Challenges and Costs of Retrofitting to Electric Cooking: Interest, Viability, Installation Costs, and Satisfaction

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ABSTRACT

The Cooking Energy and Ventilation Impacts on Children's Asthma (CEVICA) Study is a randomized control trial that replaced gas with electric induction stoves in owner-occupied, San Joaquin Valley homes with kitchen exhaust ventilation. Eligible households had a Medical-enrolled child with asthma who had participated in a program that uses education and tools to reduce within-home asthma triggers. The study inferred stove use from temperature sensors, monitored range hood use, measured indoor air quality (IAQ) parameters, and collected data on child respiratory health indicators before and after electric stove installation. Recruitment started with calls to asthma program participants who own their own homes. Homes were screened first by study staff, then by an electrical contractor to check for adequate electrical capacity and a place to install the circuit within allowable costs. Evaluation and installation costs were paid by the study, and participants received new, induction-compatible cookware and reimbursement for the anticipated higher costs of cooking with electricity vs. gas for the study duration and several additional months.

This paper presents the recruitment and screening (i.e., initial interest) statistics, the conditions that made homes ineligible, circuit and range installation costs and challenges, monitored stove electricity use for a subset of homes, and satisfaction with gas and electric stoves and the provided cookware.

Introduction

In-home exposures to air pollutants from cooking and burners and approaches to reducing these exposures received increasing attention in recent years. Cooking with any fuel emits substantial quantities of air pollutants, including fine particulate matter (PM2.5), that increase exposures in homes when not properly vented (Holm 2018). In addition to emissions related to the breakdown of oils and ingredients that occur with all burners during cooking, natural gas burners generate and emit combustion pollutants. Measurements of many in-use gas burners (Lebel, et al 2022, Singer, et al 2017) have reported substantial emissions of nitrogen dioxide (NO_2), which is a known respiratory irritant (US EPA 2016). A 2013 meta-analysis found statistically robust associations between gas stove use and asthma and between NO_2 exposure and wheeze (Lin 2103). Ultrafine particles (UFPs), which are thought to be linked to various adverse health outcomes (Ohlwein 2019), are also emitted by gas cooking burners in substantial quantities (Singer, et al. 2017). Electric coil burners can also emit UFPs (Dennekamp 2001), though limited evidence suggests emissions are much lower from electric than from gas burners (Less 2015, Li 2024). Effective venting from the cooking area via range hoods can greatly reduce cooking and burner pollutant emissions into homes (Lunden, et al. 2015) and both intervention (Holm, et al. 2024) and cross-sectional (Mullen, et al. 2016, Fang et al 2026) studies from normally occupied homes have reported meaningful reductions in nitrogen oxides with range hood use. Shifting from gas to electric cooking effectively eliminates emissions of combustion pollutants and results in lower concentrations of nitrogen oxides in homes (Paulin, et al. 2014).

This paper presents selected results from a randomized control trial that principally aimed to investigate the indoor air quality and child respiratory health impacts of shifting from gas to electric cooking. It reports statistics on interest during recruitment, electrical capacity limitations and other conditions that made homes ineligible, circuit and range installation costs and challenges, monitored electricity use for a subset of stoves, and the satisfaction of participants with their gas and electric stoves.

Study Overview

The Cooking Energy and Ventilation Impacts on Children's Asthma (CEVICA) study is a randomized control trial (RCT) that is investigating the indoor air quality (IAQ) and respiratory health impacts of replacing gas with electric induction cooking in homes with kitchen exhaust ventilation. The core elements of CEVICA are shown in Figure 1. The study recruited Medical-enrolled families in Kern and Fresno counties, in California's San Joaquin Valley that included a child with asthma and participation in the Comprehensive Asthma Remediation and Education Services (CARES) program. CARES was developed and implemented by the Central California Asthma Collaborative (CCAC) to manage children's asthma by improving adherence to medication use and reducing exposure to asthma triggers in the home. The study is funded by the California Energy Commission under contract EPC-21-033 and is being conducted by CCAC in collaboration with Lawrence Berkeley National Laboratory (LBNL), the University of California, San Francisco (UCSF), the Association for Energy Affordability (AEA), the University of California, Los Angeles (UCLA) and Stephanie Holm Consulting. The study procedures were reviewed and approved by LBNL's institutional review board for research involving human subjects.

The primary intervention was a randomized stove replacement in roughly half of the homes at the start of Phase 1 with the remainder receiving the electric induction stoves at the start of Phase 2. The study initially also included an option to receive 120-V electric cooking appliances, which was implemented in 10 homes. All participants were also provided an 11- or 12-piece cookware set along with a comal, a traditional Mexican griddle used to cook tortillas and sear meats and vegetables. Residential IAQ monitors and various sensors were installed to identify and record cooking and kitchen ventilation use starting with a two-week Baseline before any stoves were replaced and continuing through the entire study period in each home. The monitoring system also included sensors to identify the use of windows, air cleaners, and 120-V electric cooking appliances. Additional IAQ measurements were made during 2-week intensives at the end of each ~3-month phase. Analyses of cooking, range hood use and IAQ data from the first cohort of 39 homes that completed the RCT with stove replacement are reported in conference papers (Fang, et al 2026a; Fang, et al, 2026b; Lin et al., 2026).

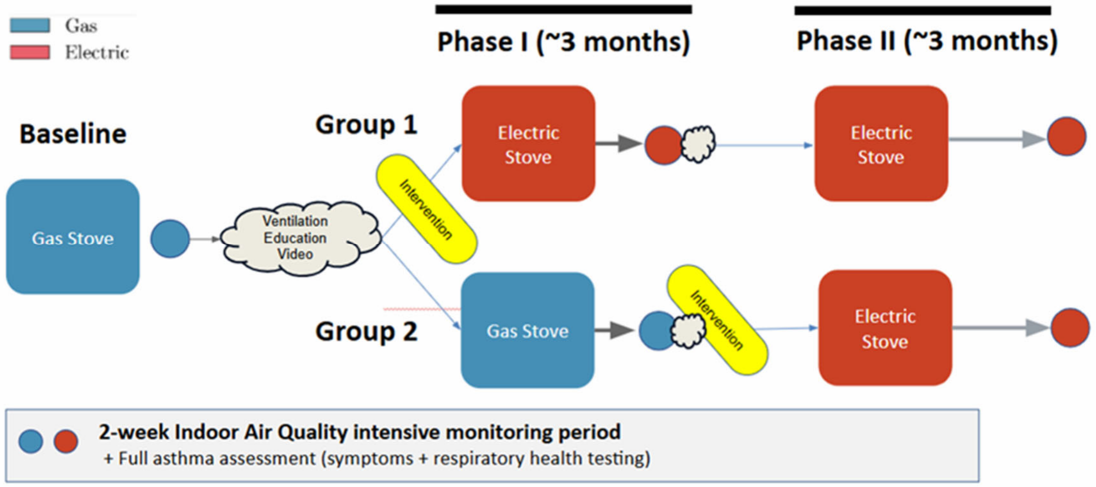

Figure 1. The core study phases starting with baseline measurements (after randomization) intensives at the end of each 3-month phase and the timing of interventions for the two groups.

The full study sequence, starting with an initial visit to screen for suitability to have a 50 A, 240 V circuit and outlet installed for an electric induction range, is shown in Figure 2.

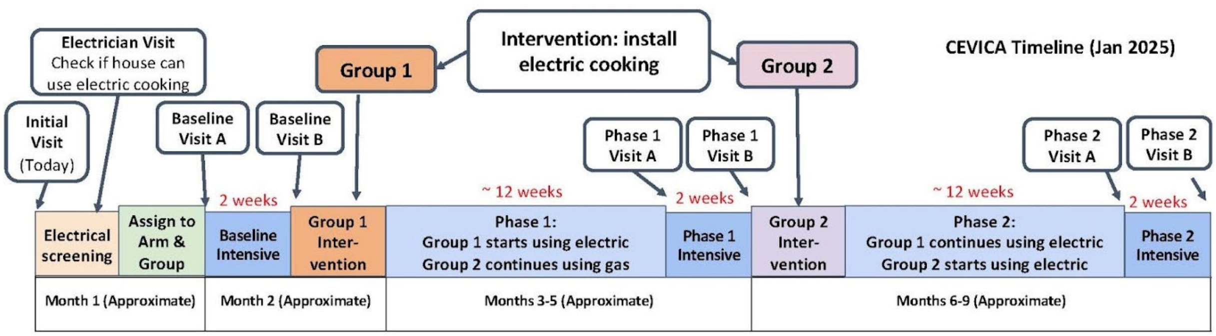

Figure 2. The full study sequence and timeline from initial visit through assessment, baseline and intensives with the intervention identified for Group 1 and Group 2.

Building Requirements

The study was limited to participants that owned their homes. The household was excluded from participating from any intervention (including the 120 V cooking appliances) if any of the following conditions applied to the residence.

- Total home electrical service was less than 60 amps.
- The electrical panel serving the kitchen had fuses.
- The main panel was Federal Pacific, Challenger, or Zinsco.
- The gas cooktop or range was not functional or presented a safety hazard.
- There were major health and safety issues, such as extensive moisture damage or mold.

The residence was excluded from the stove retrofit if any of the following conditions applied:

- The main disconnect was less than 100 amps.
- The house had a slab foundation and no attic.
- There was no space in the main panel or any subpanels to install the 50 A, 240 V circuit.
- The panel where the new circuit would be installed was located in a closet (as this could trigger additional panel upgrades for code compliance).
- A new 240 V circuit could not be installed within the study budget or timeline.

Study Stages

The study included the following stages:

- **Screening**: CCAC Research Coordinators (RCs) conducted initial outreach to describe the study, screen for eligibility, and ask about interest.
- **Initial Visit:** The RCs conducted a preliminary screening for barriers to installing the circuit and outlet for the electric range, including panels deemed unsafe for modification and lack of space in the panel. If no barriers were identified and participants consented, the RCs initiated data collection including home characterization and questionnaires about cooking and ventilation use, satisfaction with their gas cooking appliance and prior experience with electric cooking.
- **Electrician Assessment:** Electrical contractors, selected and directed by AEA, visited each home to confirm that a 50 A, 240 V circuit, outlet and induction electric stove could be installed within the study budget of an average of $1800 and total to not exceed $2500. If a home was assessed to be unsuitable, the participant was withdrawn.
- **Randomization**: Eligible homes were then randomized to receive the electric cooking intervention in the first phase (Group 1) or second phase (Group 2).
- **Baseline:** RCs installed IAQ and other monitoring equipment that remained in the home throughout the study, conducted the Baseline two-week intensive IAQ monitoring, and collected baseline data on child respiratory health indicators, cooking and ventilation activities, prior experience with electric cooking and satisfaction with their gas stoves.
- **Intervention**: For the stove retrofit, the contractor installed a 240 V circuit, capped the gas line at the stove, removed the gas range and installed a slide-in induction range. Sequencing was based on randomization. This occurred at the start of Phase 1 for Group 1 and at the start of Phase 2 for Group 2. For alternative intervention, which will not be covered in this paper, households received a package of 120 V electric appliances and circuit upgrades to support their use, as needed.
- **Phase 1:** Intensive IAQ monitoring, collection of respiratory health data and surveys about cooking, ventilation use, and cooking appliance satisfaction occurred at the end of a 3-month or longer interval. The interval duration was set to allow time for respiratory health improvements. Completion of this phase satisfied the requirement for the RCT.
- **Phase 2:** The same data collected during the Baseline and Phase 1 intensives were collected at the end of the 3-month or longer Phase 2. All monitoring equipment was removed at the conclusion of the Phase 2 intensive.

Data Collection

Below is a description of the data sets referenced in this paper including participation statistics, satisfaction surveys, assessment and installation data, and electricity usage for stoves.

Questionnaires

During the initial visit, participants completed questionnaires that asked about their general cooking activities, use of kitchen ventilation, and satisfaction with their gas range. They provided similar information about the recent 3 months during the Phase 1 and Phase 2 intensives, and those who received retrofits were asked their satisfaction with the electric stove and cookware provided by the study.

Measurements of Cooking Activity

Cooking with the stove or a range was inferred from rapid changes in temperature reported by sensors mounted above the cooktop.

Assessment and Installation Data

Electrical contractors documented any conditions observed during the assessment that made the home ineligible for installation of the 50 A, 240 Vcircuit, wiring and kitchen outlet as required for the induction stove. They identified installation elements that might be undesirable for participants, such as long runs of surface wiring outdoors or indoors. Documentation included an assessment form and photos of existing conditions, photos of the installation and a close out form completed by the participant and the contractor.

Measurements of Electricity Use for Cooking

Electrical consumption was monitored for a subset of homes for 30 days or more, after the induction stoves were installed. The electrical data was collected using HOBO (UX120-006M) and two compatible current transducers rated to measure up to 100 A or 50 A on each leg of the stove sampled at 1-minute intervals logging amperage with local storage.

Results

This results section summarizes the following aspects of this study:

- Recruitment outreach and screening,
- Contractor participation and assessment and installation conditions and challenges,
- Monitored electricity use for a subset of stoves,
- Utility impacts, and
- Satisfaction of participants with their gas and electric stoves.

The findings are relevant to owner-occupied detached houses and may not apply to renters.

Recruitment Outreach and Screening Statistics

CCAC contacted 385 households thought to be potentially eligible based on CARES records. Among 148 that did not complete screening, 70 explicitly said they were not interested in an electric stove, 57 did not specify a reason and 17 were no longer eligible for CARES.

Among the 239 that were screened, another 25 indicated disinterest in participating in the study and/or electric stove despite being eligible. The screening identified 183 households that were interested and met the basic adult and child eligibility (Figure 3). Another 28 withdrew or were withdrawn before the initial visit, resulting in 155 initial visits. Table 1 summarizes what we know about these 28, which included 11 who declined to provide a reason.

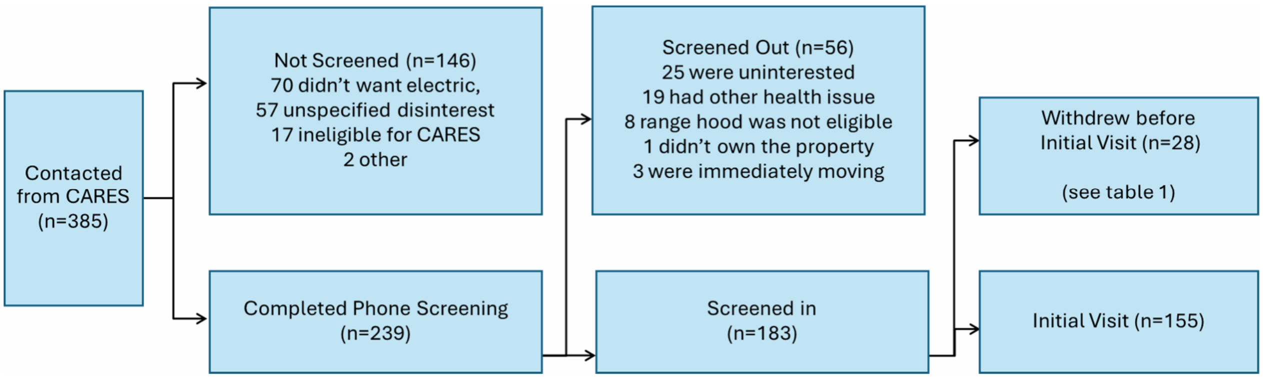

Figure 3. Participant flow through the various stages of screening for study enrollment, up to the start of the study at the initial visit resulting in 155 receiving an Initial Visit.

Figure 4 shows the filtering that occurred from the 155 initial visits to reach 105 participants having homes assessed as suitable for the electrical stove retrofit (third column of boxes). Eleven homes (7%) were screened out by our research team for basic incompatibility reasons and 17 of the 144 who passed the initial screening withdrew before the electrician assessment. Of the 127 who received the assessment, 22 homes (17%) were determined to be unsuitable for 50 A, 240 V circuit installation. Nine were deemed suitable for expanded use of 120 V cooking appliances and the other 13 were not evaluated for 120 V appliances because they were only interested in the stove retrofit.

Of the 105 participants who were approved to proceed with the stove retrofit, only 90 households had circuits and electric stoves installed. Fourteen withdrew and one opted for the 120V appliance instead of stove retrofit. Table 1 lists reasons for participant withdrawals and those withdrawn by the study team prior to and after initial visits for the study. In four homes that were determined to be suitable for the retrofit by one of the two contractors used for the study, the installation team from that same contractor determined when arriving to do the installation that it was in fact not feasible. In one of those homes, the second electrical contractor used in the study completed the installation later; but this option was not explored for the first three. Three of the 90 households that had stoves installed withdrew from the study after and replaced them with gas.

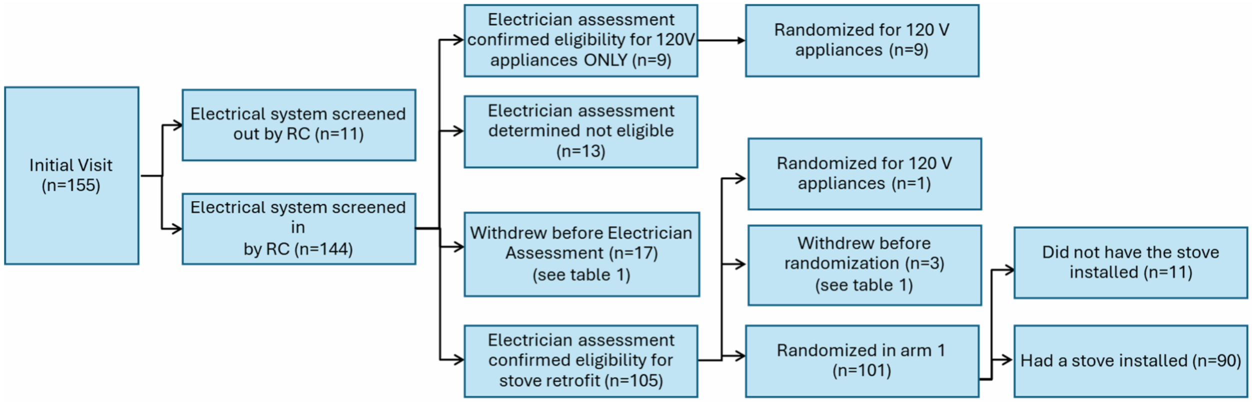

Figure 4. Participating Households in the CEVICA study and subsequent randomization to proceed with the study.

Table 1 lists reasons for participant withdrawals and those withdrawn by the study team prior to and after initial visits for the study. Reasons for withdrawal included personal reasons, household disagreement about participation, lack of desire for electric range, disapproval of installation conditions and landlord non-approval. Notably, this means that 44 (28%) households started the study (had an initial visit) but ultimately did not proceed to randomization. Eleven homes were screened out by the Research Coordinators who were trained to complete a preliminary assessment avoiding the need for an electrician visit and 22 were determined to have ineligible electrical systems and/or home conditions for a stove retrofit at the electrician assessment. Seventeen households withdrew or were withdrawn between the initial visit and electrician assessment for reasons noted in Table 1.

As illustrated in Figure 3, 70 participants specified that they were not interested in an electric stove at the time the research coordinators first reached out. With the 11 participants that withdrew later because they decided they didn't want to change to an electric stove, this indicates that a sizeable portion of the contacted households (81/384, 21%) were not interested in electric cooking even though it would be provided without cost. In addition, we know of 3 households who switched back to gas cooking after receiving an induction stove. Many participants who declined participation or withdrew did not specify their reasons (81 in the screening phase and 16 withdraws). Thus, the fraction of this population who is not interested in switching to an electric stove, even at not cost, may be larger than 21%. The limited interest of the contacted households to switch to induction cooking may have been linked to their limited prior experience with induction or poor experience with other electric cooking. Only 38% of 143 participants who completed a questionnaire at the Initial Visit had cooked with any electric stove and only 5% (7) had cooked with induction (Figure 5). Among the 55 who had any experience with electric cooking, the following concerns were selected from among a list of options: harder to control temperature (16), takes longer to heat up (20), not as powerful (9), and burners stayed hot (12). The following options were selected for what they liked more about electric: easier to clean (31), better to control (12) and less dangerous (16).

Table 1. Reasons for Study Withdrawals and Ineligibility at Various Time Points

Reason for Withdrawal or Ineligibility	Before Initial Visit	Before Electrical Assessment	After Electrical Assessment	Total
Unknown reason	11	2	3	16
Not eligible for study related to CARES	4	0	0	4
Personal reasons unrelated to the study (moving, etc.)	2	1	1	4
Disagreement between household members regarding study participation	1	2	1	4
Decided they didn't want an electric range prior to installation	5	1	5	11
Circuit installation not feasible or unacceptable to study participant	1	7	4	12
Range hood / microwave not vented (2), separate stove/oven (1)	1	2	0	3
Concerned about inspection; too many study visits; electrician missed appointments	2	1	0	3
Renter could not get landlord permission; study recruitment ended	1	1	0	2
Total	28	17	14	59

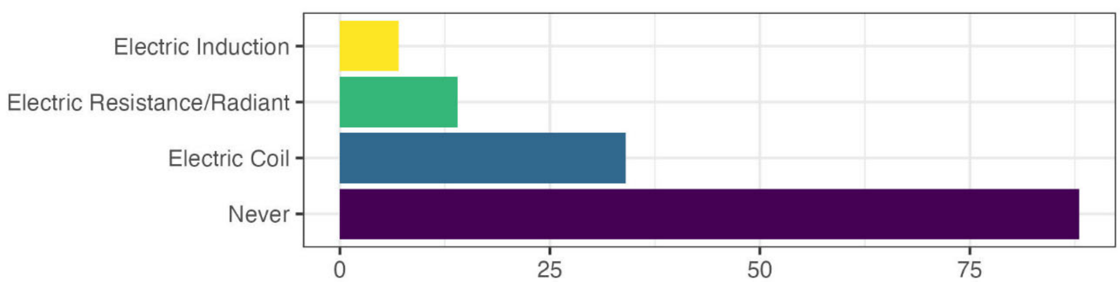

Figure 5. 62% (88) of responding participants did not have experience with electric cooking compared to 38% (55) with experience with electric cooking: electric coil/ radiant (34), electric resistance/ radiant (14) and induction (7).

Contractor Participation, Assessment and Installation Findings

Two companies with C-10 licenses, one for each region of the study (Kern and Fresno Counties), were contracted to conduct assessments of electrical infrastructure and range installation over the course of three years. Work with the contractors provided insights and findings on contractor engagement and assessment and installation challenges. A key consideration for any study or program involving any electrical retrofit is the ability for the contractors to mobilize and meet the required schedule and cadence. The study team developed a workflow specific to each contractor to align with their processes.

Since contractor assessment had to come after the initial RC visit and before a household could be randomized, it was infeasible within the study schedule to aggregate assessments to enable the contractors to do them in batches. The variability in recruitment and screening led to weeks with over four assessments and weeks with no assessments. When possible, bundling multiple assessments or installations proved to be more productive and easier to schedule rather than intermittent work. Other challenges were that 19 assessments were scheduled and then canceled due to a participant deciding to withdraw, a contractor not arriving within scheduled time window, and both the participant and the contractor claiming that they were at the house and the other was not within scheduled time window.

The assessment protocol was designed to evaluate the homes for overall eligibility to participate in the study, for stove retrofit option, or 120 V appliances option. Each contractor charged a pre-defined flat fee; one charged $200 and the other charged $250 per visit. Out of the 127 homes evaluated by an electrician, 80% were eligible for a 240 V circuit within the study budget and 16 (13%) were determined to be ineligible, including 13 screened out at assessment and three where the job was aborted on the scheduled installation day. For one home that was initially ineligible due to the panel type, the electrician reassessed the home after the owner replaced the panel and it qualified. The qualified electrical contractor made the decision of feasibility and, in some cases, overcame an exclusionary criterion. One example of this is utilizing tandem breakers to create space in a full panel. The remaining homes were either eligible for the 120 V appliance option, or they withdrew. The reasons and distributions for ineligibility of the 16 are summarized below:

- Six homes were deemed ineligible at assessment for constructability or lack of access (i.e. range on a kitchen island or a home with slab on grade foundation and no attic).
- Four were deemed ineligible due to physical panel space or recalled panel.
- Two were ineligible due to exceeding budget allowance and/or study timeline.
- Four were ineligible due to other reasons including poor electrical infrastructure.

A key element of participant approval was the aesthetic condition of the new circuit including conduit on the outside of the home and/or interior surface mount conduit. Some participants were reluctant to have a significant length of surface mount conduit on the inside or exterior of the home. The typical length of exterior conduit, when needed, was 25-35 feet, but could exceed 50 feet. Participant concerns were in some cases resolved when the details and need for the external conduit were explained and/or they were shown photos of how the conduit could be run and looks when painted to match the house color. Our team also provided guidance on how to paint the conduit to reduce visibility for participants who were interested. This engagement during and/or following the assessment resulted in better participant satisfaction at installation. While the assessment protocol was well defined, one of the contractors erred in classifying four homes as feasible at assessment then infeasible when arriving for installation. One home was reassessed by another contractor who determined the installation feasible and completed it.

Installation challenges that impacted costs included the length of conduit and wire required (circumnavigating the home), transitioning between multiple attic spaces, and confined spaces. Common installation considerations that impacted satisfaction were the form factor of the slide in induction stove (which did not have a back guard) replacing a free standing gas stove with back guard. The induction range profile could expose outlets and/or unpainted or dissimilarly painted portions of the kitchen wall. In addition, participants were not satisfied when the location of the gas line prevented the range from sliding all the way back to the wall, leaving a gap that was not visible with the free-standing gas range. To mitigate this, the contractors were provided with generic black filler strips to install when necessary. Lastly, the appliances included a phone application for troubleshooting error codes, which was also a barrier for participants.

Costs included running a new 240V circuit, installing a new breaker, removing the old gas range, capping the gas line, and installing the new induction stove. The average price across both contractors was $1591. From the outset, each contractor had a standard price point based on projected volume, yet after the first cohort, one of the contractors adjusted their pricing structure. One contractor agreed to a standard price for all jobs with a provision to request additional cost allowance for more complex circumstances such as a manufactured home, which requires working around the skirting which encloses the space under the home. This fixed price model assumed some jobs would be under, some over and some at the agreed cost, balancing over all the jobs while mitigating administrative efforts. For one contractor, the average price was $1682, and the highest job price was $2500. The other contractor had a fixed price of $1300 for the first cohort, which they realized was too low. For the second cohort, their pricing model set costs for several scenarios (tiers) of work complexity, based on their estimates of time required on site and quantity of materials (i.e. conduit and wire). For this model, a price was proposed at assessment and confirmed upon installation. The three price levels were $1430, $1936, and $2492.

Electricity Use Data

Twenty-three induction stoves were monitored for electricity use with valid data obtained for 12 to over 100 days per home, as summarized in Table 2. The data were corrected to account for each datalogger's zero offset and cleaned to remove out of range records and truncate the record to start at 6 pm on the day of installation and end at midnight the day before removal.

Table 2: Quantity of monitored homes and duration by utility rate season

Utility Season	Number of days	Number of Homes
Summer	68 - 77	3
Winter	12 - 67	17
Summer and Winter	71-211	3
Total		23

Energy Use Comparison

The distribution of hourly usage across the 23 homes is shown in Figure 6. Across homes, stove use started to increase during the 5-6 am hour, was highest from the hours starting at 10 am to 5 pm, then decreased through the evening until midnight. The median daily energy use was 3.7kWh per day ranging from 0.8 to 12.7 kWh per day. Figure 7 shows different load profiles demonstrating the diversity of usage patterns across homes and the percentage of consumption during the peak rate period of 4-9 pm, which is indicated with shading in each panel. The median daily kWh occurring during peak was 1.08 and 90th percentile was 2.19.

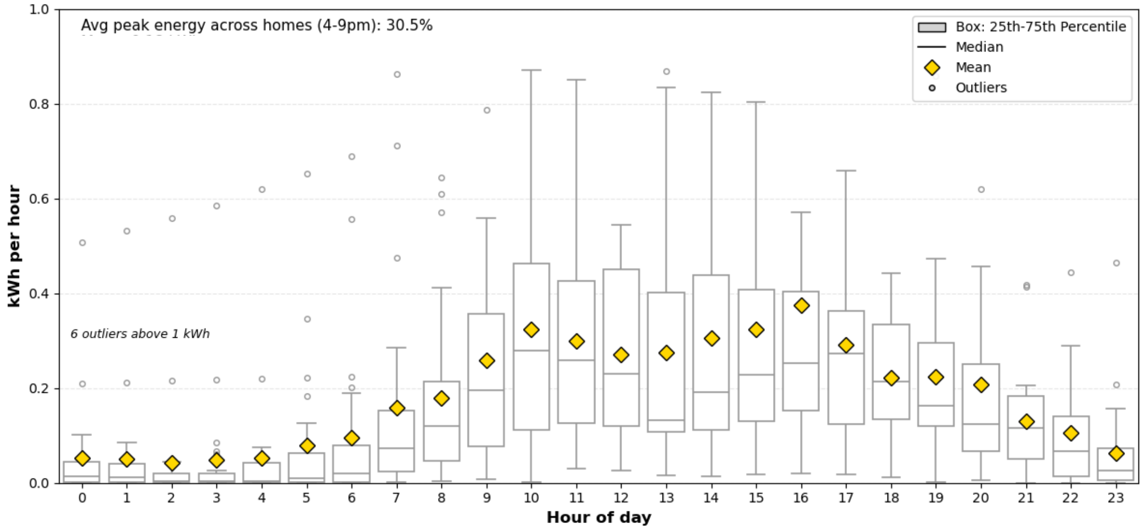

Figure 6. Daily mean was 4.5 kWh and the daily mean during peak (4-9pm) was 1.36kWh.

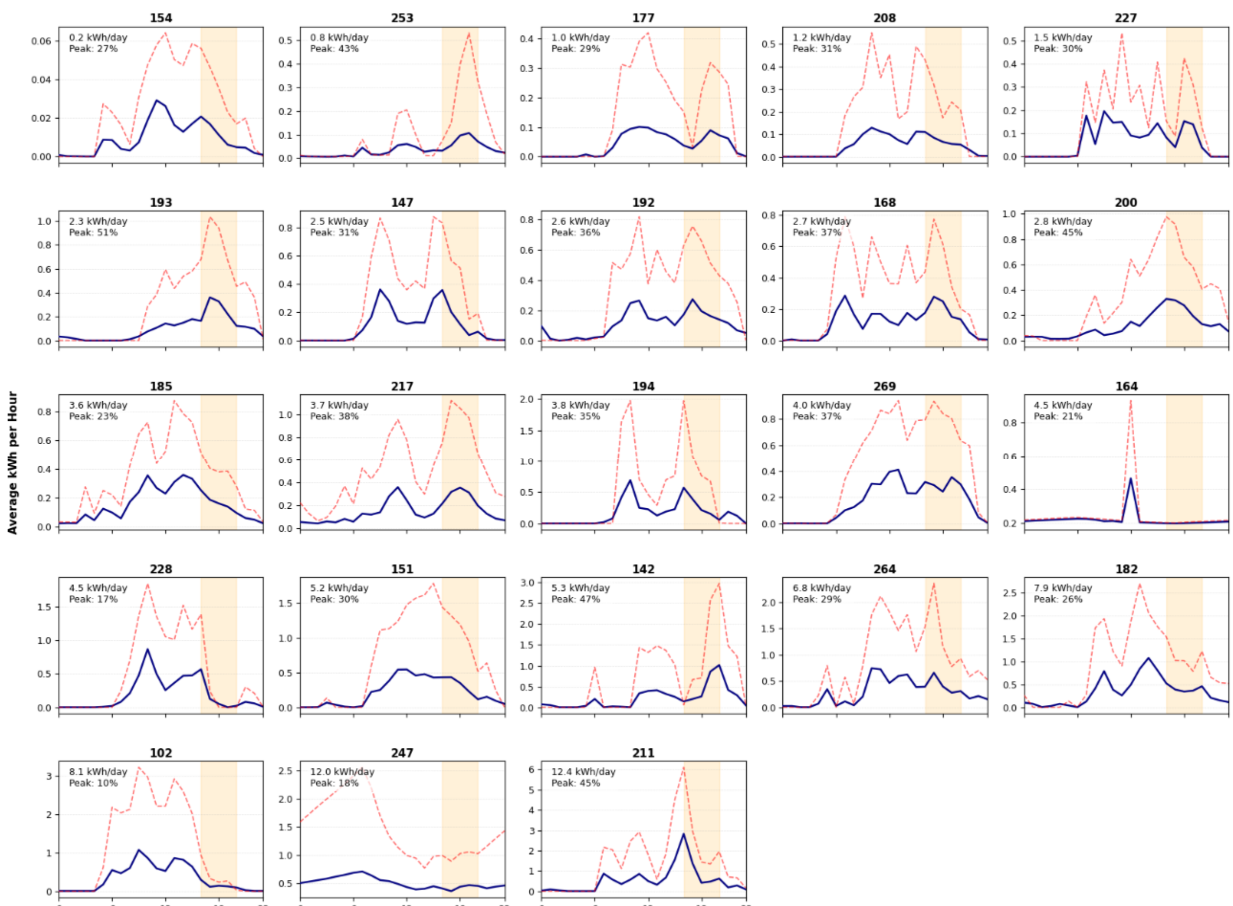

Figure 7: Daily electricity consumption by home. The Y-axis scale of kWh varies by home. The solid line is the mean and the dotted red line is the 90th percentile day. The peak electricity period is shaded. Note: While the data point is the average consumption of an hour, the point is plotted on the chart at the start of that hour.

On average, about 31% of stove energy was consumed during peak hours. For individual homes, this spanned from 10% to 51%. The cost implications are of course linked to total use and especially use during the peak interval. If overall electricity usage is low, a high fraction during the peak is not necessarily costly. In contrast, high use during peak hours can result in non-negligible costs. For example, household 142 had 47% of the daily average of 5.3kWh occur within the peak rate interval, which was 2.5 kWh per day. While it may represent a fraction of a home's energy consumption understanding it is important to understand because cooking-related energy demand is inherently difficult to shift in response to time-of-use pricing, owing to the concentration of cooking activities around typical dinner hours.

Utility Costs

The measurements of electricity use were used to estimate the cost of shifting from gas to electric induction cooking. To do this, we had to estimate the cost for the electricity used, the amount of gas that would have been used, and the cost for that gas. Gas use was estimated as the site energy equivalent of approximately twice the electricity use based on the efficiencies of gas and induction burners reported by Sweeny (2014). Electricity costs were estimated by considering two PG&E rate plans: TOU-C CARE and Tiered Rate CARE using 2026 rates (Pacific Gas and Electric, 2026). The CARE program offers reduced pricing for income qualifying households, and based on their eligibility for Medical, all study households also were eligible for CARE. Costs were estimated for each home's peak and non-peak electricity use by considering that for each period, the home could be below or above the baseline allocation, with higher costs for above baseline use. For TOU-C CARE, this resulted in 4 different bounding scenarios within each season (all cooking electricity usage below baseline in peak and non-peak, all above in peak and below in non-peak, all below in peak and above in non-peak, and all above in baseline in peak and non-peak). Both the Tiered CARE electricity plan and the gas rate plan (PG&E, 2026a; PG&E 2025c) have different pricing for above or below baseline allowance within each billing period. The Tiered electricity rate is the same each month throughout the year ($0.21 and $0.27 per kWh for below and above baseline), but gas rates vary from month to month. For this analysis, we used average annual prices from 2025, which were $2.02 per therm for below baseline and $2.41 per therm for above baseline. This resulted in two bounding cost estimates for each of these plans, with all usage above baseline or all usage below baseline. For each home and season, we calculated a minimum increment of costs over a 30-day billing period, based on gas usage being all above baseline and electricity usage being all below baseline and a maximum increment based on the inverse (all gas usage below baseline and electricity usage above). We also calculated the averages of the six estimates of electricity costs and the two estimates of gas costs and took the difference as a modal estimate of the most likely cost increase for that household.

Based on the analysis described above, we estimate that a household which cooks at the median level measured in the 23 homes could have an energy cost increase of about $8 per 30-day period. At the most favorable or unfavorable combinations of all gas and electricity usage being below or above baseline, the costs for that household could be as little as ~$4 or as high as ~$13 per 30-day period. For a home cooking at the 90th percentile energy use measured in our study, the average incremental cost for a 30-day period is about $16, with a bounding range of

$8.51–$31. The actual incremental costs for each home will depend on the rate plan and household usage relative to baseline for both gas and electric. We assume that actual incremental costs are closer to the average estimates than to the bounding estimates. And we note the median measured and 90th percentile cooking energy use measured in this sample are about 3x and 8x the estimated statewide averages (RASS, 2019).

Satisfaction Survey Data

Among 87 participants who received an induction stove and completed a satisfaction survey at the end of Phase 2, 72 (83%) were either somewhat or very satisfied with their induction cooktop and 9 (10%) were somewhat or very dissatisfied (Figure 9). These include one participant who switched back to gas (and who, ironically, was only somewhat dissatisfied with their induction cooktop and somewhat satisfied with their oven), but do not include two that switched back to gas and withdrew from the study.

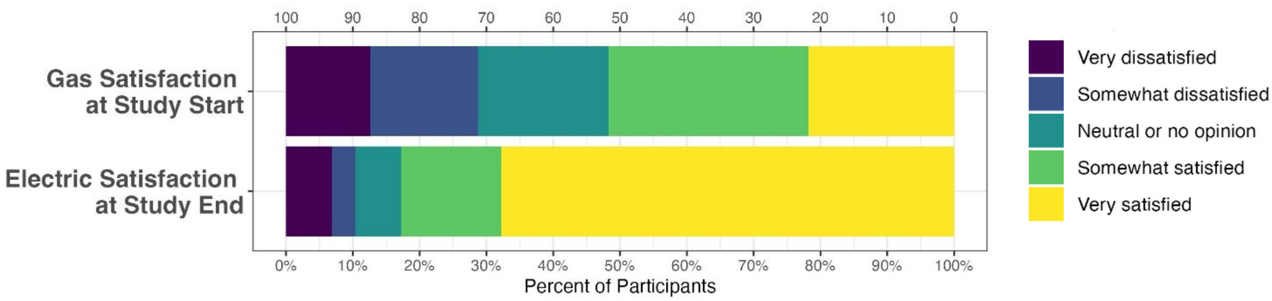

Figure 9. Satisfaction with gas cooking at the start and induction cooking at the end for the 87 people who completed two phases of the study. 83% were somewhat or very satisfied with induction at the end compared to 52% with gas cooking at the beginning.

Of the 44 participants who received the induction stove in Phase 1, 27 (61%) were somewhat or very satisfied and 14 (32%) were somewhat or very dissatisfied with the induction cooktop over the prior 3 months (essentially Phase 1). By the end of Phase 2, one of the somewhat dissatisfied dropped out; but satisfaction for the remaining 43 over the prior 3 months improved greatly, with 33 (77%) somewhat or very satisfied and only 5 (15%) somewhat or very dissatisfied. This indicates that as the participants gained experience with the induction cooktop, their satisfaction increased. Among the 87 who completed the satisfaction survey at the end of Phase 2, only 52% had been somewhat or very satisfied with their gas cooktop at the Initial Visit and 28% were somewhat or very dissatisfied with it. Thus, those who switched from gas to induction cooktop increased satisfaction from 52% to 83% and reduced dissatisfaction from 28% to 10%. At the end of the study, 23% of respondents reported that someone in the household had trouble learning to use the induction cooktop, 35% said that there was some cooking that they previously did with their gas cooktop that they could not do with their induction cooktop and 21% said the induction cooktop changed their cooking habits.

Initially, the study provided a stainless-steel cookware set and a cast iron comal. After receiving negative feedback from some participants about this cookware, the team transitioned to a set that is marketed as being nonstick ceramic and a comal marketed as nonstick with a granite coating. While most participants were satisfied with each combination (Table 3), the highest satisfaction rates were recorded for those who received the ceramic-coated cookware and granite-coated comal.

Table 3. Participant satisfaction with cookware at the end of the study

Type of Pots Received	Type of Griddle/Comal Received	Very or somewhat dissatisfied	Neutral or no opinion	Very or somewhat Satisfied
Stainless Steel	Cast Iron	6	2	17
Stainless Steel	Granite Non-Stick	0	0	2
Ceramic Non-Stick	Cast Iron	3	1	7
Ceramic Non-Stick	Granite Non-Stick	2	3	37

Conclusions

This study found that many homeowners with Medical-eligible children with asthma were reluctant to switch from gas to electric induction cooking even when offered to have it installed at no cost and with cookware and a payment for higher electricity cost. About 20% of those who were interested could not have the required 50 A/ 240 V circuit installed due to limitations of their existing panel capacity or house layout. However, among those who had suitable homes and chose to have an induction stove installed, their satisfaction with the induction stove was much higher than their satisfaction with the gas stove that they had previously. Satisfaction increased over time, presumably as the users of the induction stoves became more familiar with them. Over 20% of potential participants declined participation or withdrew due to articulated concerns about electric cooking yet lacked experience with induction electric cooking. Despite the higher efficiency of the induction stove, the estimated incremental cost of cooking with electric over gas was about $8 per 30-day period at the median cooking energy usage and $16 at the 90th percentile usage, assuming all households receive the discounted rates of the CARE program. These costs will vary based on a household's electricity rate plan and whether their gas and electricity usage are below or above the baseline allowance. In addition, our data showed 31% of cooking occurred within the higher cost peak period and it is more difficult to shift cooking outside of peak periods. Given that such costs could present a substantial challenge to households with limited incomes, it is important to collect additional data and better resolve the actual incremental costs of switching from gas to electric induction cooking. Our study indicates that targeted engagement that provides experiences with induction cooking and clear information about costs are important efforts to expand adoption

References

Holm, Stephanie M., J. Balmes, D. Gillette, K. Hartin, E. Seto, D. Lindeman, D. Polanco, E. Fong. 2018. "Cooking Behaviors Are Related to Household Particulate Matter Exposure in Children with Asthma in the Urban East Bay Area of Northern California." PLOS ONE, edited by Tesfaye B. Mersha, vol. 13, no. 6, June 2018, p. e0197199. DOI.org

Holm, Stephanie M., B. Singer, M. Kang Dufour, W. Delp. 2024. "Measured Air Quality Impacts after Teaching Parents about Cooking Ventilation with a Video: A Pilot Study." Journal of Exposure Science & Environmental Epidemiology, Nov. 2024. DOI.org

Dennekamp, M., S. Howarth, C.A.J. Dick, J.W. Cherrie, K. Donaldson, A. Seaton. 2001. "Ultrafine Particles and Nitrogen Oxides Generated by Gas and Electric Cooking." Occupational and Environmental Medicine, vol. 58, no. 8, no. 8, Aug. 2001, pp. 511–16, https://doi.org/10.1136/oem.58.8.511.

Fang Y et al. 2026. Range Hood Use and Effectiveness in Reducing Indoor Air Pollution During Gas and Induction Cooking. IAQVEC 2026, Los Angeles, CA. May 2026. Paper 514.

———.2026a. Measured Indoor Nitrogen Oxides in Homes with a Child with Asthma and Gas or Induction Electric Cooking. IAQVEC 2026, Los Angeles, CA. May 2026. Paper 513.

———.2026b. Measured Cooking Activities and Indoor Real-time Particle Concentrations in Homes Using Gas or Induction Electric Cooking. Indoor Air 2026, Singapore. June 14-19, 2026. Submission 11077. Full paper.

Mullen, N.A., J. Li, M. Russell, M. Spears, B. Less, B. Singer. 2016. "Results of the California Healthy Homes Indoor Air Quality Study of 2011-2013: Impact of Natural Gas Appliances on Air Pollutant Concentrations." Indoor Air, vol. 26, no. 2, no. 2, Apr. 2016, pp. 231–45, https://doi.org/10.1111/ina.12190.

Lebel, Eric D., C. Finnegan, Z. Ouyang, R. Jackson. 2022. "Methane and NOx Emissions from Natural Gas Stoves, Cooktops, and Ovens in Residential Homes." Environmental Science & Technology, vol. 56, no. 4, Feb. 2022, pp. 2529–39. ACS publications, https://doi.org/10.1021/acs.est.1c04707.

Less, Brennan, N. Mullen, B. Singer, I. Walker. 2015. "Indoor Air Quality in 24 California Residences Designed as High-Performance Homes." Science and Technology for the Built Environment, vol. 21, no. 1, Jan. 2015, pp. 14–24. DOI.org

Li, Jiayu, H. Zhao, M. Russell, W. Delp, A. Johnson, X. Tang, I. Walker, B. Singer, et al. "Air Pollutant Exposure Concentrations from Cooking a Meal with a Gas or Induction Cooktop and the Effectiveness of Two Recirculating Range Hoods with Filters." Indoor Environments, Sept. 2024, p. 100047. DOI.org.

Lin Z, et al. 2026. Measured indoor particulate matter, black carbon, and oxidative potential before and after replacing gas with induction electric cooking in homes with a child with asthma. IAQVEC 2026, Los Angeles, CA, USA. May 2026. Paper #550.

Lin, Weiwei, B. Brunekreef, U.Gehring. 2013. "Meta-Analysis of the Effects of Indoor Nitrogen Dioxide and Gas Cooking on Asthma and Wheeze in Children." International Journal of Epidemiology, vol. 42, no. 6, Dec. 2013, pp. 1724–37. Silverchair, https://doi.org/10.1093/ije/dyt150.

Lunden, M. M., B. Singer. W. Delp. 2015. "Capture Efficiency of Cooking-Related Fine and Ultrafine Particles by Residential Exhaust Hoods." Indoor Air, vol. 25, no. 1, 2015, pp. 45–58. Wiley Online Library, https://onlinelibrary.wiley.com/doi/abs/10.1111/ina.12118.

Ohlwein, Simone, R. Kappeler, M. Kutla Joss, N. Kunzli, B. Hoffman. 2019."Health Effects of Ultrafine Particles: A Systematic Literature Review Update of Epidemiological Evidence." International Journal of Public Health, vol. 64, no. 4, May 2019, pp. 547–59. PubMed, https://doi.org/10.1007/s00038-019-01202-7.

Pacific Gas and Electric (PG&E). 2026 Residential rate plan pricing. Accessed February 2026. www.pge.com/assets/pge/docs/account/rate-plans/residential-electric-rate-plan-pricing.pdf

——— .2026a. Residential Non-CARE and CARE Gas Tariff Rates. 2026. Accessed February 2026. https://www.pge.com/assets/rates/tariffs/Res_240101-251231.xlsx

———. 2026b. Gas Rate Advisory. 2026. Accessed February 2026. https://www.pge.com/assets/pge/docs/account/rate-plans/gas-rate-advisory-0326.pdf

Paulin, L. M., G.B Diette, M. Scott, M.C. McCormack, E.C Matsui, J. Curtin-Brosnan, D.L. Williams, A. Kidd- Taylor, M. Shea, N.N Hansel. "Home Interventions Are Effective at Decreasing Indoor Nitrogen Dioxide Concentrations." Indoor Air, vol. 24, no. 4, no. 4, Aug. 2014, pp. 416–24, https://doi.org/10.1111/ina.12085.

2019 Residential Appliance Saturation Survey. CEC-200-2021-005-PO, Table 1.

Singer, Brett C., R. Zarin Pass, W. Delp, D. Lorenzetti, R. Maddalena. "Pollutant Concentrations and Emission Rates from Natural Gas Cooking Burners without and with Range Hood Exhaust in Nine California Homes." Building and Environment, vol. 122, Sept. 2017, pp. 215–29. ScienceDirect, https://doi.org/10.1016/j.buildenv.2017.06.021.

Sweeny, Micah, J. Dols, B. Fortenbery, and F. Sharp. 2014. "Induction Cooking Technology Design and Assessment". In Proceedings of the 2014 ACEEE Summer Study on Energy Efficiency in Buildings.https://www.aceee.org/files/proceedings/2014/data/papers/9-702.pdf

U.S. EPA. Integrated Science Assessment (ISA) for Oxides of Nitrogen – Health Criteria (Final Report, Jan 2016). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-15/068, 2016