applicable to the capacity component of the dynamic prices.

6.2 AgFIT 1.0 Pricing and Cost Recovery

Aside from the settlement issue, the AgFIT 1.0 method is expected to produce prices that recover generation and delivery costs if the customer's actual load closely matches its subscription quantity.[52] This would be because the subscription component of the methodology sets the prices based on the customer's historical usage level and profile at OAT rates. However, when there are deviations from the customer's historic usage the difference is priced using marginal energy costs (i.e., CAISO LMPs) plus allocated capacity and other fixed costs. When a customer changes their load under AgFIT 1.0, savings are determined by marginal costs (which are also reduced for the Load Serving Entity, apart from the settlement profile issue discussed above). But the customer also saves on non-marginal costs, whereas the LSE doesn't see reduced non-marginal costs. Therefore, under AgFIT 1.0, customers that shift or reduce load significantly could shift some non-marginal costs to other customers. This may be mitigated when the pricing methods are recalibrated (perhaps annually) to recover sufficient revenues to cover costs.

The AgFIT 1.0 method of applying an escalation factor also had a potential problem in misallocating revenue between PG&E vs. VCE. That is, the escalation factor method described in Section 2 (that translated 2022 OAT bills into 2023 price levels) implicitly assumed that the PG&E and VCE components of the bill would escalate at the same rate and that customers did not change their OAT rate from 2022 to 2023. However, some customers may require different escalation factors than others. For example, because the all-hours demand charge (versus the peak-period demand charge) is part of the distribution bill but not the generation bill, a customer with high all-hours demand

[50] Note that the ability of the Pilot to show prices in all 24 hours aligns with the CPUC's Slice of Day (SOD) RA structure that is scheduled to be implemented in 2025. The ability of VCE to incent customers to shift out of future high-priced overnight hours and reduce its RA buy during those hours could address the current energy-only savings calculations described above.

[51] The TeMix transactive platform used for this pilot can sum the forward transactions across all of a CCA's participants in CalFUSE so that as participation scales to a significant share of a CCA's load, the CCA can self-schedule and settle with the CAISO.

[52] For the three customers enrolled during AgFIT 1.0, there tended to be significant differences between the subscription kWh and the Pilot-year observed kWh at the pump level (as shown in the billing summary tables). Some of this difference could be due to crop rotation, which may cause usage to shift across pumps from year to year.

relative to its other bill components could have a different PG&E bill impact than VCE bill impact as tariff rates change. This issue was not addressed by PG&E and VCE before August 1, 2022, but could be corrected in future applications of the pricing method by pricing each customer's historical loads at current OAT rates when creating subscription prices.

6.3 Potential Sources of Shadow Bill Credits

As shown in Section 5, all participating customers and most pumps received a shadow bill credit. From a cost recovery perspective, the important consideration is whether the bill savings are at least matched by cost savings. To assess this, it is useful to understand the source of the shadow bill credit. There are at least three potential causes:

- Price response: shifting usage from high- to low-priced hours can lead to bill savings that are offset by reduced cost to serve.
- Transaction benefits: because AgFIT allows customers to transact up to seven days ahead, and multiple times for a specific delivery time, customers may benefit by buying power at dynamic prices that are lower than the price for which they sell the power (if they don't end up pumping) or than they would have paid if they didn't schedule pumping and paid settlement prices.[53]
- Structural benefits: a customer may have usage characteristics such that the customer can save money without changing their behavior compared to what they would have done in the absence of the Pilot.
- Changes in customer usage profiles producing larger changes in OAT bills than AgFIT bills. For example, a large increase in billed demand will likely produce a larger increase in the OAT bill than the AgFIT bill, thus contributing to a Pilot credit.

We evaluated the extent of price responsiveness in Section 4, and the results showed that there was not sufficient price response to warrant the credits customers had received. We therefore focus on exploring the other potential causes in this section.

6.3.1 Transaction Benefits

Customers can benefit from transacting prior to the delivery date in two ways: buying energy at a lower price than they would have had to pay at settlement; and buying energy at a relatively low price and then selling it back at a higher price.

In this section, we examine customer transactions data to obtain a picture of how customers interacted with Pilot prices and the gains they obtained from doing so. Table

[53] The Pilot design intent was that it wouldn't be possible to consistently benefit from transactions simply due to days-ahead prices being systematically lower than settlement prices. Rather, the intent was that transactions would provide a means for customers to have certainty over pricing (by locking them in at the time of scheduling) while maintaining the customer's incentive to reduce usage if prices rise as the delivery date approaches because of changes in system conditions.

6.1 shows the percentage of dynamic transactions (i.e., scheduled pumping) by day of week for each customer. Each customer's most frequent day of week is highlighted in green and any day of week with 5% or less of the transactions is highlighted in red. These thresholds help us understand whether customers appear to be checking prices regularly or perhaps only once a week.[54] Sunday and Monday are the days with the highest shares of transactions, while Friday is the day with the lowest share. Note that the scheduling behavior has implications for the notice at which certain days are transacted. For example, customer C-002 typically schedules on a Monday, so usage scheduled for Friday will be four days ahead of delivery. This may affect customer response to price spikes that occur later in the week, if the spike was not foreseeable more than a day ahead of delivery. That is, the customer may not be aware of a price spike if it does not show up on a day they are scheduling.

Table 6.1: Share of Dynamic Transactions Scheduled by Day of Week

Customer	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
C-001	41%	19%	8%	1%	3%	6%	22%
C-002	0%	76%	20%	5%	0%	0%	0%
C-003	2%	30%	17%	15%	6%	6%	25%
C-004	46%	14%	2%	5%	12%	9%	11%
C-005	8%	33%	17%	16%	5%	10%	11%
C-006	0%	29%	20%	14%	10%	2%	24%
C-007	59%	18%	4%	0%	10%	3%	6%

Table 6.2 separates usage and average prices by hours in which a dynamic transaction was conducted (i.e., the customer scheduled pumping) versus hours that were entirely priced at the settlement (ex-post) prices. Comparing the kWh values in column 5 (usage entirely purchased at settlement) and column 3 (all usage) shows the extent to which customers scheduled their pumping, expressed as a percentage shown in column 6. For example, customers C-001 and C-002 scheduled a lower percentage of their usage than customers C-006 and C-007. In addition, every customer purchased a higher share of their usage at settlement in AgFIT 2.1 than AgFIT 2.0, with the largest percentage changes occurring for customers C-004 and C-005.

The average price columns (7 and 8) show that customers paid a lower average price per kWh when they scheduled usage (i.e., hours with a dynamic transaction) than when they did not. (The especially low dynamic transaction $/kWh value for customer C-007 is explained below.) This suggests that customers are scheduling in ways that save them money, finding hours and/or days-ahead transactions that save them money. This conclusion is only limited by the fact that two thirds of all usage shown in the table was purchased at settlement, with no scheduled pumping (dynamic transactions). That is,

[54] We only have data reflecting transactions, so we don't have direct information regarding the extent to which they viewed and acted on prices. For example, we don't know when a customer sees a high price for several days hence and therefore does not schedule pumping in that hour. It would show up in the data as an hour in which the customer had no usage and therefore no ex-post settlement or dynamic transactions.

customers appeared to benefit from dynamic transactions, but often engaged in unscheduled pumping without transactions.

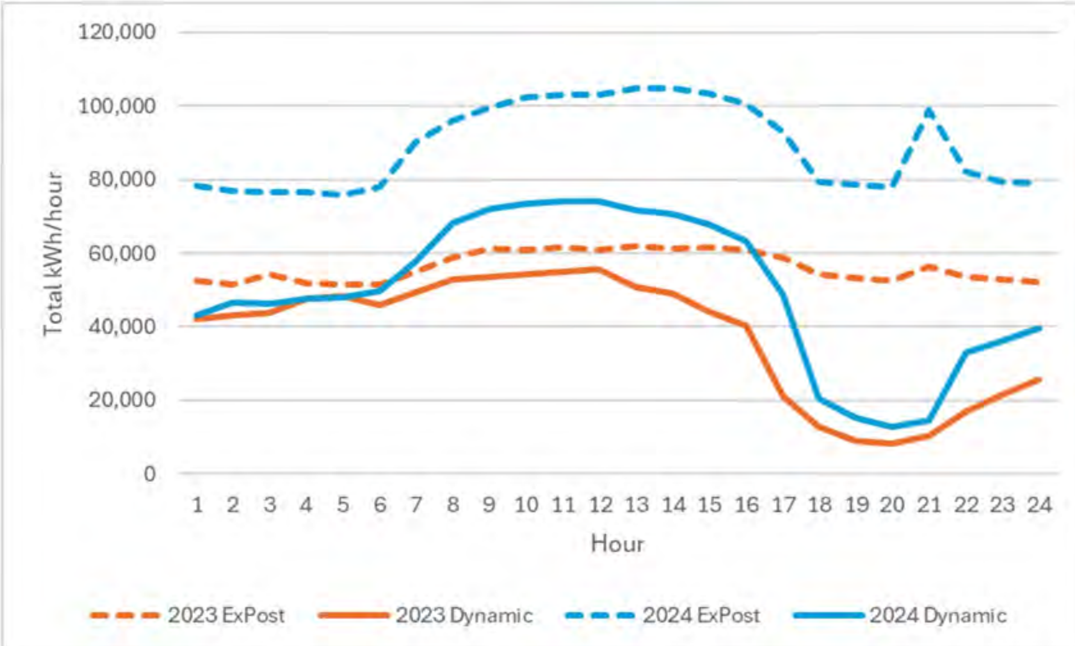
Table 6.2: Comparison of Hours with and without Dynamic Transactions

		kWh				Average $/kWh	
(1) AgFIT	(2) Customer	(3) Total	(4) Has Dynamic Transaction	(5) Ex-post Only	(6) % Not Scheduled kWh	(7) Has Dynamic Transaction	(8) Ex-post Only
2.0	C-001	1,587,141	467,819	1,119,322	71%	0.278	0.356
	C-002	514,959	114,188	400,771	78%	0.306	0.327
	C-003	416,734	276,507	140,227	34%	0.306	0.312
	C-004	32,773	25,772	7,001	21%	0.263	0.334
	C-005	34,821	22,241	12,580	36%	0.243	0.326
2.1	C-001	1,719,019	435,672	1,283,347	75%	0.392	0.432
	C-002	613,553	105,823	507,729	83%	0.339	0.361
	C-003	909,621	561,592	348,030	38%	0.337	0.358
	C-004	294,970	3,426	291,544	99%	0.371	0.428
	C-005	117,361	35,849	81,512	69%	0.348	0.450
	C-006	63,403	57,135	6,268	10%	0.322	0.364
	C-007	2,357	2,175	182	8%	0.027	0.374

Figure 6.1 provides a partial explanation of why customers pay a lower average price per kWh when they schedule pumping versus when they do not. The figure shows the average hourly usage profile by year and whether the hour had a dynamic transaction, summed across the pumps that were actively managed by the Pilot participant (i.e., excluding some customer C-001 pumps and one of customer C-005 pumps). The solid lines reflect usage on days with dynamic transactions (i.e., scheduling pumping ahead of time), while the dashed lines reflect days with pumping usage priced entirely at settlement prices (i.e., unscheduled pumping). Orange lines reflect 2023 data while blue lines reflect 2024 data (May through September in each case).

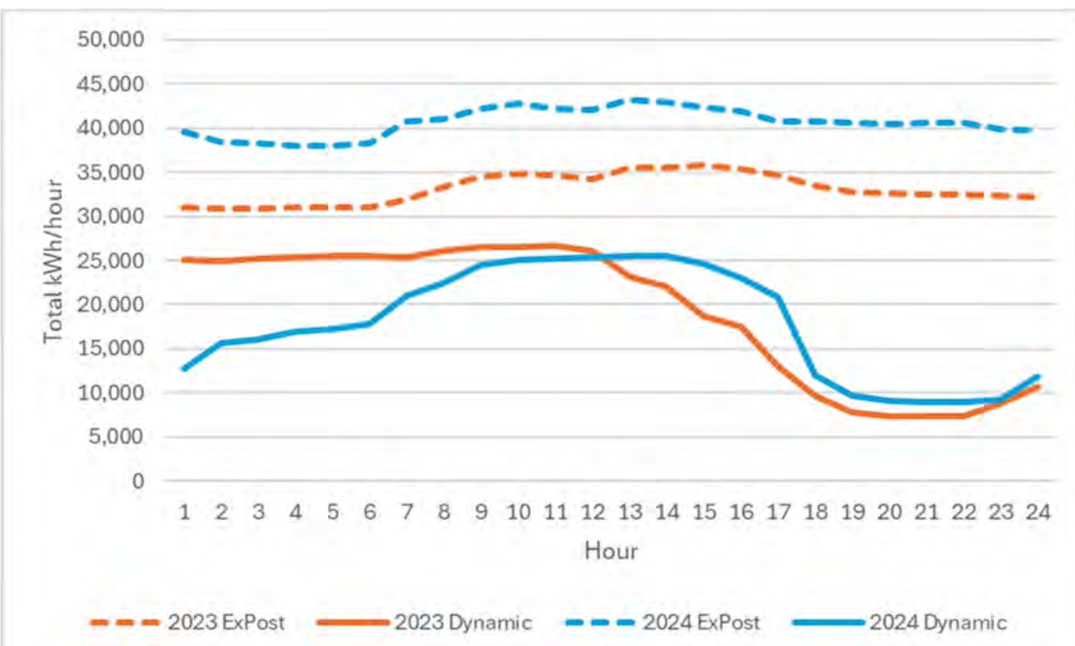
The figure shows that when customers schedule usage (the solid lines), they are more likely to avoid pumping in the hours that tend to have the highest prices. These are also hours in which OAT peak-period demand charges and energy prices are in effect, reinforcing the notion that we have a hard time distinguishing whether customers are using the automation technology to respond to dynamic prices or OAT rates.

Figure 6.1: Average Hourly Usage by Scheduling Status and Year



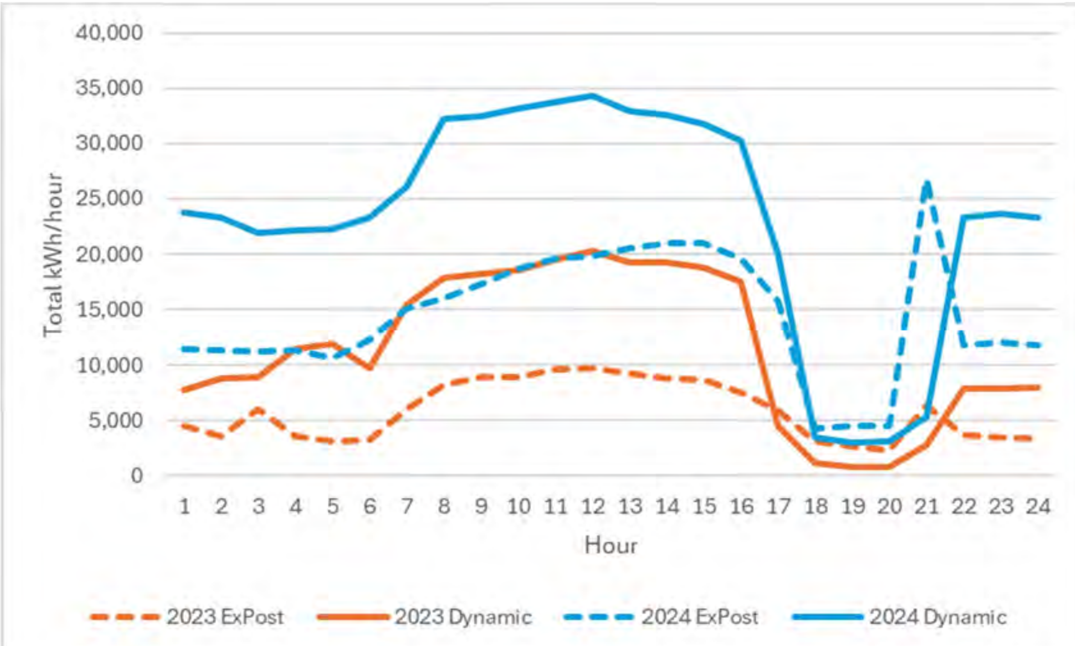
Figures 6.2 and 6.3 show the same information as Figure 6.1, but for two contrasting customers. Customer C-001, shown in Figure 6.2 (excluding the pumps the customer reported as not being managed to Pilot prices), has a stark difference between load profiles on scheduled versus unscheduled days, with a flat load profile on unscheduled days and usage that drops considerable at hour-ending 18 on scheduled days.

Figure 6.2: Average Hourly Usage by Scheduling Status and Year, C-001



In contrast, customer C-003 (shown in Figure 6.3) appears to be attempting to minimize OAT peak-period usage (from HE 18 to 20) on all days, regardless of whether they scheduled the pumping. The flatter usage associated with unscheduled pumping may reflect times when the customer needs to pump all day regardless of price.

Figure 6.3: Average Hourly Usage by Scheduling Status and Year, C-003



The differences in load profiles on scheduled and unscheduled days explains some of the differences in average prices paid across the two day types, but is likely not large enough to explain the entire difference. It is likely also the case that pumping is more likely to be scheduled when customers notice a particularly low price, whereas unscheduled usage is more likely occur as needed with less attention paid to the dynamic prices.

Table 6.3 provides an additional comparison that may help illustrate customer benefits from Pilot pricing. It compares the average price customers achieved on AgFIT to the average price they would have paid if all usage was purchased at the settlement price (which was the day-ahead price during the periods shown in the table). Bold is used to indicate customers who saved money relative to purchasing entirely at settlement prices, which applies to all but three customers, with two of those having essentially no difference between the two prices. Benefits from transacting ranged from 0.3% to 84%. The simple average of the percentage differences across rows is -8.9%, but using Total kWh to produce a usage-weighted average reduces the value to -1.3%. For customers participating in the Pilot during both years (C-001 through C-005), savings were higher in 2023 than in 2024 (2.5% in 2023 versus 0.5% in 2024, using the usage-weighted average percentage savings). This is consistent with themes we heard during our interviews: customers reported managing to prices differently during 2024 because there was less price variability outside of the peak-period, which some customers were already avoiding in response to the OAT's demand charges.

Notice that customer C-007[55] saved an unusually large amount, saving 84% relative to what they would have paid had they only purchased energy at settlement prices. This was due to a scheduling interface problem in effect from August 21 to September 22, 2024, during which dynamic purchases were treated as having a $0 per kWh price. Thus, when the customer scheduled pumping during those hours, they could purchase the expected usage of their pump for no money and later sell it back at the settlement price, which was unaffected by the problem and thus reflected typical levels. The customer's ability to benefit from the software error was limited by the fact that the customer had no discretion over the dynamic transaction quantities – the amount purchased corresponds to the pump's expected usage (i.e., customer scheduling is a pump / do-not-pump decision rather than a direct decision to purchase a customer-specified quantity of kWh).

Table 6.3: AgFIT Average Price vs. AgFIT Price if All Usage Settled at Ex-Post Prices

AgFIT	Customer	Total kWh	All kWh at Last Rate ($/kWh)	AgFIT ($/kWh)	% Difference
2.0	C-001	1,587,141	0.342	**0.332**	-2.7%
	C-002	514,959	0.323	**0.322**	-0.3%
	C-003	416,734	0.319	**0.307**	-3.7%
	C-004	32,773	0.312	**0.278**	-10.7%
	C-005	34,821	0.285	**0.272**	-4.5%
2.1	C-001	1,719,019	0.422	**0.422**	0.0%
	C-002	613,553	0.357	0.357	0.0%
	C-003	909,621	0.351	**0.344**	-1.8%
	C-004	294,970	0.428	0.428	0.0%
	C-005	117,361	0.420	**0.419**	-0.2%
	C-006	63,403	0.323	0.326	0.8%
	C-007	2,357	0.345	**0.054**	-84.3%

We explored whether customers could systematically benefit by scheduling usage due to biases in the forward prices. For example, if two- to six-day-ahead prices are consistently lower than the day-ahead settlement prices for the same hour of delivery, customers would tend to save money by scheduling. We estimated ten statistical models in which the dependent variable is the difference between the various day-ahead prices (two through six) and the one-day-ahead price that serves as the settlement price. Separate models are estimated for 2023 and 2024, each using data from the May through September growing season. The explanatory variables of interest are hourly indicator variables, for which the estimated coefficients represent the difference between the advance-notice price (e.g., four-day ahead) and the day-ahead price.

Figures 6.4 and 6.5 show the estimated coefficients by hour and notice level. A negative value indicates that the advance-notice price is, on average, lower than the day-ahead price during that hour and year, providing an opportunity to save money by scheduling pumping.

The figures provide two notable insights:

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[55] Notice that this customer had the lowest usage level among participating customers. In addition, they were the only participant controlling its pump manually.

1. Differences between advance-notice and day-ahead prices are largest during peak hours, which are the hours in which customers are least likely to schedule pumping. That is, while it does appear that customers could consistently benefit (relative to settlement prices) by scheduling pumping during peak hours, they do not tend to schedule pumping during those hours. This is likely due the fact that those are the highest-cost hours even with advance notice, and that the customers are not taking the time to look for arbitrage opportunities.

2. Differences between advance-notice and day-ahead prices tend to be lower in 2024 than 2023. This may be due to the different vendor used to provide forecasts in 2024, which could have led to reduced forecast error when setting advance-notice prices.

Figure 6.4: Average Hourly Difference between Advance-Notice and Day-Ahead Prices, 2023

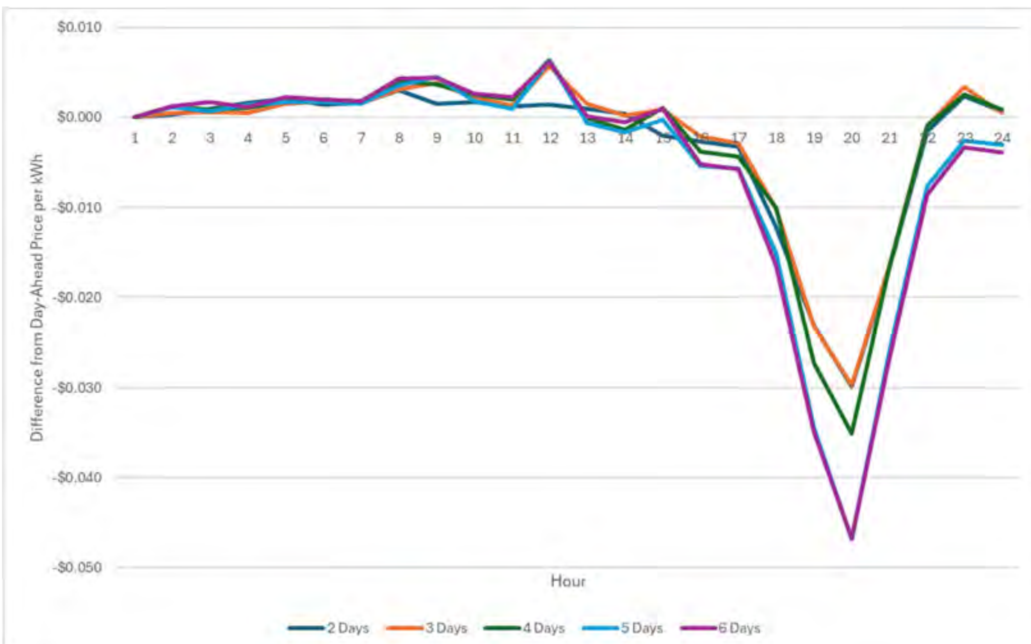
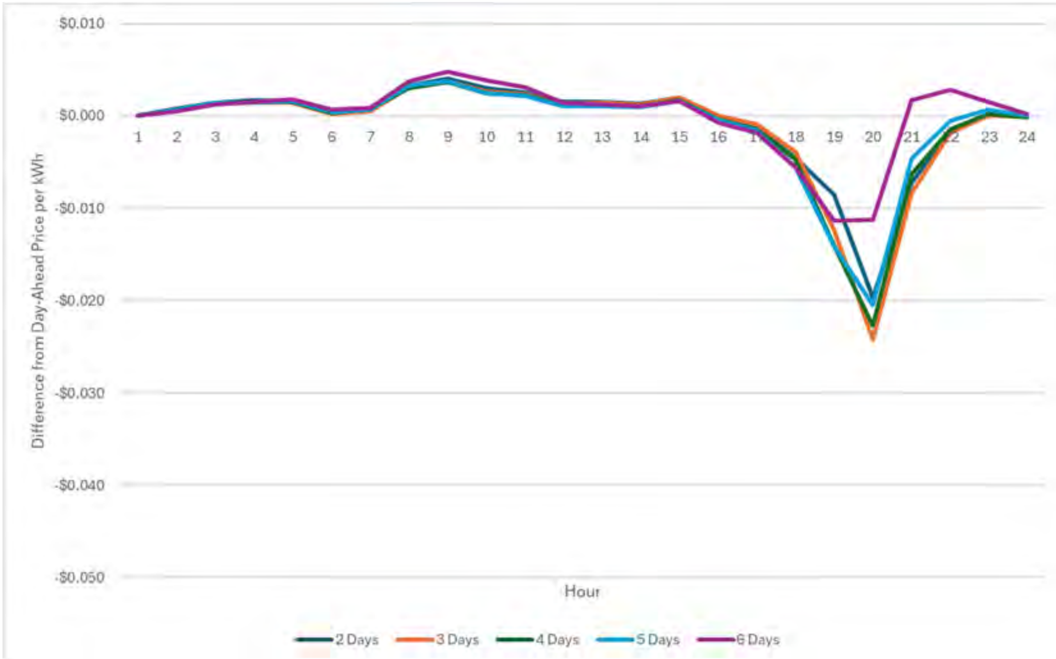


Figure 6.5: Average Hourly Difference between Advance-Notice and Day-Ahead Prices, 2024

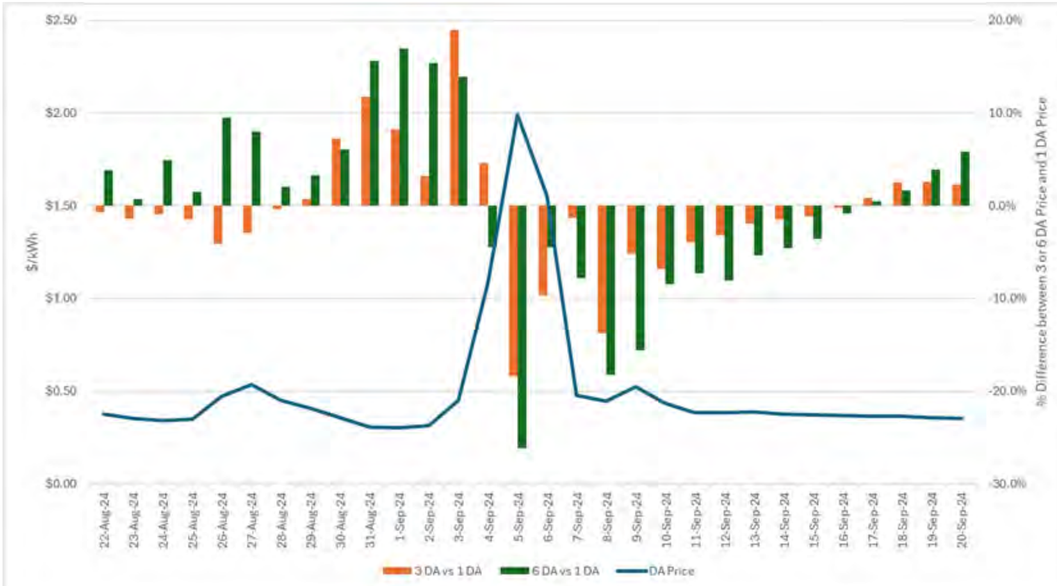


We also examined whether the moving-average price adjustment methods used in AgFIT 2.0 and 2.1 could create opportunities for customers to benefit from scheduling pumping. That is, the hourly prices are adjusted so that (in AgFIT 2.1 pricing) the average price for the seven days before and after the delivery date matches the pump's rate schedule average price. This method has the potential to "distort" prices when a high price spike is present in the days used to calculate the average.

Figure 6.6 shows price information for the dates surrounding a price spike that occurred on September 5, 2024. For simplicity, we show only HE 19 prices (the highest-priced hour of the day) and limit the advance notice prices shown to three and six days ahead. In the figure, the blue line represents the day-ahead price by date. Notice that the price reaches nearly $2 per kWh on September 5th but is below 50 cents per kWh on most other dates. The orange and green bars represent the percentage difference between the three- and six-day ahead prices (respectively) that were offered for delivery during that hour and the day-ahead settlement price. For example, on September 8th, the day-ahead settlement price was $0.45 per kWh, the three-day ahead notice price was $0.39 per kWh (13.7% below the day-ahead price), and the six-day-ahead notice price was $0.37 per kWh (18.3% below the day-ahead price).

The figure shows that in the days following the price spike, customers could have paid significantly less by scheduling pumping rather than paying settlement prices. This was not the case in the days leading up to the price spike.

Figure 6.6: Effect of the September 5, 2024 Price Spike on Hourly Prices by Date and Notice Level



In contrast, Figure 6.7 shows a time period during which no price spikes occurred. In this case, the percentage differences between the advance-notice and day-ahead prices were comparatively small and tended to be positive, indicating an average benefit from purchasing at settlement rather than scheduling pumping.

Figure 6.7: Percentage Price Differences by Date and Notice Level with Mild Prices

The conclusions we've reached from the analyses presented in this sub-section are:

- Customers paid less when they scheduled load, but only about one-third of their total usage was scheduled.
- Scheduled loads tended to avoid usage during the highest-priced hours, which contributed to the customers' savings.
- It does not appear that customers systematically benefited from forecast errors in the advance-notice prices (i.e., two or more days ahead). The peak-hour prices tended to be under-forecast relative to settlement prices, but customers generally avoided scheduling usage during those hours.
- The moving-average methodology used in AgFIT 2.0 and 2.1 can produce pricing distortions in the dates surrounding price spikes and therefore that method should be excluded from future rate offerings.

6.3.2 Analysis of the Potential for Structural Benefiters and Non-Benefiters

When customers change rate structures, it is common for them to experience a change in their bill independent of any changes in behavior. For example, if a customer changes from a rate schedule with a flat energy rate to one with time-of-use pricing, a customer with a relatively low share of peak-period usage may experience a bill reduction prior to responding to the new price signals. Similarly, the AgFIT 2.0 and 2.1 pricing methods include opportunities for customers to be structural benefiters or non-benefiters because AgFIT's dynamic prices are adjusted to match the pump's rate schedule average OAT price.

The use of the rate schedule average OAT rate to adjust dynamic prices was conceived as a means of tying Pilot prices to OAT levels of revenue recovery without requiring subscriptions. In contrast, had the dynamic prices been adjusted to the customer's own average historical OAT price, the pricing would have embedded the same issue encountered with subscriptions when applied to agricultural pumping customers: historical months with usage patterns which were not a good reflection of current pumping needs and which produced a subscription average price that was out of alignment with current OAT average prices paid. For example, if the subscription is based on a very low load factor load, the subscription price may be quite high relative to what the customer is paying on its OAT rate when they pump more consistently. Using the rate class average OAT price avoided problems with using odd historical years as the basis for Pilot pricing, but introduced the possibility that a customer could benefit when they have a higher cost to serve load profile. For example, if their load factor leads to an average OAT price paid of $0.40 per kWh but the rate schedule average price paid is $0.35 per kWh, the customer obtains the benefit of having its dynamic prices adjusted to the lower level.

We conducted a statistical analysis to examine the extent to which the use of the rate schedule average OAT rate affected a customer's ability to earn credits. Specifically, we estimated a regression model in which the unit of observation is a pump-month, the dependent variable is the pump's credit per kWh (OAT $/kWh minus AgFIT $/kWh, retaining negative values) in that month, and the explanatory variables is the difference between the pump's average OAT price and the pump's rate schedule average OAT price.

We excluded NEM pumps (due to billing issues) and "outliers" in terms of the average prices (omitting observations with credits or average OAT prices greater than 50 cents/kWh) and low usage (below 100 kWh in the month). Note that the results are robust to changes in these exclusions, but some screening is necessary given the use of per-kWh prices in the presence of some low (and sometimes zero) usage values (which results in very high $/kWh values).

Figure 6.8 shows a scatter plot of the credit per kWh (on the vertical axis) and the difference between the pump's average OAT price and the pump's rate schedule average OAT price (on the horizontal axis). Moving to the right on the horizontal axis represents a pump with a higher average OAT price relative to its rate schedule average. Moving up on the vertical axis represents a pump that paid more on the OAT than under Pilot pricing. Therefore, the top right quadrant of the figure contains pumps that received a credit (i.e., the OAT bill was higher than the Pilot bill) and the pump's average OAT rate was higher than the pump's rate schedule average.

The strong positive relationship shows that the greater the gap between the pump's own average OAT price and its rate schedule's average OAT prices, the higher the credit. That is, because AgFIT hourly prices were adjusted to the rate schedule's average, which may not have reflected the pump's actual OAT price, there was an opportunity for customers to benefit, regardless of their own actions.

Figure 6.8: Credit in $/kWh vs. the Difference between the Pump's Average OAT Price and the Rate Schedule Average OAT Price ($/kWh)

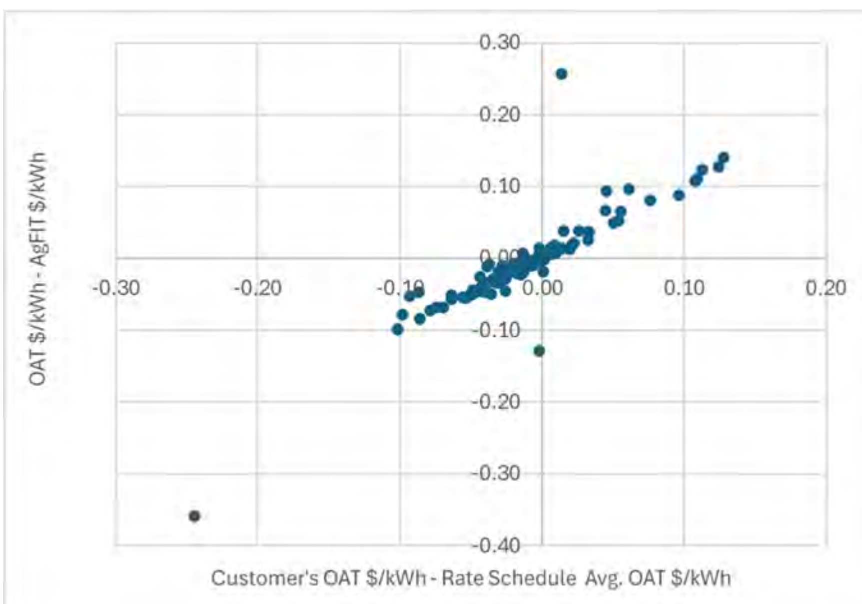


Table 6.4 shows the estimated coefficients from the regression model, with p-values in parentheses. The estimate on the OAT price difference of 1.109 reflects a nearly one-to-one correspondence between the difference between the pump's OAT price and the rate

schedule average and the credit the pump subsequently earns on the Pilot. (Note: the credit is calculated as the pump's OAT bill minus the pump's AgFIT charges, so a positive value represents a contribution to a shadow bill credit for the customer.) The R-squared value indicates that 77% of the variation in credits per kWh can be explained by the difference between the customer's average OAT price and their rate schedule's average OAT price.

Table 6.4: Estimates of the Relationship between Monthly Credits and the Difference between Pump and Rate-Class Average OAT Rates

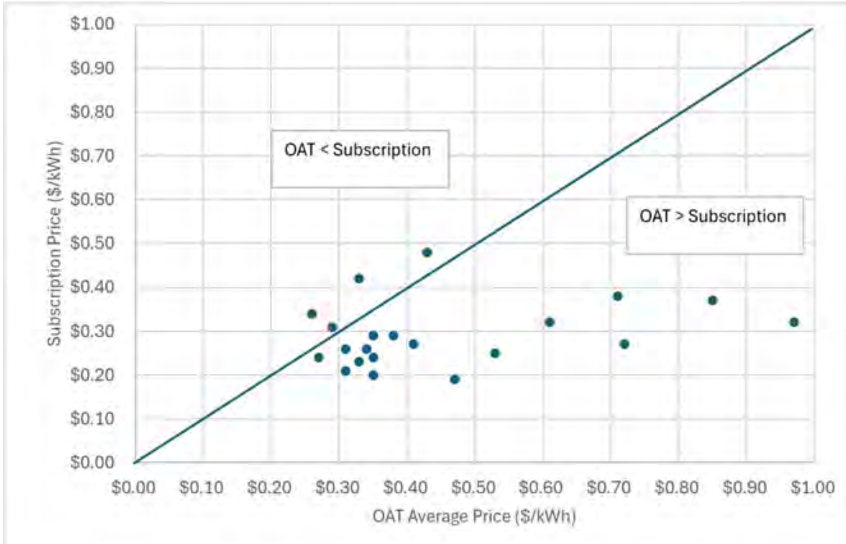
Variable	Estimated Coefficient
Pump OAT $/kWh – Rate Schedule Average OAT $/kWh	1.109 (0.000)
Constant	0.006 (0.087)
N = 97, R^2 = 0.773	

p-value in parentheses.

As described above, AgFIT 1.0 embeds an effect that is similar to the structural benefiter effect present for AgFIT 2.0 and 2.1. That is, customer credits can depend on differences between the customer's historical usage used as the basis for its subscription pricing and its current usage profile (for reasons unrelated to price response, such as differences in water conditions, or crop rotations).

Figure 6.9 shows a scatter plot of the average subscription price ($/kWh) versus the pump's average OAT price for all pumps enrolled in the Pilot during AgFIT 1.0 (from August 2022 through April 2023). The diagonal line is the line of equality for the two prices. Therefore, the upper left portion of the figure represents pumps for which the subscription price is higher than the average OAT price, while the lower right portion of the figure represents pumps for which the subscription price is lower than the average OAT price. As the figure shows, 17 of the 21 pumps had a subscription price lower than the average OAT price. For those pumps, the subscription may have provided an "instant win" for the pump, allowing it to purchase energy for less than it paid under the OAT rate. This will tend to generate shadow bill credits, as the AgFIT charges will likely be less than the OAT bills.

Figure 6.9: AgFIT 1.0 Subscription Price vs. OAT Average Price ($/kWh)



Taken together, we have two conclusions from the analyses presented in this subsection:

- AgFIT 2.0 and 2.1 pricing embeds the potential for structural benefiters and non-benefiters; and
- AgFIT 1.0 pricing embeds the potential for a pump to win or lose based on differences in load profiles across years.

6.3.3 Disproportionate OAT vs. AgFIT Bill Changes

Pilot credits are generated when a pump's current OAT bill is greater than its corresponding AgFIT bill. As discussed in Section 2.1, the presence or absence of a Pilot credit is not necessarily indicative of customer performance on the Pilot. For example, customer C-003 has a pump that had a large change in Pilot credit contributions in consecutive months, largely due to how the OAT rate was affected by an increase in billed demand.

Table 6.5 contains summary statistics for the two months, which were billing months beginning in July and August 2024.[56] In July, when the pump's AgFIT bill was higher than its OAT bill, the customer never pumped during the Peak period (0.8 kW versus 152.3 kW for its all-hours maximum demand). In contrast, during August the customer pumped during the Peak period on three days, with a maximum demand of 121.2 kW. This, combined with a higher share of usage during the Peak period (from 0.1% to 4.3%), produced a large increase in the OAT average price paid, from $0.269 per kWh in July to $0.505 per kWh in August. The corresponding change in

[56] The pump is served on Rate Schedule AG-C. Note that we summarize 60-minute demand values (which is the frequency of the interval data provided to us), while AG-C bills using 15-minute demand. AG-C also has a Demand Charge Rate Limiter, which caps the rate per kWh at 50 cents per kWh for all demand- and energy-related rates (i.e., excluding the customer charge).

the AgFIT average price paid was much smaller, increasing from $0.316 per kWh to $0.346 per kWh.

One way to summarize the change in the pump's usage profile is load factor, which is average hourly usage divided by peak demand. Lower load factors are associated with higher average prices paid on demand-based rates. Because AgFIT excludes demand charges, changes in load factor have larger effects on the OAT bill than the AgFIT bill. In short, the credit accrual from August 2024 shown in Table 6.5 does not appear to reflect customer demand response to AgFIT prices but rather is due to the fact that the change in customer usage patterns (i.e., increased Peak-period usage and demand) led to a large increase in the OAT bill, which serves as the benchmark for Pilot credits.

Table 6.5: Illustrative Months for Customer C-003, Pump 1

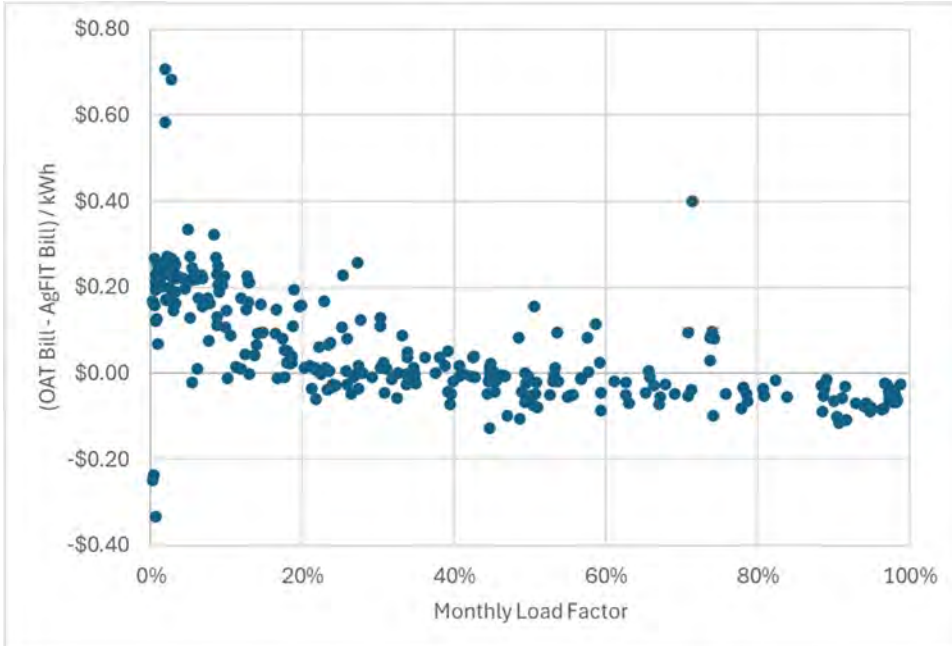
Result	Bill Start Month	
	July 2024	August 2024
Avg. kWh/hour	67.4	29.8
Peak kW	0.8	121.2
All-hours kW	152.3	150.1
Load Factor	44%	20%
Peak Usage Share	0.1%	4.3%
OAT $/kWh	$0.269	$0.505
AgFIT $/kWh	$0.316	$0.346
OAT - AgFIT $/kWh	-$0.047	$0.159
OAT - AgFIT Bill	**-$2,206**	**$3,640**

It is not typical to see month-to-month changes in credit accruals of the magnitude shown in the example above. Therefore, we investigated the extent to which the relationship between credit accruals and load factor generalizes across pumps and months. Figure 6.10 shows the relationship between load factor[57] and the credit accrual (in $/kWh) across monthly bills and pumps using data from October 2023 through September 2024.[58] The figure shows that lower load factors are associated with higher credits. That is, a low load factor typically results in a high average price paid on the OAT rate because the demand-related costs are a high portion of the bill. Because AgFIT pricing does not contain demand charges, the low load factor has a smaller effect on the AgFIT bill, this making it easier to earn a credit.

[57] Load factor is defined as the average hourly usage divided by the 60-minute all-hours peak demand during the billing period.

[58] We included only billing months for which we were able to perfectly align the billing month dates with hourly interval data (e.g., we could not include billing months that extended into October 2024 because the interval data was only provided through September 30, 2024). We also excluded billing months with zero usage (i.e., because we can't calculate average prices per kWh) and months with a credit accrual (defined as the (OAT bill – AgFIT bill) / kWh) larger than $1.00 per kWh in absolute value (to ensure the analysis isn't driven by outliers).

Figure 6.10: Monthly Load Factor vs. Credit Accrual in $/kWh



We estimated a statistical model to formalize the relationship shown in Figure 6.10. The dependent variable is the credit accrual in $/kWh, calculated as: (OAT bill – AgFIT bill) / kWh. The explanatory variables are the monthly load factor and a constant term. Pump fixed effects are included to account for the pump's rate schedule and any other time invariant pump-specific characteristics that may affect the credit accrual and load factor. In addition to a model that uses all data points shown in Figure 6.10, we estimated separate models by rate schedule to explore differences in the load factor vs. credit relationship across rates.

Table 6.6 shows the estimates, with p-values in parentheses. The coefficient for load factor of -0.300 can be interpreted as follows: an increase in load factor from 25 percent to 75 percent (a 50-percentage point increase) will lead to a reduction in the difference between the OAT and AgFIT average prices of 15 cents per kWh. The R-squared value indicates that more than half of the variability in credit accruals can be explained by load factor and pump fixed effects. When examining estimates by rate schedule, it is important to note that AG-C has, by far, the most observations. Because of this, its estimate is the most statistically significant and the point estimate is close to the estimate for all pumps (-0.289 for AG-C versus -0.300 for all pumps). The remaining rate schedules all have point estimates that reflect the same qualitative relationship, though not all estimates are statistically significant due to small sample sizes.

Table 6.6: Estimated of Relationship between Load Factor and Credit Accruals

Group	Estimated Load Factor Coefficient	Number of Observations	R-squared
All	-0.300 (0.000)	289	0.537
AG-A2	-0.338 (0.228)	26	0.396
AG-B	-0.344 (0.011)	39	0.489
AG-C	-0.289 (0.000)	203	0.592
AG-FB	-0.706 (0.117)	9	0.385
AG-FC	-0.201 (0.035)	12	0.437

p-value in parentheses.

Taken together, the findings of this section indicate that the presence of a credit does not necessarily indicate significant and beneficial price response on the part of the customer. Rather, credits can be accrued via structural benefiter effects and differential effects of exogenous load changes (i.e., unrelated to Pilot pricing) on AgFIT vs. OAT bills.

7 STAKEHOLDER COMMENTS

In this section, we provide each of the key stakeholders to the project an opportunity to provide their comments on the Pilot. Each stakeholder's subsection represents their views and not those of other stakeholders or the evaluator.

<u>VCE Comments</u>

The following text was provided by VCE for inclusion in the evaluation.

VCE's original pilot concept to test the willingness and ability of farmers to shift agricultural load by using a combination of price signals, automation, and customer support has shown encouraging results. As a Load Serving Entity responsible for and directly exposed to customer outcomes, we conclude that generally, farmers in our service territory do show a willingness and ability to shift load given the right combination of price signals, automation, and customer support. The pilot also yielded lessons that can be applied to future pilots or rates designed to encourage customer response to dynamic prices in agricultural and other customer classes.

As pilot results are evaluated, we would encourage stakeholders and policymakers to consider the decisions that were made in designing the pilot, as well as the systemic barriers that may have had an impact on customer behavior. While it is important to assess quantifiable metrics, it is also important to assess non-energy impacts such as customer experience and co-benefits (e.g. water conservation) to understand the full value of this pilot. VCE appreciates that this third-party evaluation report recognizes those co-benefits.

Based on the final evaluation results, VCE makes four general observations: (1) agricultural customers are willing to respond to dynamic prices, but sometimes are unable to; (2) further calibration of the rate design is necessary to achieve lasting results; (3) systemic barriers such as timely access to accurate data need to be removed in order to ensure the success of dynamic rates; and (4) non-energy factors and co-benefits can be important additions to the overall value proposition for this type of pilot.

More detailed comments/observations include:

1. Several factors may have limited growers' ability to respond to prices, including weather/precipitation conditions, crop type, and attempts to manage OAT costs.

2. During the pilot, different pricing methodologies were employed to better calibrate the tariff for desired customer load shift and satisfaction (e.g. AgFIT 1.0, 2.0). While these decisions were made to fix issues or better integrate certain cost recovery mechanisms, the changes may have affected customer behavior. More study on the various pricing methodologies is suggested, using a single pricing methodology (e.g. AgFIT 2.1) for at least 3 years.

3. Automation was cited as important by the growers in responding to price signals. However, one cannot overstate the impact of customer engagement on the success of AgFIT. Automation incentives, demand response programs and TOU rates have been available for years, and many participating customers did not take full advantage of these load-shift tools until coached on the utility and use of software during AgFIT.

4. Throughout the course of AgFIT, pilot partners encountered barriers to accessing timely, accurate usage data. VCE was unable to consistently create and share monthly Shadow Bills with customers, so scheduling decisions were not fully guided by pilot performance. In the absence of pilot performance data, growers potentially managed their usage according to existing OAT costs (including demand charges) instead of scheduling on the dynamic rate, potentially affecting results (e.g. how much usage was scheduled).

5. It should be within scope for future dynamic rate pilot evaluation reports to thoroughly assess non-energy and co-benefits associated with the pilot. Additionally, to more fully measure price response to dynamic rates, we would suggest recruiting a wide range of customer load shapes to participate (e.g. customers with a flat load as well as customers actively responding to TOU prices before the pilot).

<u>PG&E Comments</u>

PG&E declined the opportunity to provide comments.

Polaris Comments

The following text was provided by Polaris for inclusion in the evaluation.

- It is reasonable to assume that incentive funding will need to be made available to drive industry transformation and adoption of automation technologies to help consumers manage complex hourly dynamic rate tariffs. There would likely be very few customers able to manage such a tariff without automation equipment and the funding for it. We look to PG&E's Automated Demand Response program as precedent for this.

- The findings from the Pilot illustrate the importance of being nimble enough to rapidly evolve with and adapt from learnings and other program developments that require real-time action. Future pilots should ensure adequate resources and support to tune the pilot towards desired price responsiveness and load shifting outcomes.

TeMix Comments

The following text was provided by TeMix for inclusion in the evaluation.

TeMix believes this pilot, its sister SCE pilot[59], and the previous RATES pilot[60] demonstrate that the CALFUSE vision is technically sound and feasible, reassuring everyone about CALFUSE's direction and potential for future success. The CALFUSE vision features a two-part subscription and dynamic transactive pricing tariff. The subscription component ensures stable bills and cost recovery while supporting resource adequacy and equity. Customer-facing dynamic prices reflect locational scarcity and abundance in conventional and renewable wholesale generation, storage, and transmission. Furthermore, these customer-facing prices account for locational scarcity and losses in two-way distribution service. The vision entails customers' flexible devices primarily responding automatically to these granular, locational dynamic prices, thus eliminating the need for centralized distributed energy resource management systems (DERMS). CALFUSE aims not just to be another retail tariff but also to establish a system that enables customer-centric load management to lower system costs and customer bills.

The CALFUSE vision aims to establish a standard tariff (unified, universally acceptable, dynamic economic signal) to replace the numerous complex OAT tariffs[61]. The OAT tariffs include TOU rates, baselines, demand charges, counterfactual demand response, centralized dispatch of distributed energy resources (DERs), and virtual power plants (VPPs). These demand-side programs are costly and inefficient. For example, PG&E has requested $761 million through 2030 to partially update its COBAL billing system to handle the complexities of the existing complex OAT tariffs and demand-side programs[62].

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59 SCE Dynamic Rate Pilot – Emerging Markets & Technologies
60 Complete and Low-Cost Retail Automated Transactive Energy System (RATES) – Emerging Markets & Technologies
61 Page 2 of the June 22, 2022 Energy Division white paper entitled "Advanced Strategies for Demand Flexibility Management and Customer DER Compensation".
62 $761.3 million for a Billing System?

How much money could be saved by transitioning to a uniform CALFUSE tariff for all customers?

Tying the subscriptions to OAT tariffs was a temporary way to kick off the pilot. The vision is to base the CALFUSE subscriptions on the same formulas used for dynamic pricing, with inputs for these formulas relying on forward hourly forecasts extending more than a week ahead with various ways to construct the subscription load shapes. The TeMix Platform™ offers the computing infrastructure and methodology necessary to fully implement these subscription transactions and the CALFUSE vision at scale.

Before the pilot began, there was discussion of a one-part tariff; however, the CPUC and VCE opted for TeMix's two-part tariff in line with the CPUC CALFUSE design. Midway through AgFIT 1.0, with only two customers, it was decided to abandon the two-part CALFUSE tariff with subscriptions in favor of an untested, ad-hoc, one-part tariff. This one-part tariff adjusted the average dynamic prices to align with the average OAT prices for AgFIT 2.0 over the next seven days, and for AgFIT 2.1, it used a fourteen-day period that included seven days ahead and seven days back. This daily price averaging distorts the dynamic prices in a way that is difficult to comprehend. It does not make sense for a price spike from seven days ago or seven days ahead to influence today's hourly prices. PG&E identified an exploitable flaw in the combination of price averaging and forward transactions and recommends that this combination not be used in future offerings.

As noted in the report, customers whose load shapes deviate from the average load shapes of an OAT rate class can instantly become either winners or losers with the one-part price averaging tariff. This issue is particularly significant for customers with solar generation. Furthermore, fixed customer charges and any income-based fixed charges cannot be accurately represented in a one-part tariff; therefore, a two-part tariff is necessary. Lastly, following any forward transaction, a one-part tariff transitions into a two-part tariff. PG&E has adopted the two-part tariff for its extended pilot, which is used for only a brief duration. The AgFIT 1.0 two-part tariff performed well and did not require immediate replacement. However, numerous opportunities to enhance the two-part tariff were never pursued due to the shift to a one-part tariff. The work and expenses associated with AgFIT 2.0 and 2.1 held little value and would have been much more beneficial if allocated toward developing and testing subscriptions that were not tied to OAT tariffs.

The California energy system increasingly relies on primarily fixed-cost renewable generation, storage, transmission lines, and energy-consuming devices that require no fuel and have minimal variable costs. There is no straightforward method to calculate the customer-facing marginal energy cost. Energy prices can be influenced by the customer's willingness to adjust and optimize their energy usage during extreme weather conditions and grid events.

For AgFIT 1.0, TeMix implemented a scarcity pricing methodology developed during the RATES pilot. Higher energy prices recover a larger share of the largely fixed costs of generation when overall loads and load ramps are elevated, or circuits are more heavily loaded in either direction. For AgFIT 2.0 and 2.1, PG&E introduced pricing formulas and complex spreadsheets that relied on outdated marginal cost concepts, including flat $/kWh charges, which diminished the effectiveness of the price signals.

The CPUC's decision to shadow-bill customers as a means of bill protection severely compromised the AgFIT pilot. As outlined in this report, many customers continued to focus on minimizing their OAT charges, including demand charges, rather than reducing their AgFIT bills. The subscriptions in a two-part tariff stabilize customer bills for bill protection, rendering the entire shadow billing and credit system unnecessary.

TeMix understands that California's electricity institutions require time to implement the CALFUSE vision fully. Retail pricing, distribution services, and wholesale operations are separate systems with their experts and infrastructures. The CALFUSE system can concurrently address customer, distribution, wholesale operational, investment issues, and billing.

Dynamic pricing may intimidate some, but it should not be viewed this way in the context of the CALFUSE two-part subscription transactive tariff. The transactive components of the CALFUSE vision are essential for enabling effective operational planning and generating savings for energy customers and suppliers, as well as for distribution and transmission services. Months and years in advance, physical transactions are needed to ensure resource adequacy. These transactive features also enable intra-day and intra-hour price responses to maintain grid reliability and savings, particularly during extreme grid conditions.

California's complex retail tariffs and demand-side programs require replacement. CALFUSE presents a vision and roadmap to foster a more customer-centric, efficient, clean, and equitable electricity system.

8 SUMMARY AND CONCLUSIONS

Our summary of the key takeaways from the Pilot can be divided into two categories: comments on the enrolled customer experience; and comments on the shadow billing and pricing methods used during the Pilot.

8.1 Customer Experience

<u>Customers face constraints that may limit their ability to respond to prices.</u>

Agricultural pumping customers face a number of operational constraints that can vary seasonally and with weather conditions (e.g., causing them to need to run in all hours, not need to pump at all, or need to have minimum run times) that may affect their ability to shift or reduce load at any given time. While the load can sometimes be highly responsive, one should not assume that a high percentage of the pumping load will be curtailed in response to a specific high-price event. In addition, customers may not be aware of a high-price hour if they scheduled pumping for that hour before the spike showed up in pricing. Interviews revealed little awareness of price spikes in 2022 and 2023.

Automating pump operations helped customers respond to prices.

Customers value the ability to control pumps remotely and can use it to respond to both TOU and dynamic prices. One customer reported in an interview that the technology incentives in the Pilot were important, and the customer would not have been able to install the automation without them.

Customers paid a lower average price when they scheduled pumping.

Customers were effective in their use of pump scheduling, obtaining a lower average price per kWh than they would have paid if they'd purchased all usage at settlement prices. Scheduled pumping was less likely to occur during peak hours than unscheduled pumping, which contributed to the savings from scheduling. However, two-thirds of usage during the Pilot was purchased at settlement prices, so scheduled pumping was not the dominant behavior for most customers.

Customers need more frequent billing feedback to understand the benefits.

Customers need more frequent feedback on their savings/billing under the Pilot to be able to determine the value of their actions and adjust their behavior accordingly.

In a post-Pilot world, customers will compare dynamic pricing to TOU pricing if both are available as voluntary rates. If the pump's TOU rate provides greater bill savings to the customer (either because it's easier to act on or because the rewards to responding are higher), it is unlikely that they would adopt dynamic pricing as a voluntary rate even if it has better pricing from a societal perspective (i.e., even if TOU rates "overpay" customers for peak-period usage reductions and dynamic rates do not).

Interviewed customers had positive views of the Pilot but had some reservations about whether they would adopt it as a permanent rate. Managing usage under dynamic pricing is time consuming.

The interviewed customers had positive things to say about their experience, but they need more information to determine whether Pilot pricing would work for them as a permanent rate. They reported valuing the automation, the Pilot incentives, and the Pilot credits, but needed to learn more before understanding whether the time it takes to respond to dynamic prices leads to high enough benefits. Customers are busy and the time it takes to manage usage against dynamic prices needs to have a corresponding benefit.

8.2 Shadow Billing and Pricing Methods

The shadow bill credit method affected Pilot results and how they ought to be interpreted.

While on AgFIT, the customer pays its current OAT bill and will receive a credit each year[63] if the sum of its OAT bills is greater than the sum of its shadow (Pilot) bills calculated separately for each service account (typically one meter). However, those OAT bills may be higher than their pre-Pilot OAT bills if the customers stop managing their billed demand and instead focus on the dynamic prices. Therefore, the presence or absence of an AgFIT credit is not necessarily indicative of whether the customer benefited from Pilot participation. A customer who used the automation (i.e., remote pump control) technology to reduce their OAT bill would receive that benefit in the current month's bill and could further benefit by trying to respond to dynamic prices to earn an AgFIT credit, provided the response did not conflict with the incentives embedded in the OAT rates. In other words, a profit-maximizing customer may focus mostly on its OAT bill, which could reduce dynamic load response compared to what the customer would have done in the absence of the shadow bill credit methodology.

In addition, because the shadow bill credit method meant that Pilot customers should have continued to pay attention to OAT price signals while participating in the Pilot, we were unable to conduct a valid evaluation of customer response to Pilot prices alone. That is, at any given time, customers face two sets of incentives (not to mention the various forward contracting opportunities presented by the Pilot) and it is not possible for us to know with certainty which price signals are driving the resulting behavior. All price response analyses in this report should be viewed through this lens. For example, we know from our interview that customer C-005 paid close attention to the Pilot's hourly prices and responded to them, but they had no peak-period usage to adjust to hourly prices because of an everyday response to the OAT demand charge. Our statistical estimates of their price response captured this behavior, but made it unable for us to determine what their peak-period price responsiveness would have been in the absence of the OAT incentives.

The change to one-part pricing under AgFIT 2.0 and 2.1 addressed an issue in AgFIT 1.0's two-part pricing but had other consequences.

A motivation for changing from two-part pricing to one-part pricing (in May 2023) was to avoid subscription prices that were based on historical loads that did not reflect pumping needs in the Pilot period. For example, if the historical month used to calculate the subscription had an unusually low load factor, the subscription would have a very high price that may have made it difficult for the customer to save money on the Pilot pricing.

The one-part pricing method used in the 2023 and 2024 growing seasons addressed this issue by removing subscriptions and instead adjusting the dynamic prices to match the average rate paid on the pump's rate schedule. The removal of the subscription and adoption of this method of linking Pilot prices to OAT revenue levels introduced a different source of structural benefiters and non-benefiters. That is, a pump with a lower load

[63] The expectation at the beginning of the Pilot was that credit calculations would be based on 12 months of billing data. In practice, the number of months used to calculate credits varied over the course of the Pilot.

factor vs. the rate schedule average would pay a higher average OAT price per kWh but would receive the benefit of having its dynamic prices scaled to the lower rate schedule average. We confirmed that this structural benefiter effect was present in customer outcomes. That is, larger differences between a pump's average OAT price and its rate schedule average OAT price were associated with higher shadow bill credits. Note that the presence of structural benefiters is common feature of voluntary rates (e.g., customers with flatter load profiles experiencing a lower bill after changing from a flat to a TOU rate, even in prior to any price response) and is therefore not necessarily a reason to avoid using the AgFIT 2.0 and 2.1 pricing methods.

However, the price averaging used to develop AgFIT 2.0 and 2.1 prices leads to pricing distortions in the days around price spikes that could be systematically arbitraged by customers.[64] While there is no evidence that customers engaged in this form of arbitrage during the Pilot, the moving-average pricing method should not be used in future rate offerings to prevent the possibility of it happening.

<u>Customers appear to pay more attention to prices when price variability is higher.</u>

Hourly prices were less variable across and within days in 2024 than in 2023, which corresponded to a lower share of scheduled pumping in 2024 and a lower benefit from scheduling pumping. Customer interviews were consistent with this, with feedback indicating that they paid less attention to prices in 2024 than 2023.

[64] For example, a customer could systematically benefit by scheduling pumping for future days after experiencing a day with especially high prices, regardless of whether they expect to need to pump on those days. If they end up pumping, the purchased energy would tend to cost less than if they had purchased it at settlement prices and if they do not end up pumping, they would tend to benefit by selling the purchased energy at higher settlement prices.

APPENDICES

Appendix A: Day Type Comparisons by Customer

In the following figures, we compare average hourly prices and loads across the two day types. Each year is presented as a two-figure panel, with the top panel showing average prices and the bottom panel showing average usage. The dashed lines represent the high-priced days and the solid lines represent the comparison days, with separate figures by year. For two customers (C-001 and C-005), we further differentiate between pumps that are managed to Pilot prices by the customer vs. those that are either not managed to Pilot prices (for customer C-001) or leased to a different customer (for customer C-005). We have set the vertical scale to be constant within customer to facilitate comparisons across years.

A.1 Customer C-001

When examining customer C-001's managed loads, the differences between the high-price and comparison days vary somewhat across years. In 2022 (Figure A.1), the usage in the highest-priced hours is low compared to that of the comparison days. To some extent, this is matched by reductions in earlier hours, during which the two price profiles don't differ much. In contrast, the 2023 comparison shows little difference in usage across the two day types. The 2024 comparison (Figure A.3) is somewhat similar to 2022, though the difference in usage across hours is more of an all-hours shift downward.

Figure A.1: High Price vs. Comparison Day Usage and Prices, C-001 Managed, 2022

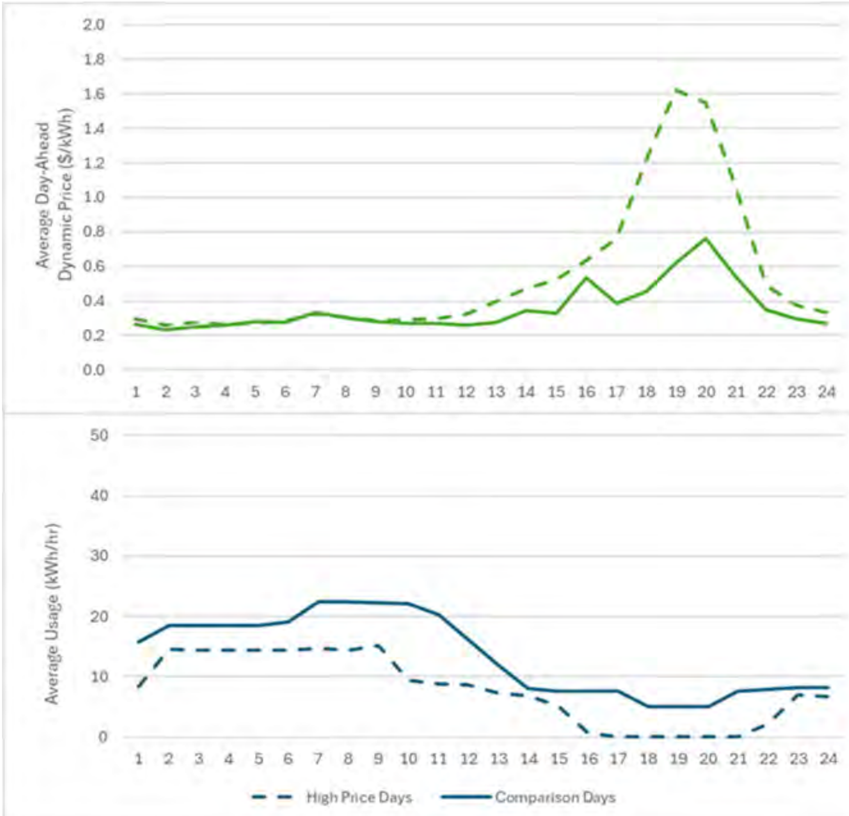


Figure A.2: High Price vs. Comparison Day Usage and Prices, C-001 Managed, 2023

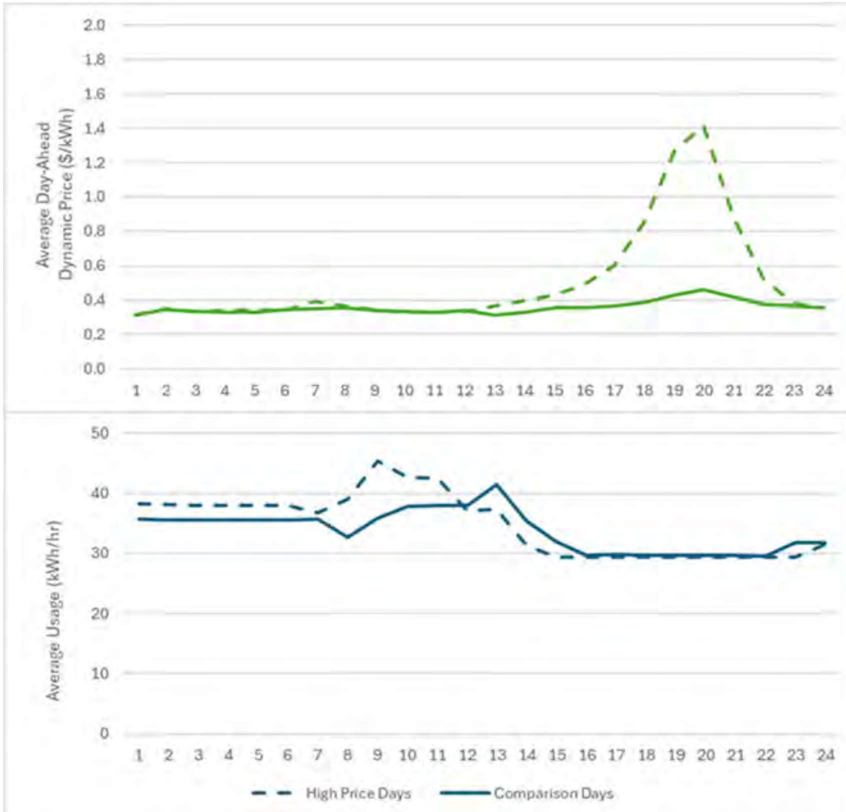
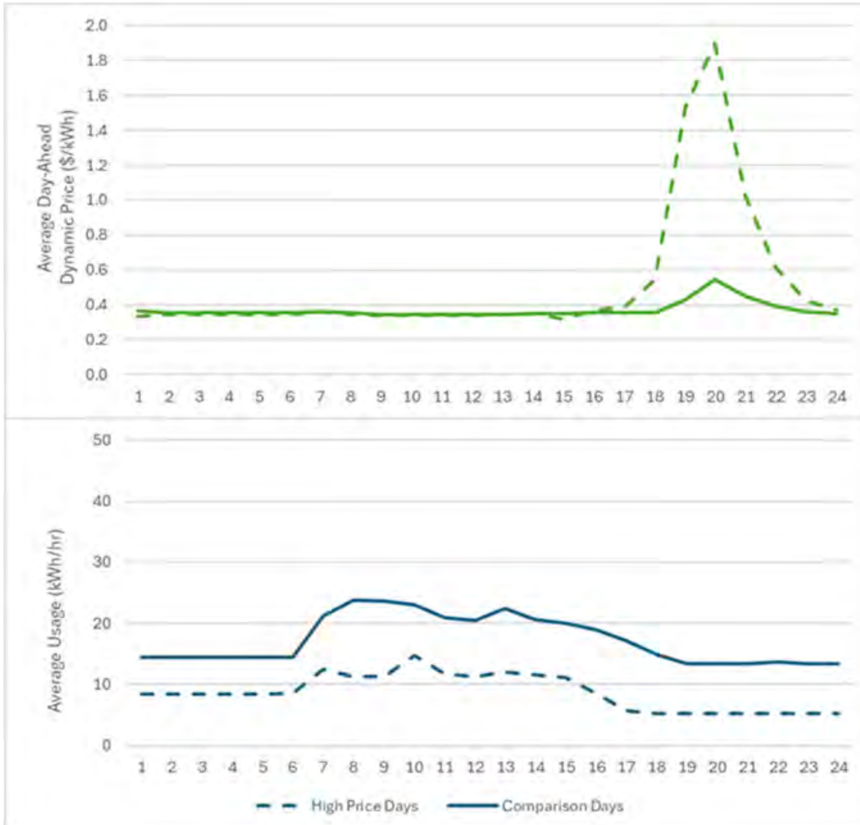


Figure A.3: High Price vs. Comparison Day Usage and Prices, C-001 Managed, 2024



Figures A.4 and A.5 show the 2023 and 2024 comparisons for customer C-001's pumps that were not managed to dynamic prices. (The applicable pumps were not enrolled in the Pilot in 2022.) The figures show generally lower usage in both years, with the reductions spread across nearly all hours of the day. Because we know that these customers were not managed to Pilot prices, we can infer that the usage differences are due to non-price effects. Therefore, the figures may provide an indication of the types of non-price effects that are embedded in the figures for the managed pumps.

Figure A.4: High Price vs. Comparison Day Usage and Prices, C-001 Not Managed, 2023

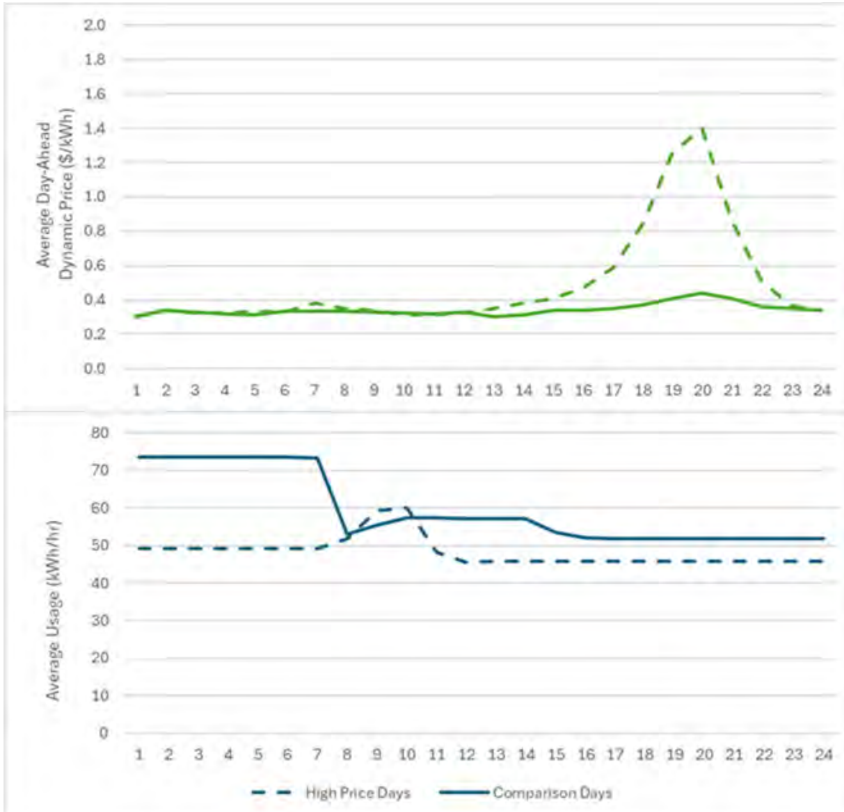
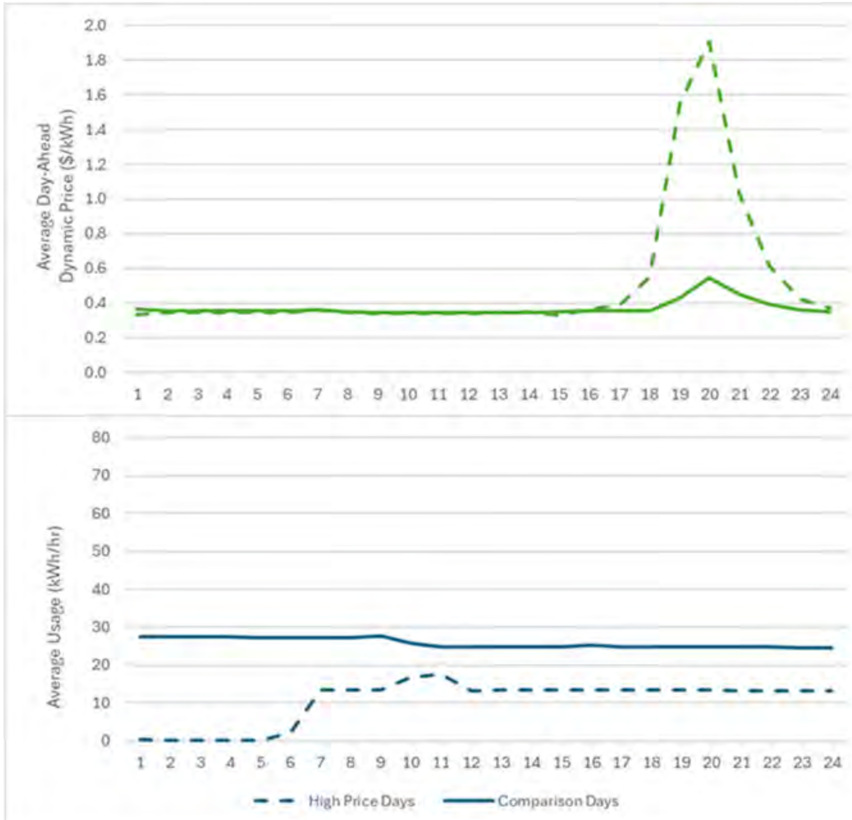


Figure A.5: High Price vs. Comparison Day Usage and Prices, C-001 Not Managed, 2024



A.2 Customer C-002

The figures for customer C-002 provide mixed evidence of response to high-price days. In 2022 (Figure A.6), there is very little difference in the usage profiles by day type, though both reflect the avoidance of the highest prices during their respective days. (I.e., more of an everyday response to average peak prices rather than a response to the peak prices on a specific day.) The usage profiles in 2023 (Figure A.7) are more consistent with price response across day types, with the high-price usage profile being notably lower than the comparison usage during the highest-price hours. Figure A.8 shows usage differences in 2024 that appear unrelated to the price differences. The peak-hour usage is higher on the high-price days, while the earlier hours of the day (when prices are nearly the same across day types) have much lower usage on the high-price day.

Figure A.6: High Price vs. Comparison Day Usage and Prices, C-002, 2022

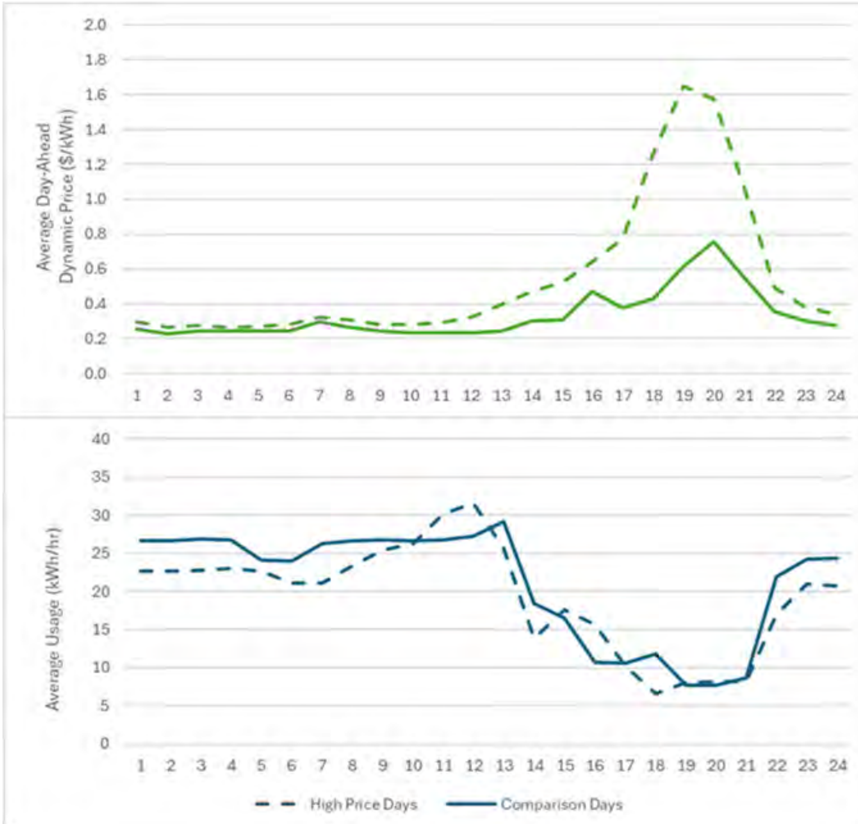


Figure A.7: High Price vs. Comparison Day Usage and Prices, C-002, 2023

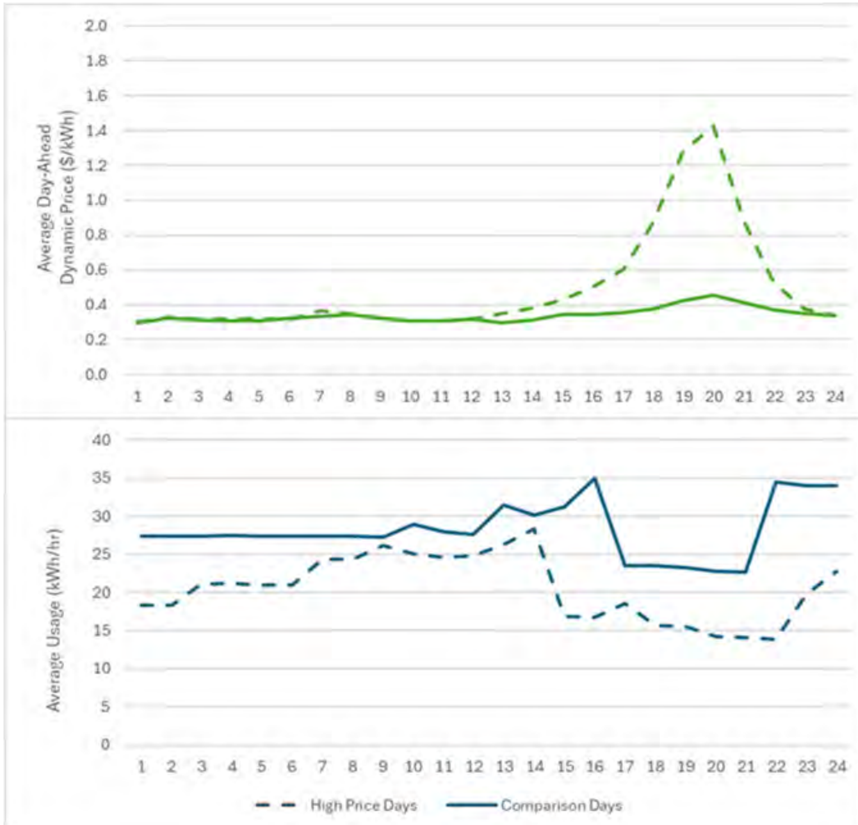
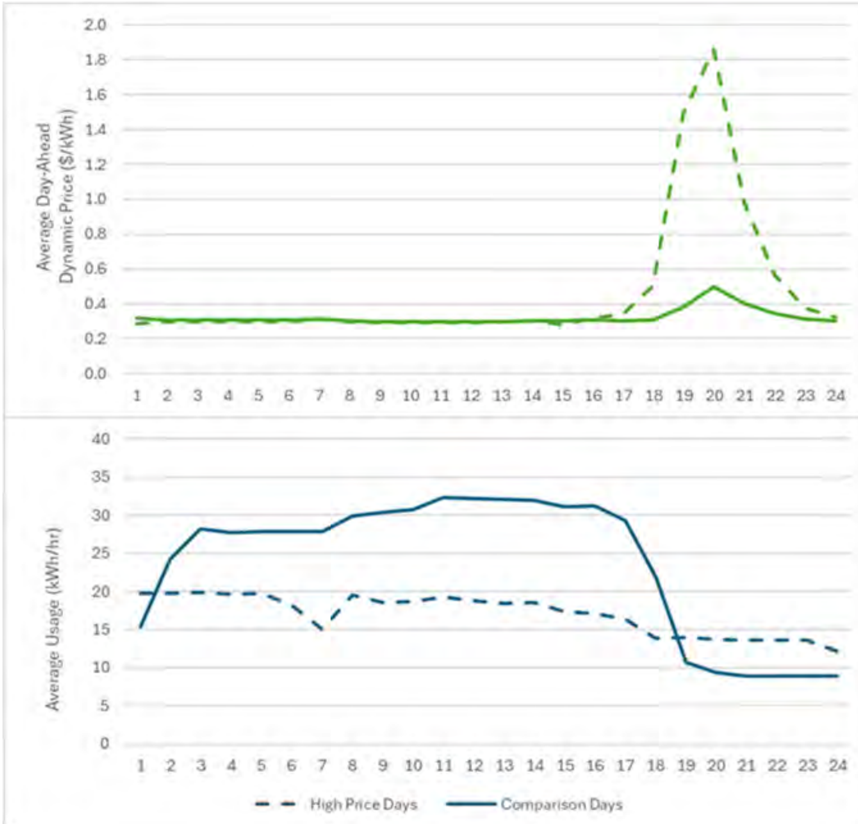


Figure A.8: High Price vs. Comparison Day Usage and Prices, C-002, 2024



A.3 Customer C-003

Customer C-003 provides a good example of a customer who appears to be responding to both OAT and Pilot pricing. In Figure A.9, the customer entirely avoids peak-period (HE18-20) usage on both day types, thus minimizing billed demand under OAT pricing. Evidence presented in this report indicates a response to off-peak dynamic prices, but it is not readily apparent in Figures A.9 and A.10. However, Figure A.10 does reflect the possibility that some peak-period usage may be reduced on higher-price days (i.e., in the absence of the Pilot, they would have used slightly more during peak hours but would still be somewhat restrained by the OAT demand charges).

Figure A.9: High Price vs. Comparison Day Usage and Prices, C-003, 2023

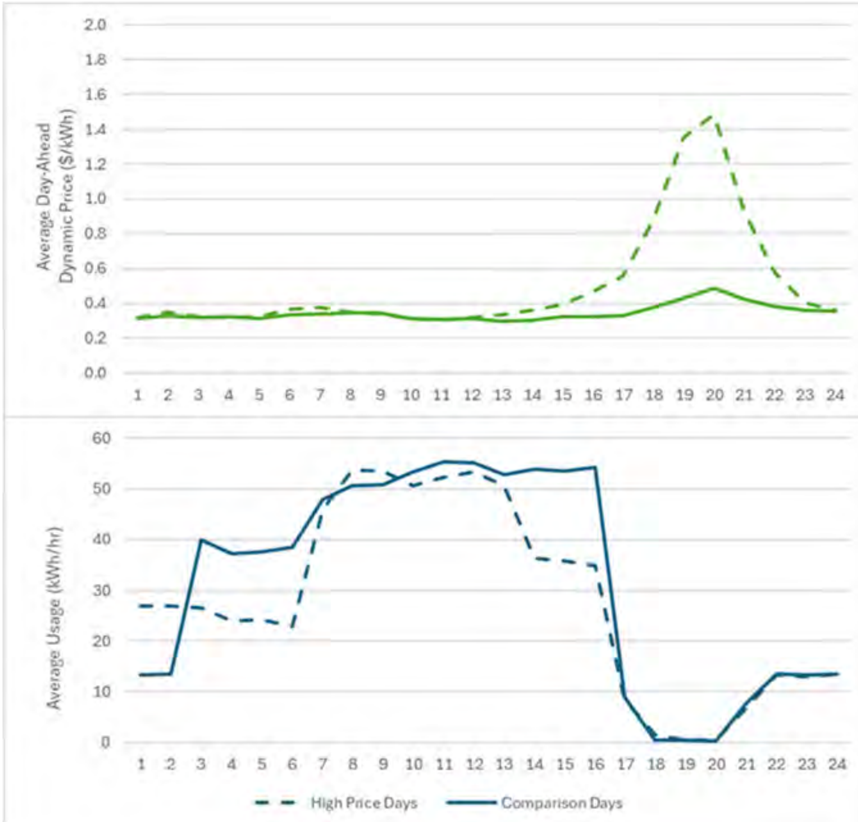
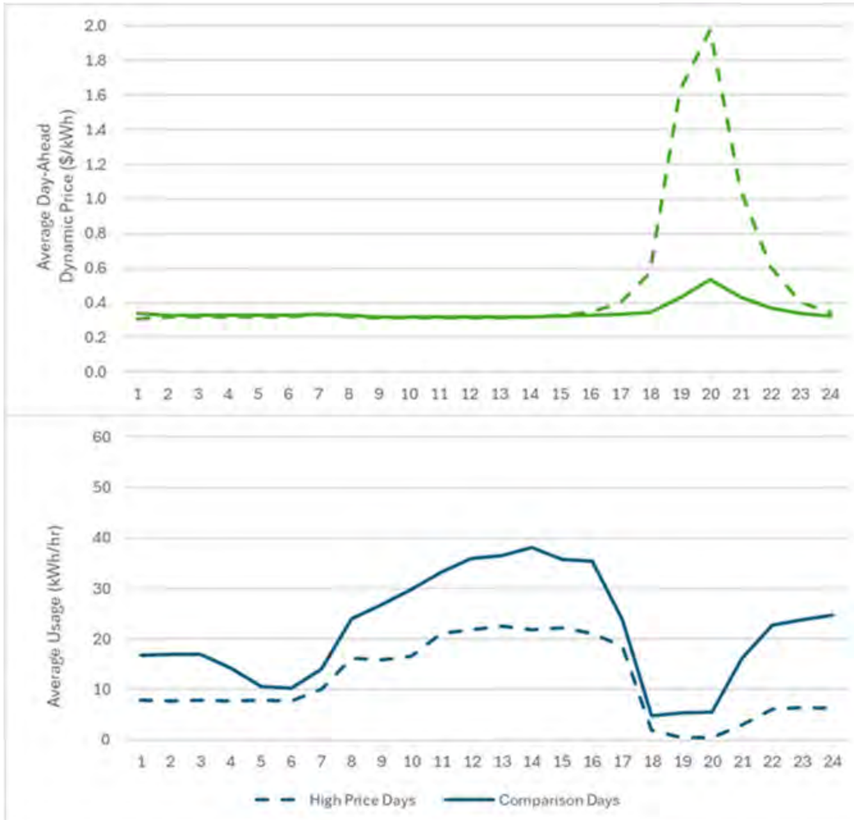


Figure A.10: High Price vs. Comparison Day Usage and Prices, C-003, 2024



A.4 Customer C-004

Figures A.11 and A.12 show that customer C-004 likely had no usage to curtail during the highest-price hours. In 2023, the customer only pumped in overnight hours on both day types. According to Polaris, this pump was filling a reservoir in 2023 and therefore did not follow traditional crop irrigation profiles or needs. In 2024, the customer appeared to have no need to pump on either day type.

Figure A.11: High Price vs. Comparison Day Usage and Prices, C-004, 2023

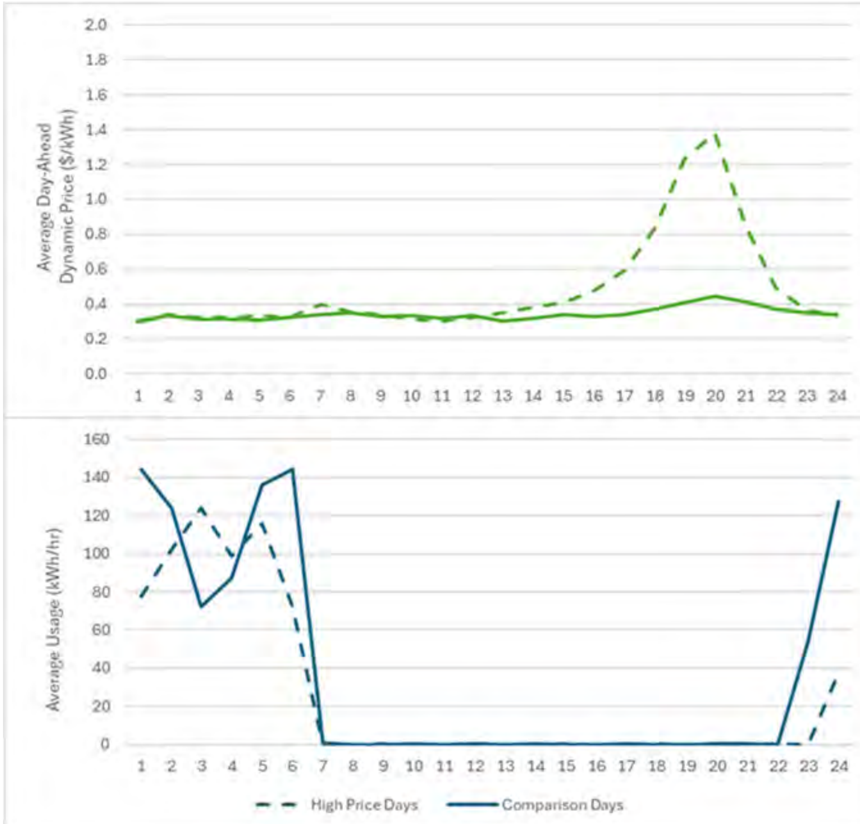
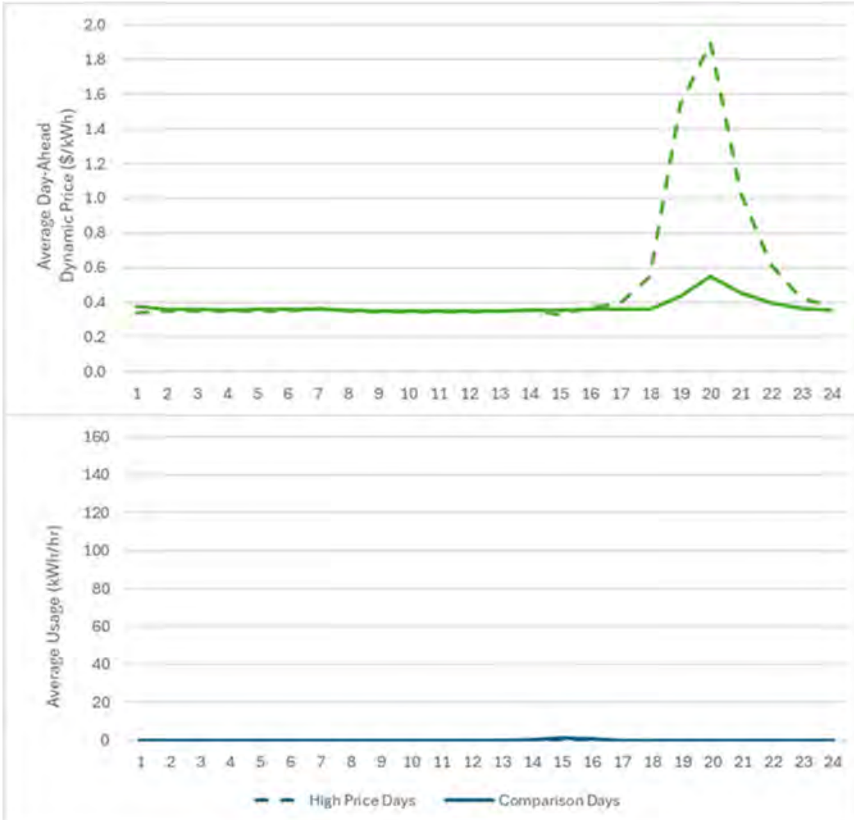


Figure A.12: High Price vs. Comparison Day Usage and Prices, C-004, 2024



A.5 Customer C-005

As with customer C-003, the pump managed by customer C-005 entirely avoided using during peak hours (on all days, not just those shown in the figures). Our interview with them confirmed that this was a response to the OAT demand charge. However, the customer reported being very attentive to dynamic prices in other hours. Response to those prices is difficult to identify in these figures, as the differences in prices across day types is small in most hours of the day.

Figure A.13: High Price vs. Comparison Day Usage and Prices, C-005 Managed, 2023

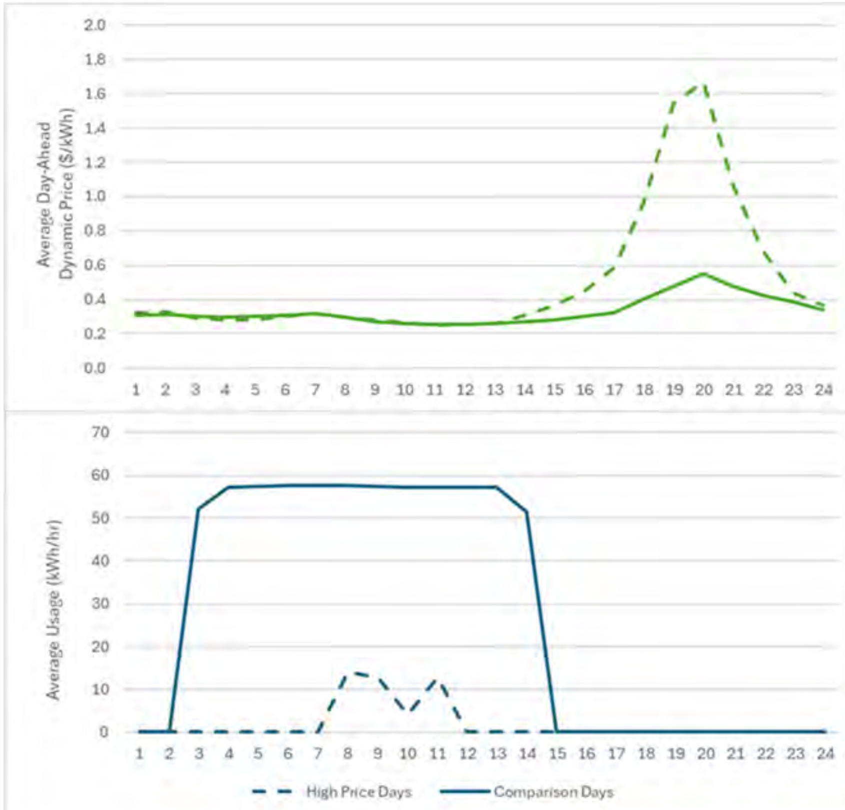
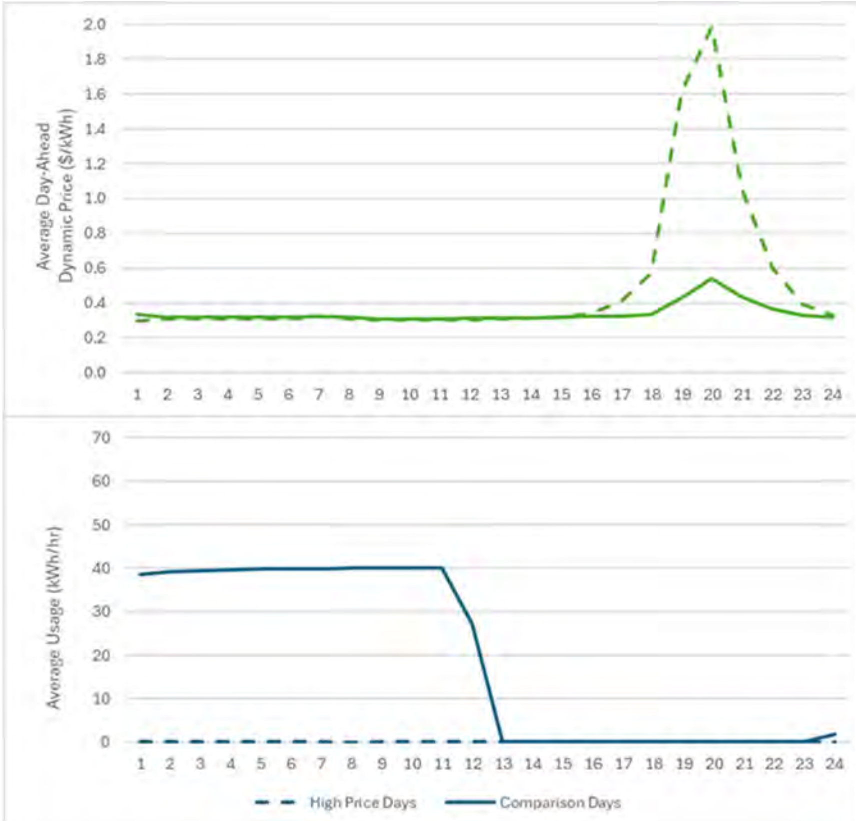


Figure A.14: High Price vs. Comparison Day Usage and Prices, C-005 Managed, 2024



For the pump that customer C-005 leased to another customer, the 2023 usage profile is consistent with price response (i.e., usage dropped to zero on the high-price days), but the 2024 usage profile showed no need for pumping on either day type. Our interview with customer C-005, who reported that the leasing customer was not responding to prices, indicates that the usage differences shown in Figure A.15 are likely unrelated to the price differences.

Figure A.15: High Price vs. Comparison Day Usage and Prices, C-005 Leased, 2023

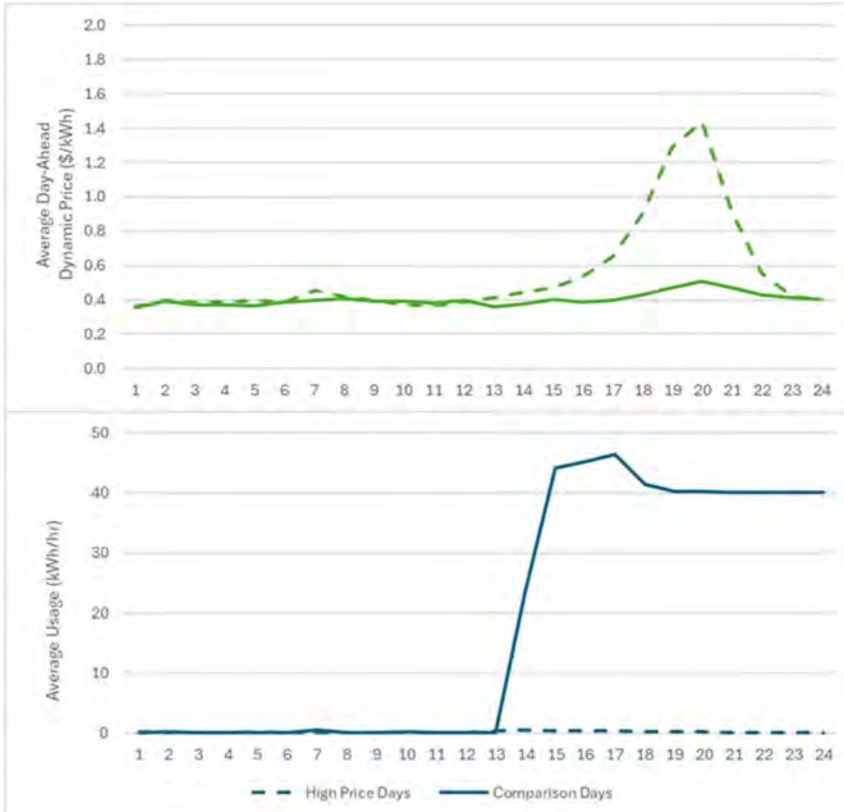
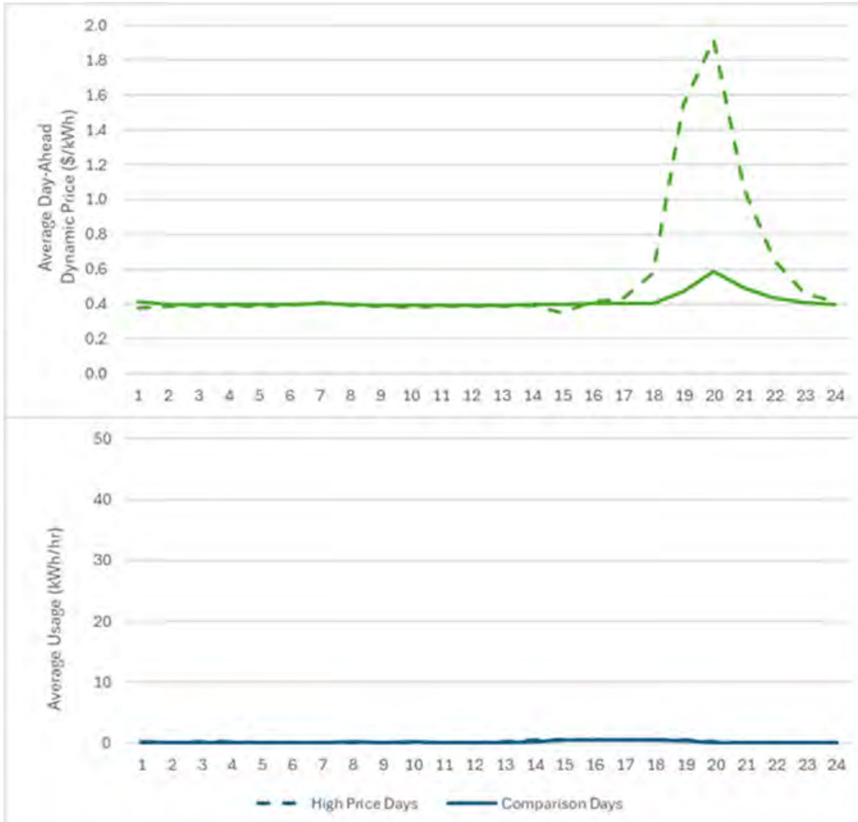


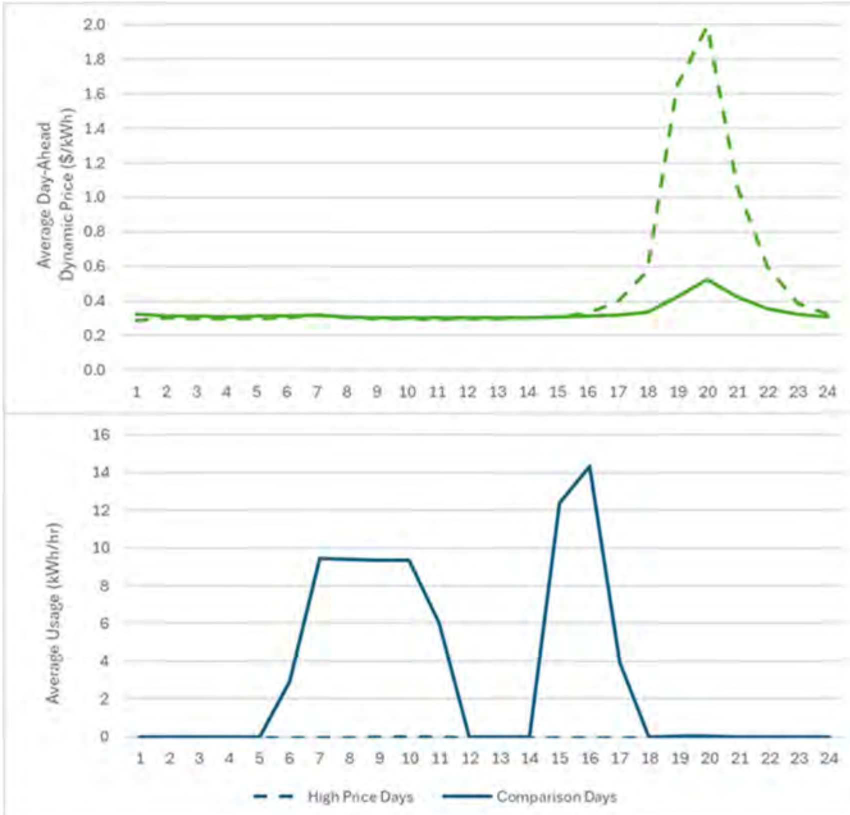
Figure A.16: High Price vs. Comparison Day Usage and Prices, C-005 Leased, 2024



A.6 Customer C-006

Figure A.17 shows that customer C-006 used essentially no energy on the high-price days, whereas the comparison days had some usage in the pre-peak hours. This may be response to prices, though the pre-peak hours had little difference in prices.

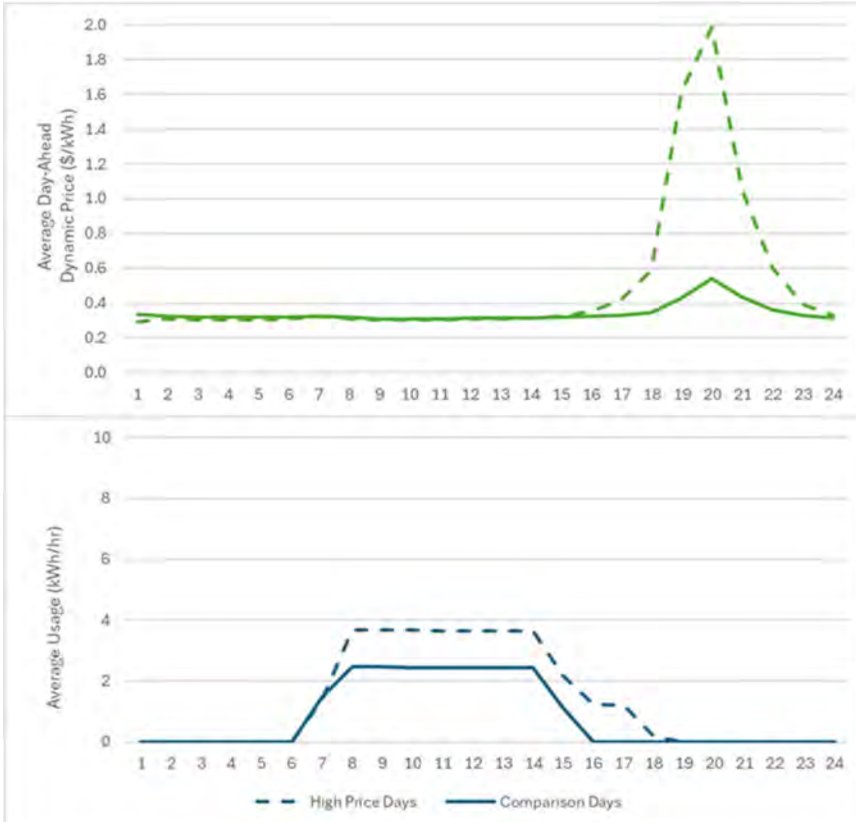
Figure A.17: High Price vs. Comparison Day Usage and Prices, C-006, 2024



A.7 Customer C-007

Figure A.18 shows little evidence of price response for customer C-007. The customer rarely pumped during the highest-price hours (across all days, as shown in Section 2) and the usage differences that exist between the two usage profiles are in the opposite direction than one would expect from price response (e.g., higher usage during HE 17 on the high-price days despite the higher price relative to the comparison days).

Figure A.18: High Price vs. Comparison Day Usage and Prices, C-007, 2024



Appendix B: Price Response Regression Model Statistics

Table B.1: Regression Model Statistics

Customer	Managed?	AgFIT 1.0		AgFIT 2.0		AgFIT 2.1	
		N	R^2	N	R^2	N	R^2
C-001	No	N/A	N/A	9,504	0.278	9,192	0.340
	Yes	9,154	0.337	41,904	0.276	49,128	0.446
C-002	Yes	8,530	0.212	28,800	0.141	32,520	0.182
C-003	Yes	N/A	N/A	21,696	0.295	38,016	0.446
C-004	Yes	N/A	N/A	1,416	0.397	32,832	0.348
C-005	Leased to a Customer	N/A	N/A	2,880	0.053	3,648	0.185
	Yes	N/A	N/A	2,832	0.263	3,672	0.297
C-006	Yes	N/A	N/A	N/A	N/A	7,296	0.327
C-007	Yes	N/A	N/A	N/A	N/A	2,688	0.456