Induction Cooking Market Transformation Initiative

Appendix B: Market Forecasting & Cost-Effectiveness Modeling Approach

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CalMTA is a program of the California Public Utilities Commission (CPUC) and is administered by Resource Innovations.

Contents

List of Abbreviations

Abbreviation	Definition
ACC	Avoided Cost Calculator
ACS	American Community Survey
BMA	Baseline Market Adoption
CalMTA	California Market Transformation Administrator
CE	Cost-Effectiveness
CET	Cost-Effectiveness Tool
CPUC	California Public Utilities Commission
DEER	Database for Energy Efficient Resources
DOE	Department of Energy
EERE	Office of Energy Efficiency and Renewable Energy
EIA	Energy Information Administration
EIA RECS	Energy Information Administration's Residential Energy Consumption Survey
ES	ENERGY STAR
EUL	Estimated Useful Life
GHG	Greenhouse Gas
IMC	Incremental Measure Cost
IOU	Investor-Owned Utility
MF	Multifamily
MTI	Market Transformation Initiative
NC	New Construction
NR	Normal Replacement
PAC	Program Administrator Cost
PG&E	Pacific Gas and Electric
RA	Resource Acquisition
RASS	Residential Appliance Saturation Survey
SCE	Southern California Edison
SCT	Societal Cost Test
SDG&E	San Diego Gas and Electric
SF	Single-Family
TMA	Total Market Adoption
TRC	Total Resource Cost
TSB	Total System Benefit
UEI	Unit Energy Impact
UES	Unit Energy Savings

1 Purpose

Market Transformation Initiatives (MTIs) generate energy savings and related benefits by accelerating and increasing market adoption of energy-efficient technologies and practices. Estimating the energy impacts and cost-effectiveness of MTIs requires developing a forecasting model that uses a set of inputs based on well-documented sources, methods, and assumptions.

This appendix details the methodology used to estimate incremental impacts resulting from the Induction Cooking MTI and summarizes findings from the analysis. These methods are consistent with the approach described in Appendix F: Evaluation Plan.[1]

2 Executive summary

To estimate incremental impacts for the Induction Cooking MTI, CalMTA developed models that forecasted Baseline Market Adoption (BMA) and Total Market Adoption (TMA) and, ultimately, the net incremental market adoption achieved by the MTI. Forecasted units of adoption are a key input to the calculation of Total System Benefit (TSB) and cost-effectiveness ratios: Total Resource Cost (TRC), Program Administrator Cost (PAC), and Societal Cost Test (SCT).

2.1 Market adoption forecasts

CalMTA developed BMA and TMA forecasts to estimate the net incremental market adoption of induction and ENERGY STAR certified electric radiant cooking products resulting from the MTI. BMA represents the expected "naturally occurring" market adoption, taking into account current and expected market, regulatory and technological trends. TMA includes the additional adoption forecasted to result from strategic interventions described in this MTI plan.

To estimate BMA and TMA of these products for existing households, CalMTA developed a stock turnover framework that models households' decisions to retire their existing products and replace them with new cooking products. The baseline projection incorporates historical trends in appliance retirement and replacement decisions, along with residential energy usage patterns. The model builds on methods used by the U.S. Department of Energy (DOE)'s Office of Energy Efficiency and Renewable Energy (EERE 2022) to assess the impacts of ENERGY STAR specifications for cooking appliances. [2] Model assumptions were further informed by surveys of

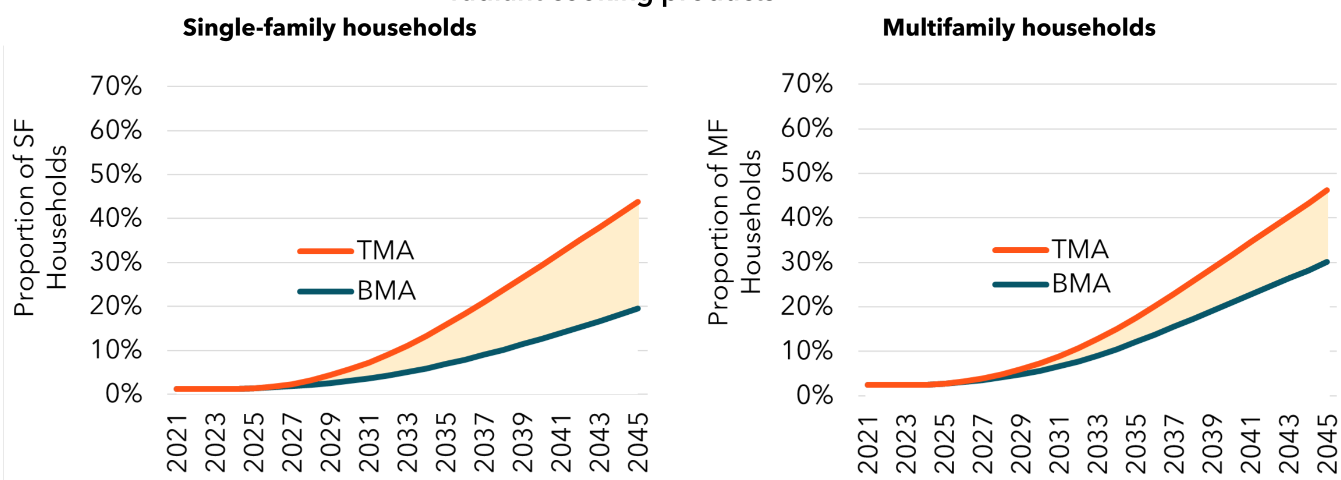
[1] The MTI Evaluation Framework provides foundational guidance for the evaluation of CalMTA's MTIs. The framework is available here: https://calmta.org/wp-content/uploads/sites/263/Market-Transformation-Evaluation-Framework-FINAL.pdf. The framework outlines the approach that will be used to measure incremental adoption of cooking products, including the high-level process to estimate incremental adoption and produce the necessary inputs to that model, such as BMA and TMA, and to calculate TSB and cost-effectiveness ratios.

[2] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program (2022). Technical support document: Energy efficiency program for consumer products and commercial and

property managers and households, discussions with stakeholders such as manufacturers, inputs from the Delphi panel and related analyses by the California Energy Commission and DOE's Energy Information Agency (EIA). As a result, the BMA reflects expected adoption considering existing and projected market conditions, technological advancements, and regulatory trends. The TMA analysis is aligned with MTI planned interventions and milestones and accounts for accelerated retirement of gas equipment and an enhanced transition toward efficient electric cooking appliances.

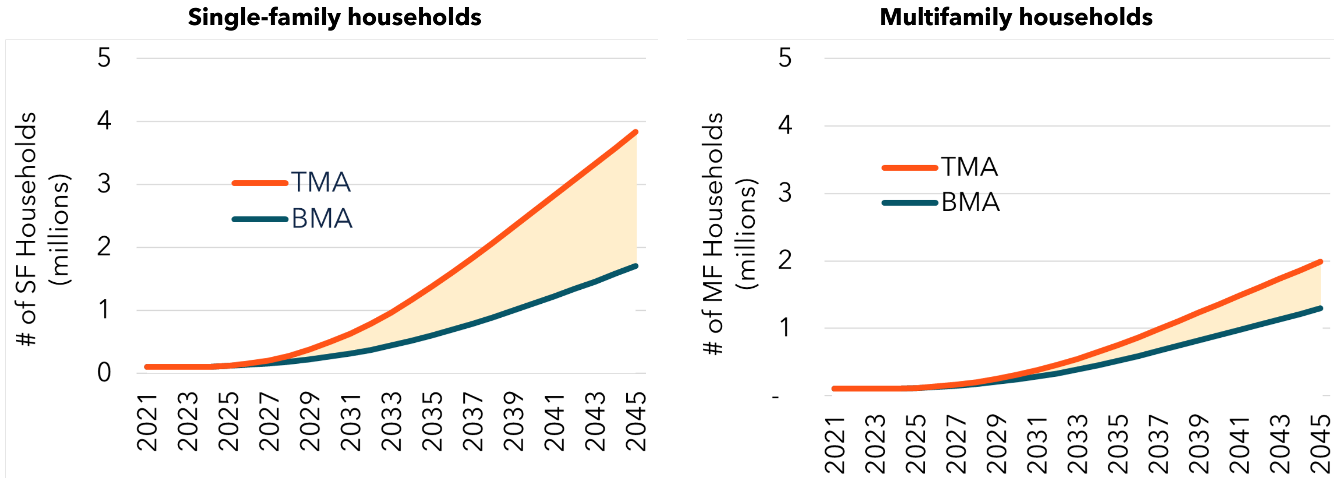
Figure 1 illustrates the estimated adoption proportions for existing single-family (left) and multifamily (right) households, while Figure 2 on the following page presents the adoption numbers in thousands of households.

Figure 1. Estimated proportion of households adopting induction and ENERGY STAR certified radiant cooking products



industrial equipment: Consumer conventional cooking products. Retrieved October 24, 2024, from https://www.regulations.gov/document/EERE-2014-BT-STD-0005-0090.

Figure 2. Estimated number of households adopting induction and ENERGY STAR certified radiant cooking products (in thousands)



After developing the BMA and TMA forecasts, CalMTA calculated the net incremental unit adoption, which is equal to TMA minus BMA, minus the estimated adoption associated with Program Administrators' (PA) verified savings (this included all PA programs statewide; for IOUs, this included programs reported in the California Energy Data and Reporting System or CEDARS).[3] The net incremental adoption is summarized in the equation below.

$$Y^{N.incremental} = Y^{TMA} - Y^{BMA} - Y^{PA}$$

Where Y represents cumulative adoption of induction and radiant cooking products over the forecast period of 2024 to 2045. The superscripts $N.incremental$, TMA, BMA, and PA represent net incremental adoption attributed to the MTI, TMA, BMA, and verified PA claimed savings respectively. Table 1 below summarizes TMA, BMA, PA-verified units, and net incremental adoption in terms of units of efficient cooking products adopted.

The approach described above estimated adoption at a statewide level. The last two columns of Table 1 show the adoption attributed to households outside the service territories of the investor-owned utilities (IOUs) and the adjusted adoption estimates included in the estimation of TSB and cost-effectiveness.[4]

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[3] https://cedars.cpuc.ca.gov/.

[4] It is important to note that the state of California will realize electric system benefits from statewide incremental MTI cooking product market adoption – not only from adoption inside the IOU service territories. While the adjusted values may be the most appropriate values to use for the CPUC's cost-effectiveness tests, as a matter of policy, they do not fully represent the statewide benefits that will result from investment in the Induction Cooking MTI. This approach discounts statewide benefits by nearly 26%.

Table 1. Forecast of adoption of MTI cooking products (in thousands, 2024-2045)

	TMA (Y^{TMA})	BMA (Y^{BMA})	PA-verified units (Y^{PA})	Net Incremental ($Y^{N.Incremental}$)	Adoption attributed to non-IOU territory	Adoption for TSB and CE estimation
Single-family households	3,559	1,511	124	1,924	492	1,433
Multifamily households	1,610	958	35	617	158	460
New construction	459	338	-	121	31	90
Total	**5,629**	**2,808**	**158**	**2,663**	**681**	**1,982**

Source: CalMTA estimates. Note: Differences in totals are due to rounding. PA verified units include adoption associated with PA programs statewide.

In addition to the net incremental adoption estimates attributed to households in the territories of the three IOUs, the TSB and cost-effectiveness calculations also considered initiative costs, incremental measure cost (IMC), avoided costs, load shapes, and unit energy impacts (UEI).

2.2 Total System Benefit (TSB) & cost-effectiveness forecast

CalMTA estimated the TSB and cost-effectiveness for the Induction Cooking MTI, including the TRC, PAC, and two SCT results. Table 2 shows MTI TSB with a breakout of energy, grid, and greenhouse gas (GHG) impacts.

The initiative will deliver an estimated $537 million in TSB between 2024 to 2045. Most of these benefits come from GHG emission reductions associated with switching from gas to electric cooking appliances. Negative grid TSB benefits are due largely to the impact of fuel substitution as induction and efficient electric cooking products are projected to replace natural gas units. Overall, the initiative creates $36 million in net energy benefits. The initiative is cost-effective under the TRC, PAC, and SCT test perspectives. Cost-effectiveness is higher for SCT than TRC due to its lower discount rate. Table 3 includes MTI cost-effectiveness estimates for 2024-2045.

Table 2. Induction Cooking TSB estimates, 2024-2045

TSB ($M)	Energy ($M)	Grid ($M)	GHG non-refrigerant ($M)	GHG refrigerant ($M)
537	36	(125)	626	N/A

Source: CalMTA estimates.

Table 3. MTI cost-effectiveness estimates, 2024-2045

TRC	PAC	Base SCT	High SCT
1.12	14.36	3.04	3.04

Note: The "Base" and "High" SCT values refer respectively to the average and 95th percentile social cost of carbon, as explained in the ACC documentation.

Source: CalMTA estimates.

3 MTI product definition

The MTI includes three distinct cooking technologies: 120V battery-equipped induction, 240V induction, and 240V electric radiant. The MTI includes two form factors: stand-alone cooktops designed for permanent installation in a countertop, and freestanding or slide-in ranges. The MTI considers only radiant cooking products with ENERGY STAR certification. Induction products, regardless of ENERGY STAR certification, are part of the MTI scope.

The scope excludes cooktops and ranges with coil-style heating elements, radiant cooking products that are not ENERGY STAR certified, stand-alone wall ovens, and small plug-in cooktops designed to sit on countertops without permanent installation. In this Appendix, the terms "cooking products" or “cooking appliances” includes both stand-alone cooktops and ranges and does not include ovens or plug-in products that do not require permanent installation.

4 Market adoption analysis

CalMTA modeled adoption of induction and ENERGY STAR certified cooking products separately for both existing and new construction single-family and multifamily households in California from 2024 to 2045. For existing households, CalMTA employed a stock turnover model for three mutually independent segments based on cooking appliance ownership (gas, electric coil, radiant or induction cooking appliances). CalMTA considered historical trends and recent regulatory developments supporting electrification in newly built units to make assumptions about the share of electric products for single family and multi-family homes in the residential new construction sector. For each sub-segment, CalMTA estimated annual adoption for the baseline scenario (BMA), which considered existing and projected market conditions, recent and projected California energy efficiency program activity, technological advancements, and regulatory trends. For each sub-segment, CalMTA then estimated the adoption in presence of the MTI (TMA) which additionally considered the MTI planned interventions and milestones.

4.1 Existing households

CalMTA employed a stock turnover model for this analysis. This approach allows CalMTA to model both the decisions related to the replacement of existing appliances and the selection of replacement technology. By using this model, CalMTA can assess the impact of the MTI on both sets of decisions. CalMTA’s model is based on a stock turnover model developed by the DOE (DOE EERE 2022) to assess the impacts of ENERGY STAR specifications for cooking appliances.[5]

[5] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program. (2022). Technical support document: Energy efficiency program for consumer products and commercial and industrial equipment: Consumer conventional cooking products. Retrieved October 24, 2024, from https://www.regulations.gov/document/EERE-2014-BT-STD-0005-0090.

The DOE model combines historical shipment data with survival functions to model retirement and failure rates across cooking technologies at a national level. Cooking appliances are disaggregated by fuel type, technology, and form factor. The DOE study forecasts future shipments of cooking appliances and evaluates the environmental, employment, and utility impacts of ENERGY STAR specifications.

For California-specific analysis, CalMTA adapted the DOE EERE 2022 model using state-specific cooking product saturation data from the EIA's 2020 Residential Energy Consumption Survey (EIA RECS 2020). The analysis applies the DOE's annual retirement rates to estimate the proportion of cooking appliances retired each year throughout the forecast period. This adaptation makes two key assumptions from the national model: first, that California's base-year appliance age distribution mirrors national patterns, and second, that product failure and retirement rates in California align with national trends. Under the MTI implementation scenario, the model incorporates an accelerated replacement rate to reflect impact of MTI interventions on consumer behavior. This methodological approach allows for a targeted assessment of California's unique market conditions while leveraging the robust analytical framework established by DOE EERE 2022.

CalMTA segmented existing households into three mutually independent segments based on cooking appliance ownership in the base year. For each sub-segment, CalMTA estimated annual adoption for the baseline scenario (BMA) and in the presence of the MTI (TMA). At a very high level, the approach involved two main steps: (1) estimate the proportion of customers transitioning from gas to electric or from coil to efficient electric cooking products, and (2) for those who transition, estimating the increased adoption of efficient cooking appliances. CalMTA developed two estimates, one for the baseline (BMA) scenario and one for MTI scenario (TMA).

Table 4 lists the three segments and summarizes the modeled impact of the MTI for each segment.

Table 4. Population segments and modeled impact of the MTI

Segment	Cooking appliance in base year	Number of households (millions)+	Modeled impact of the MTI (TMA)
S1	Gas cooking appliances	9.3	(a) Accelerates replacement of existing gas appliances (b) Promotes more households to transition out of gas (c) Increases adoption of efficient cooking appliances during replacement relative to other competing cooktops
S2	Coil-based cooking	1.5	(a) Promotes more households to transition out of coil cooking products (b) Increases adoption of efficient cooking appliances during replacement
S3	Radiant or induction appliances	2.2	(a) Increases adoption of efficient cooking appliances during replacement of existing appliances

Note: (+) Includes both existing single-family and multifamily households.

4.2 Newly built housing units

In addition to the three segments above, we projected adoption for newly built housing units (new construction). For new construction projections, the baseline scenario considers historical electrification trends, adjusted to reflect recent policy interventions and current codes and standards that encourage transition away from gas appliances. In the presence of the MTI, the model projects a more rapid and comprehensive transition to electric cooking appliances, consistent with planned interventions and program objectives. Table 5 provides the total new housing units in the forecast period, and the assumed impacts of the MTI.

Table 5. Modeled impact of the MTI on new construction

Segment	Cooking appliance in base year	Number of households (millions)	Modeled impact of MTI (TMA)
S4	Newly built housing units	0.86	(a) Promotes a higher share of electric cooking (vis-a-vis gas) (b) Accelerates the timeline for achieving a higher share of electric cooking in newly built units (c) Increases adoption of efficient cooking appliances during replacement

Note: The third column from the left gives the cumulative new housing units in the forecast period. The estimate is based on population and household size forecasts by California Department of Finance.

4.3 Summary

For each of the four segments above, CalMTA forecasted adoption for each of the three cooking technologies covered in this MTI and disaggregated by household type (single-family and multifamily).

Baseline market adoption (BMA) in year t of 120V induction, 240V Induction, and 240V ENERGY STAR radiant cooking products or $y_t^{120V\_I,BMA}$, $y_t^{I,BMA}$ and $y_t^{ESR,BMA}$ may be expressed in the following way:

$$y_t^{120V\_I,BMA} = y_{t,S1}^{120V\_I,BMA} + y_{t,S2}^{120V\_I,BMA} + y_{t,S3}^{120V\_I,BMA} + y_{t,S4}^{120V\_I,BMA}$$

$$y_t^{I,BMA} = y_{t,S1}^{I,BMA} + y_{t,S2}^{I,BMA} + y_{t,S3}^{I,BMA} + y_{t,S4}^{I,BMA}$$

$$y_t^{ESR,BMA} = y_{t,S1}^{ESR,BMA} + y_{t,S2}^{ESR,BMA} + y_{t,S3}^{ESR,BMA} + y_{t,S4}^{ESR,BMA}$$

Where:

y refers to annual adoption of a cooking product. The report uses Y to refer to cumulative adoption over multiple years.

Superscripts $120V\_I$, I and ESR represent the three cooking technologies covered in this MTI - 120V battery-equipped induction, 240V induction, and 240V ENERGY STAR radiant respectively.

Subscript t represents year t in the forecast period from 2024 to 2045.

Subscripts $S1$, $S2$, $S3$, $S4$ represent the four population segments as defined above.

The overall annual adoption of efficient cooking products in the baseline model may be represented as:

$$y_t^{BMA} = y_t^{120V\_I,BMA} + y_t^{I,BMA} + y_t^{ESR,BMA}$$

The above estimates are estimated separately for multifamily and single-family households.

Similarly, the overall annual adoption of efficient cooking products in the presence of the MTI may be represented as:

$$y_t^{TMA} = y_t^{120V\_I,TMA} + y_t^{I,TMA} + y_t^{ESR,TMA}$$

Our model estimates the BMA and TMA adoption of efficient electric cooking products as a whole that encompasses both stand-alone units and ranges.

4.4 Key Assumptions

CalMTA considered four segments: existing single-family households, existing multifamily households, and new constructions. The analysis established the size of each of these segments as detailed below.

Base-year population

CalMTA used data from the 2022 American Community Survey 1-Year Estimates (ACS 2022), conducted by the U.S. Census Bureau for estimate of the number of single-family and multifamily households in California in 2023 as shown in Table 6.[6]

Table 6. Number of households in California in 2023

	Single-family households	Multifamily households
Number of households (million)	8.79	4.29

Base-year saturation of residential cooking equipment

The base-year saturation of cooking appliances in California, disaggregated by fuel type and form factor (range or stand-alone cooktops) is presented in Table 7. The data is based on the EIA RECS 2020 estimates.[7,8] The EIA RECS 2020 is calibrated to ACS 2020 household population estimates. CalMTA further calibrated the household population estimates in EIA RECS 2020 to ACS 2022.

Table 7. Cooking product appliances in existing California homes – disaggregated by fuel and appliance form factor (millions)

	Electric			Gas+		
	Range	Stand-alone	**Total**	Range	Stand-alone	**Total**
Single-family	1.41	0.41	1.82	5.45	1.48	6.93
Multifamily	1.86	0.07	1.93	2.27	0.11	2.38
Total	**3.27**	**0.48**	**3.75**	**7.72**	**1.59**	**9.31**

Source: EIA RECS 2020; CalMTA recalibration of household population to ACS 2022. (+) Gas includes both natural gas and propane. Note: Differences in totals are due to rounding.

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[6] U.S. Census Bureau. (2023). *American Community Survey 1-Year Estimates: 2022*. Retrieved October 24, 2024, from https://data.census.gov/table/ACSDP1Y2022.DP04?g=040XX00US06.

[7] U.S. Energy Information Administration. (2023). *Residential Energy Consumption Survey: 2020*. Retrieved October 24, 2024, from https://www.eia.gov/consumption/residential/data/2020/.

[8] The study also explored the California Energy Commission's 2019 Residential Appliance Saturation Study (RASS) to assess the base year saturation of cooking appliances. However, the CEC 2019 RASS does not provide data at the level of granularity required by this study.

The table indicates that multifamily housing units are more likely to have a range compared to single-family households (96% and 79% of all cooking products respectively). Further, multifamily households are more likely to have an electric cooktop or range compared to single-family households (45% and 20% respectively).

Table 8 disaggregates electric cooking products by technology type (coil, radiant, and induction) for both single-family and multifamily households. The estimates are based on data from the EIA RECS 2020 and U.S. DOE EERE 2022 study on cooktops and ranges.[9]

Table 8. Saturation of electric cooking appliances in California by technology type and household segment

Segment	Coil	Radiant	Induction
Single-family	29.2%	62.8%	8.0%
Multifamily	50.1%	44.9%	4.9%

Source: CalMTA estimates based on EIA RECS 2020, US DOE EERE 2022.

Forecast period population

Based on population and average household size projections from the California Department of Finance[10], and proportion of single-family and multifamily households from U.S. Census and EIA RECS 2020, CalMTA forecasted the number of households in California over the forecast horizon. Net new construction for each year was calculated by subtracting the total number of households forecasted for any given year from the total number of households forecasted in the prior year. The summary of these forecasts is provided in Table 9.

Table 9. Household projections for California

Year	Population (millions)	Household size (persons / household)	Single family households (millions)	Multifamily households (millions)
2020	39.54	2.86	8.55	4.17
2025	39.02	2.80	8.97	4.45
2030	39.43	2.78	9.09	4.58
2035	39.87	2.76	9.21	4.71
2040	40.11	2.75	9.27	4.81
2045	40.15	2.73	9.29	4.89

Source: CalMTA based on population and HH size projections by California Department of Finance.

[9] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program. (2022). Technical support document: Energy efficiency program for consumer products and commercial and industrial equipment: Consumer conventional cooking products. Retrieved October 24, 2024, from https://www.regulations.gov/document/EERE-2014-BT-STD-0005-0090.

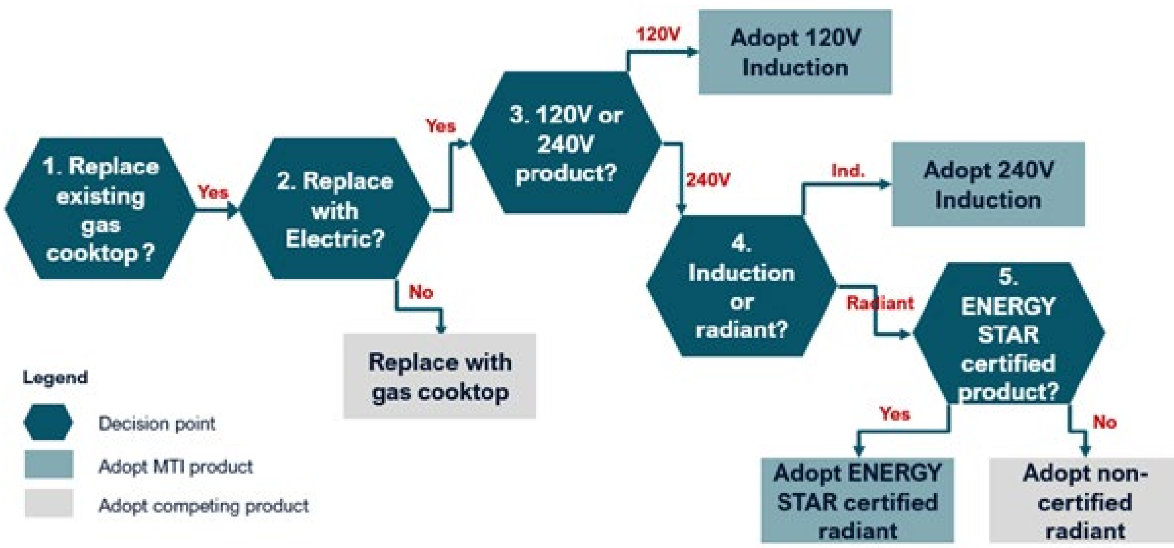
[10] California Department of Finance. *Demographic projections*. Retrieved October 24, 2024, from https://dof.ca.gov/Forecasting/Demographics/projections/.

4.5 Adoption by existing households

Adoption by existing households with gas cooking appliances in the base year

This section describes the methods used to forecast adoption of the MTI products by households with gas cooking appliances in the base year[11] modeled as a likely sequence of decisions taken by a household in this segment (S1). The methods to forecast adoption by this segment are summarized in Figure 3, which represents the sequence of decisions and actions taken by a household with a gas cooking appliance. For each decision point, two sets of assumptions were developed: one reflecting baseline market conditions and another incorporating the effects of the MTI.

Figure 3. Decision framework for households transitioning from gas cooking



[11] Around 6.9 million single-family and 2.4 million multifamily households currently use gas cooking appliances, based on EIA RECS 2020.

Table 10 summarizes the specific assumptions areas for each decision point and also provides a high-level overview of how the assumptions differ in presence of the MTI compared to the baseline scenario.

Table 10. Decision framework steps, decision questions, and assumption area for households transitioning from gas

Step	Decision	Assumption area	Impact of the MTI
#1	Replace existing gas cooking appliances?	Proportion of households retiring their equipment.	Accelerated replacement of gas cooking products in MTI scenario compared to normal replacement in the baseline.
#2	If replacing, then transition to electric or continue with gas?	Proportion of households transitioning to electric cooking after retiring their gas cooking appliance.	Higher proportion of household's transition to electric cooking.
#3	If transitioning to electric, should the appliance be 120V or 240V?	Relative market shares of 120V products (120V battery-equipped induction) and 240V products (240V induction and 240V radiant).	Higher share of 120V products given greater product availability and lower costs relative to the baseline.
#4	If adopting a 240V product, should it be induction or radiant?	Relative market shares of 240V induction and 240V radiant.	Higher share of induction given greater product awareness and product availability.
Step #5	If adopting a 240V radiant, should it be an ENERGY STAR certified or non-certified product?	Relative market shares of ENERGY STAR certified radiant and non-certified radiant.	CalMTA assumed that share of ENERGY STAR is similar in both baseline and in presence of the MTI.

The steps above led to estimates of annual adoption by segment S1 of the three products covered in this MTI (i.e. $y_{t,S1}^{120V\_I}$, $y_{t,S1}^{I}$ and $y_{t,S1}^{ESR}$).

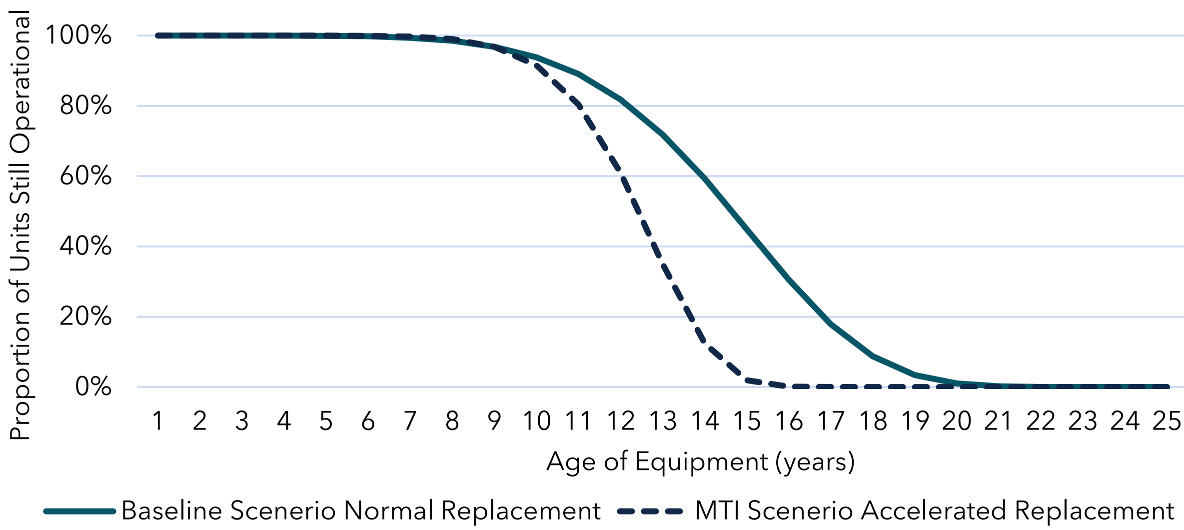
Step 1: Replacement decision to existing gas cooking products

To estimate baseline values for retirement and replacement of existing gas cooking appliances, CalMTA considered the historical trends in retirement and replacement of gas cooking appliances as modeled by the DOE EERE 2022 study. That study used historical shipment and saturation data to develop a survival function that estimates the percentage of appliances of a given age that would still be in operation each year. The function captures retirement of equipment due to both product failure and early replacements from remodeling or upgrading.[12,13] Based on these historical trends, gas cooking appliances have an average life of approximately 14.5 years.[14]

In the presence of the MTI, increased awareness of health risks associated with gas cooking and greater availability of induction and radiant alternatives will encourage households to replace their gas cooking equipment sooner than historical patterns. To model accelerated replacement occurring because of the MTI, CalMTA adjusted the survival function to reduce the average life by approximately two years. As shown in Figure 4, the survival probability curves illustrate both historical replacement patterns (solid line) and accelerated replacement in presence of the MTI (dashed line). The steeper decline of the dashed line for older equipment ages indicates that accelerated replacement is expected to be more pronounced among households with aging gas cooking appliances, reflecting a greater willingness to replace older, less efficient units.

[12] Lutz, J. D., Hopkins, A., Letschert, V., Franco, V. H., & Sturges, A. (2011). Using national survey data to estimate lifetimes of residential appliances. *HVAC&R Research*, *17*(5), 726-736.
[13] Franco, V., Bennani-Smires, Y., Ke, J., Cubero, E., & Lekov, A. (2018). Estimating Residential Appliance Lifetime for Energy Efficient Policy Analysis.
[14] The DOE EERE 2022 study assumes that the survival function takes the form of a cumulative Weibull distribution. Based on historical data, the study estimated Weibull parameter values of 14.56 and 5.73 for scale and shape parameters respectively for both gas standalone cooktops and ranges giving an average age of 14.5 years.

Figure 4. Replacement of a gas cooktop or range (survival probability)



Step 2: Transition from gas to electric cooking products

Figure 5 summarizes CalMTA's estimates of the trajectory of transition from gas to electric cooking products in the baseline scenario (BMA, solid line) and in presence of the MTI (TMA, dashed line) for both single-family and multifamily households.

The solid lines reflect the number of households who continue to own gas cooking appliances during the forecast considering existing and projected market conditions, technological advancements, and regulatory trends.

To inform the assumptions for trends in the baseline, CalMTA conducted a multi-pronged analysis to estimate the proportion of households that would transition from gas to electric cooking appliances, based on both historical trends and a literature review of analyses from other studies. A historical analysis of U.S. Census American Housing Survey[15] data for California, combined with EIA RECS data shows that the proportion of households with electric cooking has remained relatively stable over the past two decades.[16] CalMTA also reviewed projections of cooking energy use by various studies. A forecast by California Energy Commission's 2023 Integrated Energy Policy Report (CEC IEPR)[17] shows that natural gas consumption by the residential sector

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[15] https://www.census.gov/programs-surveys/ahs/about.html.

[16] In California, electric cooking appliance saturation has remained steady at approximately 33% over the past two decades. For comparison, the national average has maintained a consistent level of about 65% during the same period.

[17] California Energy Commission (CEC). 2023 Integrated Energy Policy Report. Retrieved October 24, 2024, from https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report/2023-integrated-energy-policy-report/2023-1.

will stay constant over next 20 years.[18] Despite expectations for electrification of space-conditioning and water-heating through adoption of heat pumps in the residential sector, this suggests that the CEC IEPR forecasts expect continuing dominance of gas going forward.[19] The above analysis suggests that natural gas cooking equipment is expected to continue to dominate residential cooking in the baseline (BMA) scenario.

CalMTA estimated that approximately 1.2 million single-family households, at maximum, may transition to electric cooking products in the baseline. This ceiling for potential electrification among single-family households was determined through analysis of existing electrical panel capacity[20] across different household income levels.[21] For multi-family households, the transition potential is significantly lower due to two key barriers: a higher proportion of units with inadequate panel capacity[22] and the prevalence of rental properties (over 90% of units) where split-incentive challenges limit investments in electrical infrastructure upgrades.

Based on the above analysis, CalMTA assumed limited transition from gas to electricity in the baseline.

In the presence of the MTI (TMA), CalMTA assumes a greater proportion of households will transition from gas to electric cooking appliances, as depicted by the dashed lines in Figure 5. This assumption is based on the expectation that the interventions planned in the MTI will lead to more households migrating out of gas. For example, through direct engagement with manufacturers, the MTI will accelerate the introduction of affordable 120V battery-equipped induction cooking products. These innovative products offer a plug-and-play solution that eliminates the need for costly electrical infrastructure upgrades for homes transitioning from gas

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[18] CEC IEPR 2023 projects residential natural gas use to change from 4,446 million therms in 2023 to 4,437 million therms by 2040.

[19] CalMTA also reviewed cooking fuel consumption forecasts by Energy Information Agency's 2023 Annual Energy Outlook (EIA AEO 2023). The EIA AEO 2023 projects that natural gas use for residential cooking in the United States will remain at current levels in 2050.

[20] Fournier, E. D., Cudd, R., Smithies, S., & Pincetl, S. (2024). Quantifying the electric service panel capacities of California's residential buildings. *Energy Policy*, *192*, 114238. Retrieved October 24, 2024, from https://www.ioes.ucla.edu/wp-content/uploads/2024/06/2024-Quantifying-the-electric-service-panel-capacities-of-Californias-residential-properties.pdf.

[21] This estimate was developed by segmenting single-family homeowners with gas cooking appliances based on household income (above/below $100,000) and panel capacity (above/below 100 Amps). Using housing unit attributes from EIA RECS 2020 and panel capacity analysis from Fournier et al. (2024), CalMTA identified four segments: high-income with adequate panel capacity (1.1M households), low-income with adequate panel capacity (1.0M), high-income with inadequate panel capacity (1.1M), and low-income with inadequate panel capacity (1.5M). Assumed transition rates of 33%, 25%, 25%, and 12.5% respectively were applied to these segments. An additional market potential of 0.1M was included for rental units and rural households with low grid reliability, resulting in the total estimate of 1.2M households.

[22] Fournier et al. (2024) estimate that nearly 60% of multifamily housing units lack adequate electrical panel capacity for full electrification.

to electric appliances, and thus are expected to increase electric cooking product adoption. CalMTA will engage with consumers, builders and property managers to increase product awareness and adoption. Increased adoption is expected to lead to greater efficiencies in the supply chain leading to lower average prices. Consistent with the above interventions, CalMTA assumes that a greater proportion of households will transition to electric cooking in presence of the MTI

Figure 5 summarizes the above trends in the baseline scenario (BMA, solid line) and in presence of the MTI (TMA, dashed line) for both single-family and multifamily households.

Figure 5. Trends in gas appliance ownership, millions of households

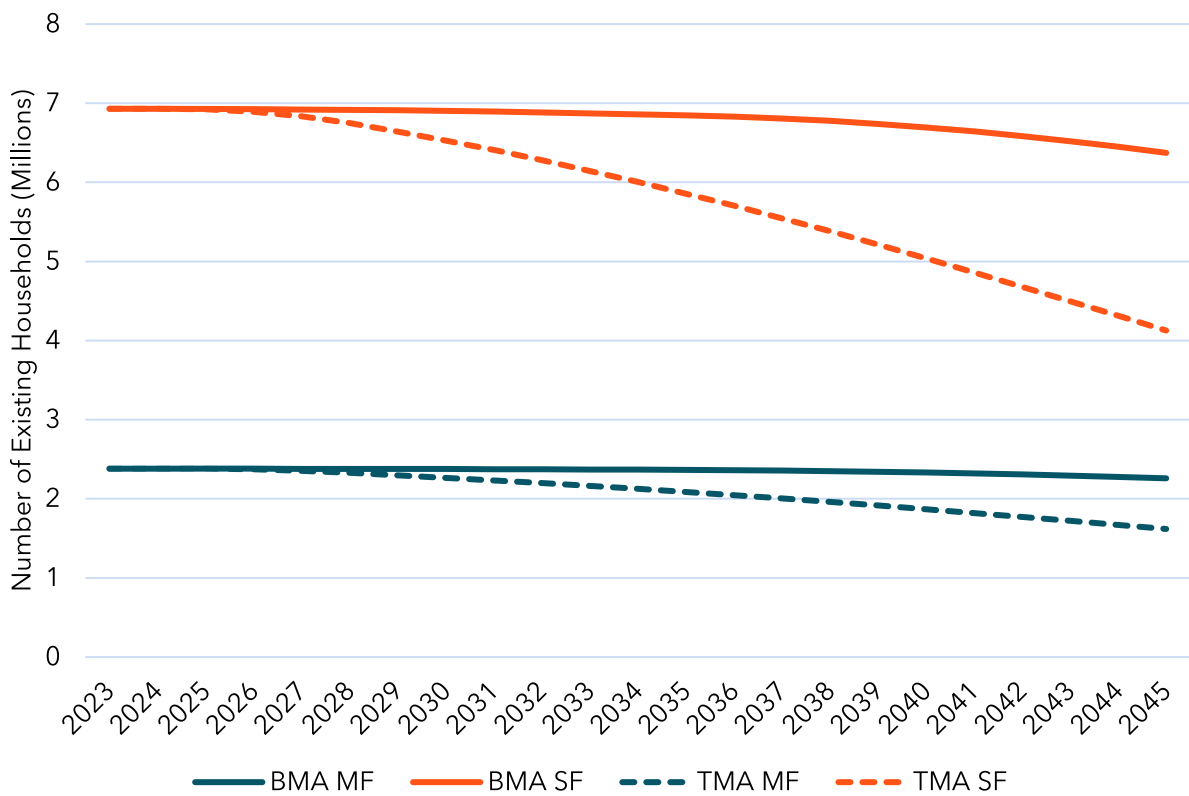


Table 11 presents our estimates of the number of households, disaggregated by household type, that will transition to electric cooking products.

Table 11. Number of existing households that will transition from gas to electric cooking appliances between 2024 and 2045 (thousands)

	Existing single-family households	Existing multifamily households
Baseline (BMA)	557 (8%)	122 (5%)
In presence of the MTI (TMA)	2,802 (40%)	761 (32%)

Source: CalMTA assumptions. Note: Figure in parentheses represents percentage of total gas cooking product owners by household type in 2023. Table captures both normal replacement as well as accelerated replacement.

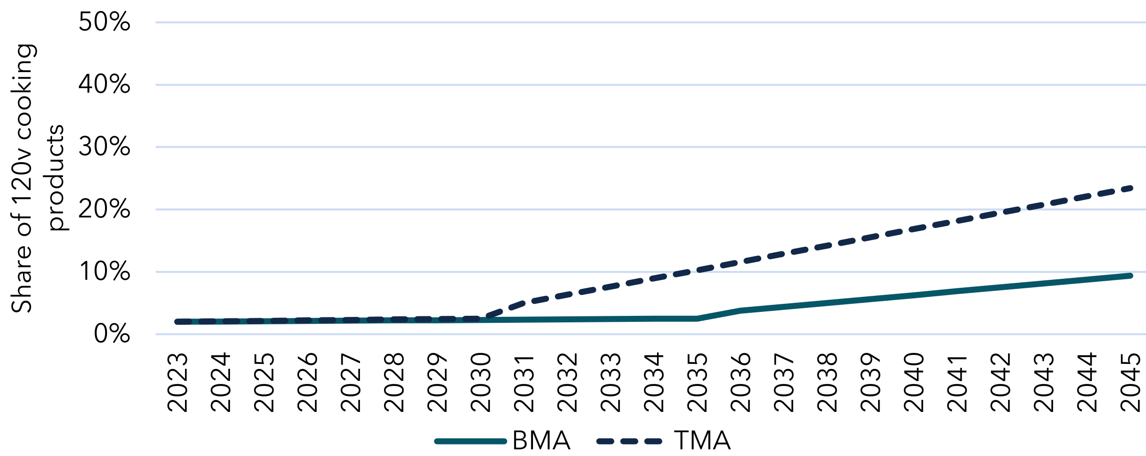
The tables indicates that both in baseline and TMA, a greater number of SF households will transition out of gas. This results directly from the greater share of gas among SF households in the baseline compared to FM households (80% versus 55% respectively), and also the larger number of SF households (8.3 versus 4.8 million).

Step 3: Choice between 120V and 240V cooking products

Figure 6 summarizes CalMTA's assumptions regarding the share of 120V battery-equipped in the market for electric cooking appliances among households transitioning from gas to electric. In other words, the figure reflects the proportion of these households that will adopt 120V products, both in the baseline scenario (solid line) and in the presence of the MTI (dashed line).

In the baseline forecast, CalMTA expects these products to be available through various retailers – both in-store and online – by 2035. The introduction of these products is anticipated to lead to an increase in demand in the following year, followed by a steady increase through 2050. In the presence of the MTI (TMA forecast), this product availability milestone occurs in 2028 rather than 2035 because CalMTA will engage with influential builders, remodelers, and property management firms to aggregate demand and catalyze the market. This is expected to motivate manufacturers to introduce more models, including an affordable 120V product by 2030, and to accelerate retail availability of products. These developments are expected to lead to an increase in demand for 120V products beginning in 2030.

Figure 6. Assumed trend in annual share of 120V induction in market for electric non-coil cooking products for retrofit in existing households



Note: Market includes 120V induction, 240V induction, and 240V electric radiant (both ENERGY STAR certified as well as non-certified). It is assumed that households transitioning from gas will not adopt coil electric.

Step 4: Choice between 240V induction or 240V radiant cooking products

CalMTA made assumptions for relative shares of induction and radiant among 240V electric cooking products (not including coil), guided by trends in share of induction in the European Union (EU) market. CalMTA expects that the California market will eventually follow the overall EU market, where around 40% of cooking products sold in 2018 were induction. In the presence of CalMTA interventions, it is anticipated that California will follow the pattern of countries like Germany, Finland, the Netherlands, France, Denmark, and Poland, where strong government support has led to a 50-80% market share of induction cooktops.[23]

Step 5: Choice between ENERGY STAR certification for 240V radiant cooking products

CalMTA made assumptions about the relative share of market adoption that would be ENERGY STAR certified radiant and non-certified radiant, based on experience with other appliances. CalMTA considered the share of ENERGY STAR products in the categories of residential clothes washers and dryers, as well as residential refrigerators, which have a market share between 45-60%. CalMTA also considered the market shares of residential dishwashers, dehumidifiers and air purifiers which have a market share of around 90% in the respective categories.[24] Based on the observations above, CalMTA assumed a market share of 75% for ENERGY STAR products in the

[23] Rodríguez Quintero, R., Bernad D., Donatello, S., Villanueva, A., Paraskevas, D., Boyano, A., Stamminger, R., Schmitz, A. Review study of Ecodesign and Energy Labelling for Cooking appliances – European Commission, Joint Research Centre, 2021. Retrieved October 24, 2024, from https://susproc.jrc.ec.europa.eu/product-bureau/sites/default/files/2021-04/EDEL_Cooking_appliances_ReviewStudy_2nddraft_corrected_April2021.pdf.

[24] https://www.energystar.gov/sites/default/files/2022%20Unit%20Shipment%20Data%20Summary%20Report.pdf.

market for 240V radiant cooking products for both the BMA and TMA forecasts. This share is expected to be reached by 2035 in both the BMA and TMA, with a linear interpolation between 2024 and 2035. The share is assumed to remain constant beyond 2035.

Based on assumptions in steps 3, 4, and 5, the relative shares of the four electric cooking technologies among households transitioning from gas in the baseline (BMA) and MTI scenario (TMA) are summarized in Figures 7 and 8. The BMA reflects considerable naturally occurring market adoption of radiant especially ENERGY STAR-certified radiant. It also reflects steadily increasing adoption of induction technologies, especially 240V induction, in part due to stimulation by Program Administration incentives. Compared to BMA, the share of induction technologies is expected to increase much faster in the presence of the MTI.

Figure 7. CalMTA-assumed relative shares of the four electric cooking products for retrofits in existing households (BMA)

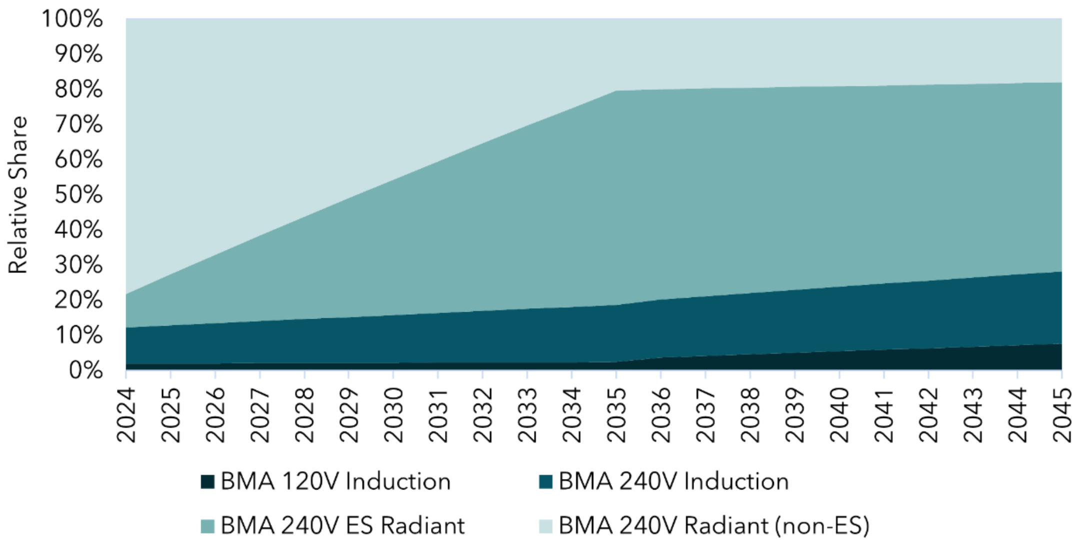
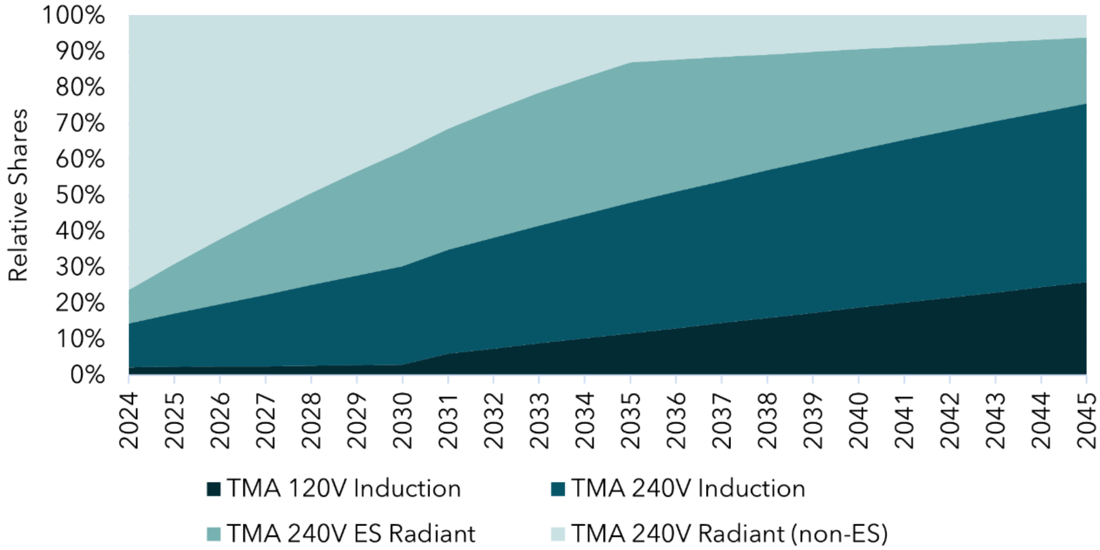


Figure 8. CalMTA-assumed relative shares of the four electric cooking products for retrofits in existing households (MTI scenario)



Note: Market includes 120V induction, 240V induction, and 240V electric radiant (both ENERGY STAR certified as well as non-certified). It is assumed that households transitioning from gas will not adopt coil electric.

Summary of adoption estimates

Table 12 on the following page summarizes cumulative adoption by segment S1 over the forecast period for the three cooking products covered in this MTI using the following three equations. Estimates are provided for both BMA and TMA and disaggregated for multifamily and single-family households:

$$Y_{S1}^{120V\_I} = \sum_{t=2024}^{2045} y_{t,S1}^{120V\_I} \qquad Y_{S1}^{I} = \sum_{t=2024}^{2045} y_{t,S1}^{I} \qquad Y_{S1}^{ESR} = \sum_{t=2024}^{2045} y_{t,S1}^{ESR}$$

For simplicity, we did not include the superscripts TMA and BMA in the above equations representing cumulative adoption.

Table 12. Adoption of the MTI products between 2024 and 2045 by households with gas-based cooking products appliances in the base year (thousands of cooking appliances)

	Existing single-family households		**Existing multifamily households**		**(Total) All households**	
	BMA	**TMA**	**BMA**	**TMA**	**BMA**	**TMA**
120V induction $Y_{S1}^{120V\_I}$	32	413	7	112	39	525
240V induction Y_{S1}^{I}	102	1,085	23	294	125	1,379
ENERGY STAR radiant Y_{S1}^{ESR}	303	819	66	222	370	1,041
Total Y_{S1}	**437**	**2,317**	**96**	**628**	**533**	**2,945**

Source: CalMTA estimates.

Adoption by existing households with coil-based cooking appliances

The methods to forecast adoption by this segment (S2) are summarized in Figure 9, which represents the sequence of decisions and actions taken by a household with a coil-based cooking appliance. For each decision point, two sets of assumptions were developed: one reflecting baseline market conditions and another incorporating the effects of the MTI.

Figure 9. Decision framework for households transitioning from coil-based cooking

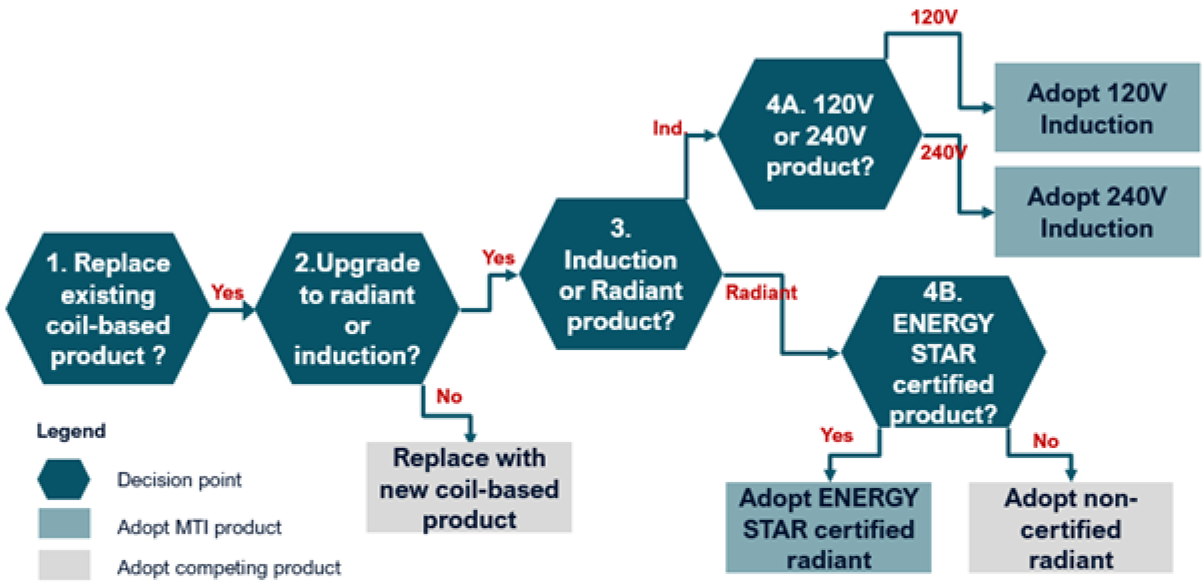


Table 13 summarizes the specific assumptions for each decision point and also provides a high-level overview of how the assumptions differ in presence of the MTI compared to the baseline scenario.

Table 13. Decision framework for households with coil-based cooking appliances

Step	Decision	Assumption	Impact of the MTI
#1	Replace coil-based appliance?	Proportion of households retiring their coil-based appliance.	CalMTA assumed normal replacement of existing equipment for both the baseline and MTI scenarios.
#2	Upgrade to induction or radiant? Or continue with coil?	Proportion of households transitioning away from coil-based cooking appliances.	A higher proportion of households will migrate to induction and radiant in the MTI scenario.
#3	If transitioning away from coil, should the appliance be induction or radiant?	Relative market shares of induction and radiant.	Higher share of induction given greater product awareness and product availability.
#4A	If adopting a radiant, should it be an ENERGY STAR certified or non-certified	Relative market shares of ENERGY STAR certified radiant and non-certified radiant.	CalMTA assumed that share of ENERGY STAR is similar in both baseline and in presence of the MTI.

Step	Decision	Assumption	Impact of the MTI
#4B	If adopting an induction product, should the appliance be 120V or 240V?	Relative market shares of 120V and 240V induction products.	Higher share of 120V products given greater product availability and lower costs relative to the baseline.

The steps above lead to estimates of annual adoption by segment S2 of the three MTI products covered in this MTI i.e. $y_{t,S2}^{120V\_I}$, $y_{t,S2}^{I}$ and $y_{t,S2}^{ESR}$.

Step 1: Replacement decision for existing coil-based cooking products

For retirement of existing coil-based cooking appliances in both baseline and in presence of the MTI, CalMTA considered the historical trends in retirement and replacement of such appliances as modeled by the DOE EERE 2022 study. As mentioned before, the DOE EERE 2022 used historical shipment and saturation data to develop a survival function that estimates the percentage of appliances of a given age that would still be in operation each year. The function captures retirement of equipment due to both product failure and early replacements from remodeling or upgrading. Based on these historical trends, such appliances have an average life of approximately 16.8 years.[25]

Step 2: Transition to induction or radiant cooking products

In this step, CalMTA made assumptions about the proportion of households transitioning away from coil products in any given year. Consistent with historical trends, we assume that coil-based cooking products will remain prevalent in the baseline scenario. Historical data from DOE EERE 2022 shows that coil-based cooking products have maintained a consistent 27% market share nationally between 1970 and 2020. This persistence can be attributed to their durability, ease of maintenance, and low cost, making them particularly attractive for rental properties and budget-conscious consumers. These factors are especially relevant in multifamily housing, where over 90% of units are rentals.

In the presence of the MTI, improved cost competitiveness of induction and electric radiant products will encourage more households to transition away from coil-based appliances. This transition is simplified by existing electrical infrastructure - households switching from coil to induction or radiant products can utilize their existing 240V plug points without requiring additional panel capacity upgrades.

[25] The DOE EERE 2022 study assumes that the survival function takes the form of a cumulative Weibull distribution. Based on historical data, the study estimated Weibull parameter values of 16.88 and 6.99 for scale and shape parameters respectively for both gas standalone cooktops and ranges giving an average age of 14.5 years.

Table 14 summarizes CalMTA's assumptions about the proportion of households with coil products in the base year who will transition to induction or radiant products by 2050.

Table 14. Proportion of existing households with coil products in the base year that will transition to induction or radiant products by 2050

	Existing single-family households	Existing multifamily households
Baseline (BMA)	33.3%	20.0%
In presence of the MTI (TMA)	50.0%	33.3%

Source: CalMTA assumptions based on secondary data review, market actor conversations and interviews conducted for the market characterization study.

Step 3: Choice between radiant or induction cooking products

CalMTA expects a limited uptake of induction cooking products among households that currently have coil-based cooking products, as this represents a substantial upgrade and hence a higher financial outlay than with radiant products. However, in the presence of the MTI, relatively more households are likely to adopt induction products than in the baseline due to increased product awareness and availability. Overall, CalMTA estimated that 10% and 20% of households will adopt induction products in the baseline and in presence of the MTI respectively, by 2050, with numbers increasing linearly in the intervening years. The remaining households transitioning away from coil products will likely adopt electric radiant products.

Step 4a: Choice of ENERGY STAR certified radiant cooking products

For households that choose to adopt electric radiant products, CalMTA assumed the same relative shares of radiant products that are ENERGY STAR certified (75%) and not ENERGY STAR certified (25%), as described previously for segment S1.

Step 4b: Choice between 120V or 240V induction cooking products

CalMTA does not anticipate the uptake of 120V induction products in households with electric coil cooktops, as they already have the electric infrastructure to support 240V. Additionally, a 120V battery-equipped induction cooktop would represent a higher financial outlay compared to a 240V product and would be significantly more expensive than a coil product, which the segment is transitioning from. The existing 240V infrastructure in these households makes the transition to 240V induction and radiant products more cost-competitive compared to scenario for households without electric technology.

Summary of adoption estimates

Table 15 on the following page summarizes cumulative adoption by segment S2 over the forecast period for the three cooking products covered in this MTI using the following three equations. Estimates are provided for both BMA and TMA and disaggregated for multifamily and single-family households.

$$Y_{S2}^{120V\_I} = \sum_{t=2024}^{2045} y_{t,S2}^{120V\_I} \qquad Y_{S2}^{I} = \sum_{t=2024}^{2045} y_{t,S2}^{I} \qquad Y_{S2}^{ESR} = \sum_{t=2024}^{2045} y_{t,S2}^{ESR}$$

The above equations representing cumulative adoption do not include the superscripts TMA and BMA for simplicity.

Table 15. Adoption of efficient cooking products by households that are forecasted to transition away from coil between 2024 and 2045 (thousands of cooking appliances)

	Existing single-family households		Existing multifamily households		All households	
	BMA	TMA	BMA	TMA	BMA	TMA
120V induction cooking products $Y_{S2}^{120V\_I}$	0	0	0	0	0	0
240V induction cooking products Y_{S2}^{I}	0	0	0	0	0	0
ENERGY STAR radiant cooking products Y_{S2}^{ESR}	57	105	66	107	123	211
Total	**57**	**105**	**66**	**107**	**123**	**211**

Source: CalMTA estimates.

Adoption by existing households with radiant and/or induction cooking appliances

The methods to forecast adoption by this segment (S3) are summarized in Figure 10, which represents the sequence of decisions and actions taken by a household with a radiant/induction cooking appliance. For each decision point, two sets of assumptions were developed: one reflecting baseline market conditions and another incorporating the effects of the MTI.

Figure 10. Decision framework for households with induction or radiant cooking

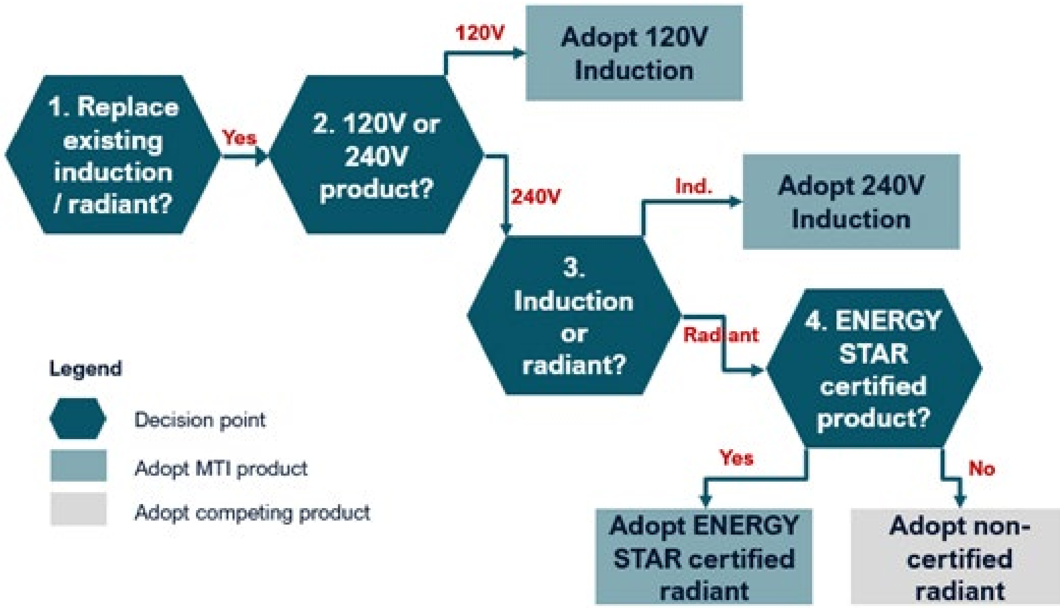


Table 16 summarizes the specific assumptions areas for each decision point and provides a high-level overview of how the assumptions differ in presence of the MTI compared to the baseline scenario.

Table 16. Decision framework for households with radiant or induction cooking appliances

Step	Decision	Assumption	Impact of the MTI
Step #1	Replace existing radiant or induction cooking product?	Proportion of households retiring their equipment.	CalMTA assumed normal replacement of existing equipment for both the baseline and MTI scenarios.
Step #2	If transitioning to electric, should the appliance be 120V or 240V?	Relative market shares of 120V products (120V battery-equipped induction) and 240V products (both radiant and induction).	Higher share of 120V products given greater product availability and lower costs relative to the baseline.
Step #3	If adopting a 240V product, should the appliance be an induction or a radiant?	Relative market shares of 240V induction and 240V radiant.	Higher share of induction given greater product awareness and product availability.
Step #4	If adopting a 240V radiant, should it be an ENERGY STAR certified or non-certified	Relative market shares of ENERGY STAR certified radiant and non-certified radiant.	CalMTA assumed that share of ENERGY STAR is similar in both baseline and in presence of the MTI.

The steps above lead to estimates of annual adoption by segment S3 of the three products covered in this MTI i.e. $y_{t,S3}^{120V\_I}$, $y_{t,S3}^{I}$ and $y_{t,S3}^{ESR}$.

Step 1: Replacement decision for existing radiant/induction cooking products

For retirement of existing electric cooking appliances in both the baseline scenario (BMA) and in presence of the MTI (TMA), CalMTA considered the historical trends in retirement and replacement of such appliances as modeled by the DOE EERE 2022 study. See prior section for further information.

Step 2: Choice between 120V or 240 induction or radiant cooking products

Households in this segment (S3) are expected to have 240V plug points as well as adequate panel capacity. Therefore, the value proposition of a 120V battery-equipped product is primarily limited to providing resiliency during grid outages. Given high costs as well as limited value proportion, we expect limited adoption of 120V products in the baseline scenario. In the presence of the MTI, high product availability as well as relative price competitiveness will induce households who value resiliency to adopt this product.

Step 3: Choice between 240V radiant or 240V induction cooking products

CalMTA assumed the same relative shares of 240V radiant and 240V induction cooking appliances for this segment as was assumed for segment S1 (households transitioning from gas to electric appliances).

Step 4: Choice of ENERGY STAR certified radiant cooking products

CalMTA assumed the same relative shares of ENERGY STAR certified radiant cooking appliances and non-certified radiant cooking appliances for this segment as for segment S1 segment S1.

Summary of adoption estimates

Table 17 summarizes cumulative adoption over the forecast period for the three cooking products covered in this MTI using the following three equations. Estimates are provided for both BMA and TMA and disaggregated for multifamily and single-family households:

$$Y_{S3}^{120V\_I} = \sum_{t=2024}^{2045} y_{t,S3}^{120V\_I} \qquad Y_{S3}^{I} = \sum_{t=2024}^{2045} y_{t,S3}^{I} \qquad Y_{S3}^{ESR} = \sum_{t=2024}^{2045} y_{t,S3}^{ESR}$$

For simplicity, we did not include the superscripts TMA and BMA in the above equations representing cumulative adoption.

Table 17 below provides the BMA and TMA for MTI products adopted by households with radiant/induction products for each MTI product type.

Table 17. Adoption of the MTI products between 2024 and 2045 by households with radiant/induction products in the base year (thousands of cooking appliances)

	Existing single-family households		Existing multifamily households		All households	
	BMA	TMA	BMA	TMA	BMA	TMA
120V induction $Y_{S3}^{120V\_I}$	0	72	14	55	14	127
240V induction Y_{S3}^{I}	232	602	178	463	410	1,065
ENERGY STAR radiant Y_{S3}^{ESR}	785	465	604	357	1,389	822
Total Y_{S3}	**1,017**	**1,138**	**796**	**875**	**1,813**	**2,013**

Source: CalMTA estimates. Note: Any differences in totals are due to rounding. PA verified units include adoption associated with PA programs statewide.

4.6 Adoption by newly built units

The methods to forecast adoption by this segment (S4)[26] are summarized in Figure 11, which represents the sequence of decisions and actions taken in newly built housing units. For each decision point, two sets of assumptions were developed: one reflecting baseline market conditions and another incorporating the effects of the MTI.

[26] CalMTA expects around 450,000 multifamily and 345,000 single-family new housing units to be built during the forecast period, based on data from California Department of Finance.

Figure 11. Decision framework for adoption of cooking appliances in newly built housing units

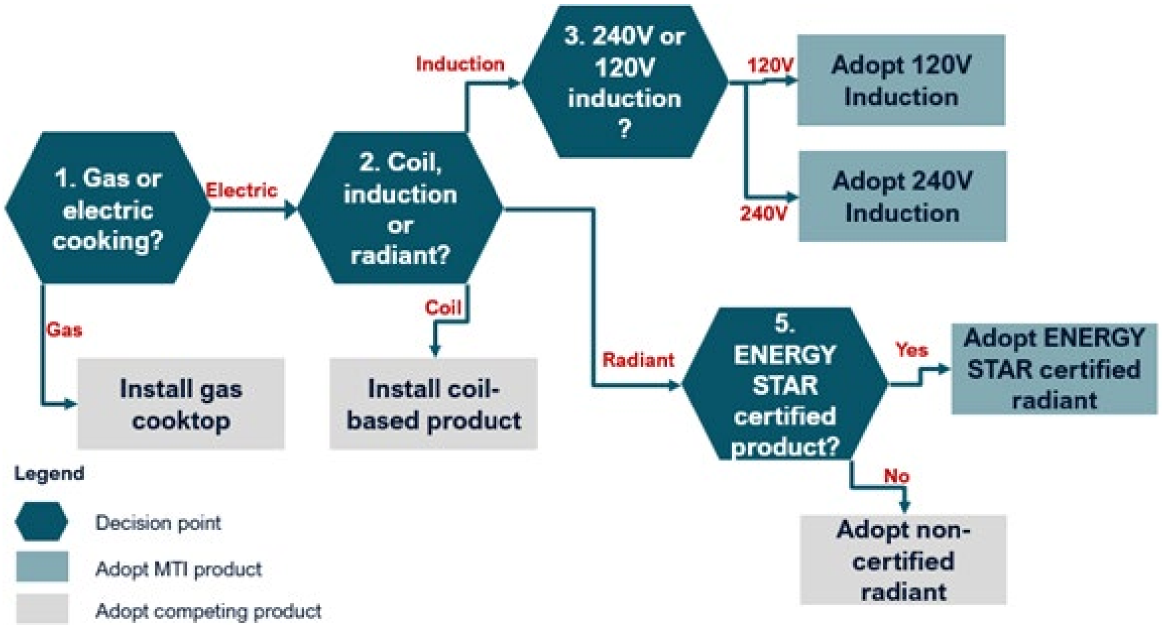


Table 18 on the following page summarizes the specific assumptions areas for each decision point and provides a high-level overview of how the assumptions differ in presence of the MTI compared to the baseline scenario.

Table 18. Decision framework for households in newly built housing units

Step	Decision	Assumption	Impact of the MTI
#1	Should newly built housing units have gas or electric cooking?	Relative market shares of electric and gas cooking appliances.	Higher share of electric cooking vis-a-vis gas. Accelerated timeline for achieving a higher share of electric cooking in newly built units.
#2	If adopting electric, decision between coil, induction and radiant.	Relative market shares of the three electric technologies in new construction.	Higher share of induction given greater product awareness and product availability.
#3A	If adopting a 240V radiant, should it be an ENERGY STAR certified or non-certified?	Relative market shares of ENERGY STAR certified radiant and non-certified radiant.	CalMTA assumed that share of ENERGY STAR is similar in both baseline and in presence of the MTI.
#3B	If adopting induction, should it be a 120V or 240V product?	Relative market shares of 120V induction and 240V induction.	Higher share of 120V products given greater product availability and lower costs relative to the baseline.

The steps above lead to estimates of annual adoption by segment S4 (newly built units) of the three cooktop technologies covered in this MTI i.e. $y_{t,S4}^{120V\_I}$, $y_{t,S4}^{I}$ and $y_{t,S4}^{ESR}$.

Step 1: Choice between electric or gas cooking products?

To forecast relative shares of electric and gas cooking products in the baseline scenario, CalMTA considered historical trends. Per EIA RECS 2020, less than 5% of single-family housing units built in the periods from 2000 to 2010 and 2010 to 2020 have electric cooking products. The corresponding percentages for multifamily housing units are 53% and 49% respectively. Per the CEC 2019 Residential Appliance Saturation Study (RASS), less than 27% of all housing units built between 2012 and 2019 have electric cooking products.[27]

CalMTA also considered recent regulatory developments supporting electrification in newly built units to make assumptions about the share of electric products in the residential new construction sector. This includes elimination of subsidies for both electric line extensions and natural gas line extensions for newly built units that use natural gas and/or propane in addition to electricity as was mentioned in prior section. These regulatory developments signal the likelihood for future regulatory actions which will lead to rapid and large-scale electrification in the new construction sector even in the absence of CalMTA.

[27] California Energy Commission. (2019). *2019 residential appliance saturation study*. Retrieved October 24, 2024, from https://www.energy.ca.gov/data-reports/surveys/2019-residential-appliance-saturation-study.

We anticipate that various CalMTA interventions will expedite this process. For example, CalMTA's initiatives to collaborate with builders and property managers to incorporate induction cooking products in some model homes and developments are expected to accelerate electrification trends. Additionally, efforts to raise consumer awareness of the health benefits associated with electric cooking products are likely to result in higher levels of electrification. Based on these factors, CalMTA made the following assumptions about the level of electrification in new construction shown in Table 19.

Table 19. Assumed share of electric cooking products in newly built units

	New single-family housing units		New multifamily housing units	
	BMA	**TMA**	**BMA**	**TMA**
Base year (2023)	15%	15%	55%	55%
2030	33%	50%	68%	75%
2045	75%	95%	85%	95%

Source: CalMTA assumptions.

Step 2: Choice between radiant or induction cooking products

For households that decide to install electric cooking products, CalMTA assumed that the relative shares of induction and radiant products in the new construction sector will mirror those for households re-adopting radiant or induction products in both the BMA and TMA scenarios (segment S3) with an additional assumption to account for the share of coil products. Given the high proportion of rental units among multifamily households, CalMTA assumed the share of coil products to be 20% for multifamily and 5% for single-family households in the base year. CalMTA assumed these shares will fall to 2.5% for multifamily and 1% for single-family by 2050.

Step 3a: Choice of ENERGY STAR certification for radiant cooking products

For households that decide to install electric radiant cooking products, CalMTA assumed that the relative shares of ENERGY STAR–certified and non-certified radiant products will be consistent with those in other segments for both the baseline and MTI scenarios (segments S1, S2, and S3).

Step 3b: Choice between 120V or 240V cooking products

For households that decide to install induction products, CalMTA assumed that the relative shares of 120V and 240V induction products will be the same as those among households re-adopting radiant or induction products in both the baseline and MTI scenarios (segment S3).

Summary of adoption estimates

Table 20 on the following page summarizes cumulative adoption by newly built units over the forecast period for the three cooking products covered in this MTI using the following three equations. Estimates are provided for both BMA and TMA and disaggregated for multifamily and single-family households.

$$Y_{S4}^{120V\_I} = \sum_{t=2024}^{2045} y_{t,S4}^{120V\_I} \qquad Y_{S4}^{I} = \sum_{t=2024}^{2045} y_{t,S4}^{I} \qquad Y_{S4}^{ESR} = \sum_{t=2024}^{2045} y_{t,S4}^{ESR}$$

For simplicity, CalMTA did not include the superscripts TMA and BMA in the above equations representing cumulative adoption.

Table 20. Adoption of efficient products in newly built housing units between 2024 and 2045 (thousands of cooking appliances)

	Newly built single-family units		Newly built multifamily units		All newly built units	
	BMA	**TMA**	**BMA**	**TMA**	**BMA**	**TMA**
120V induction $Y_{S4}^{120V\_I}$	0	9	4	17	4	26
240V induction Y_{S4}^{I}	22	78	54	142	76	221
ENERGY STAR radiant Y_{S4}^{ESR}	76	90	182	123	258	213
Total (Y_{S4})	**98**	**177**	**240**	**282**	**338**	**459**

Source: CalMTA estimates. Note: Any differences in totals are due to rounding.

4.7 Consolidated statewide adoption forecasts for California

Figure 12 illustrates the estimated adoption in terms of proportions for single-family (left) and multifamily households (right), while Figure 13 presents the adoption numbers in thousands of households.

Figure 12. Estimated proportion of households adopting induction and ENERGY STAR certified radiant cooking products

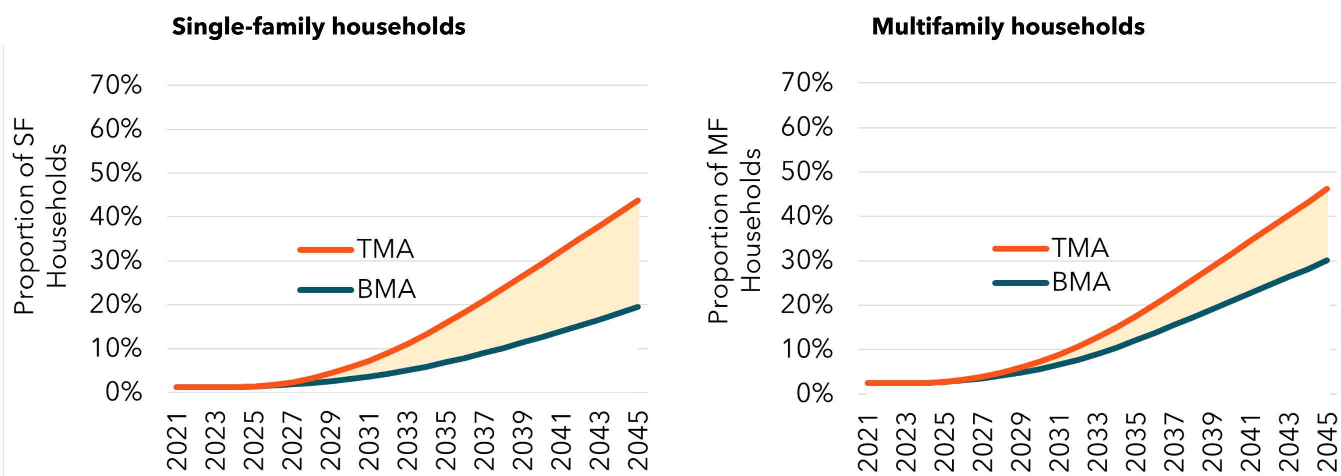
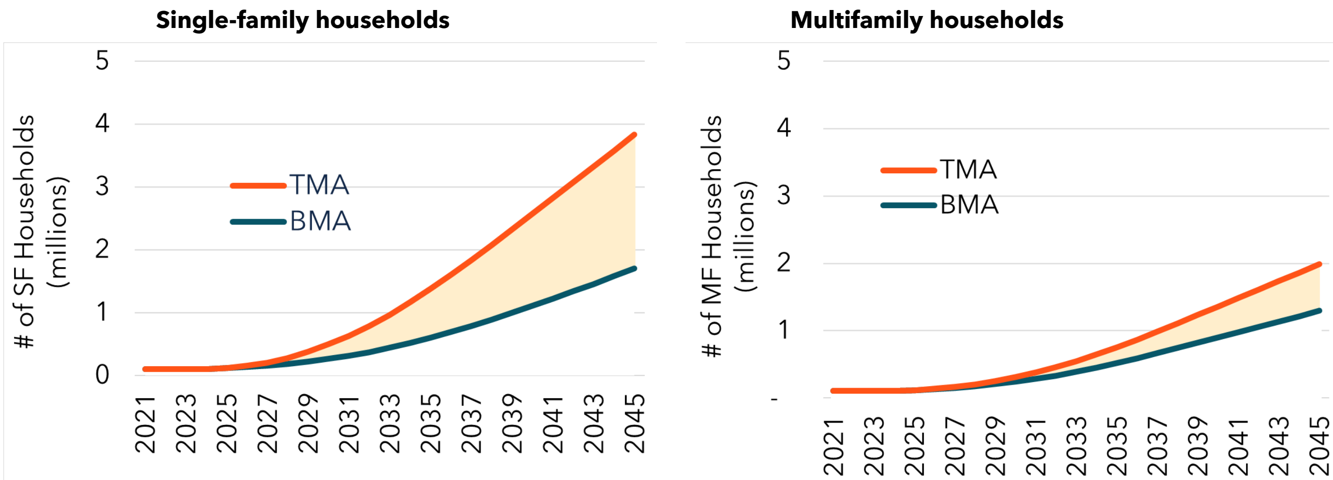


Figure 13. Estimated number of households adopting induction and ENERGY STAR certified radiant cooking products (in thousands)



The presence of the MTI is expected to lead to a substantial increase in the adoption of each efficient cooking technology. CalMTA forecasts that approximately 43% of single-family households and 35% of multifamily households will adopt induction or ENERGY STAR certified cooking products by 2045 in the presence of the MTI. For comparison, current saturation levels for these cooking products stands around 1% and 2% for single-family and multifamily households respectively.

Table 21 below summarizes the cumulative adoption of the MTI products disaggregated by the four population sub-segments. These key points are notable:

- 120V battery-equipped induction cooking appliances are projected to evolve significantly in presence of the MTI. While these products are estimated to represent a small fraction of total cumulative adoption in the baseline, the implementation of MTI interventions targeting increased product availability and reduced-price premiums is projected to drive substantial growth, resulting in a significantly larger share of total cumulative adoption during the forecast period than in the BMA scenario.
- The combined adoption of induction technology (both 120V and 240V) is estimated to demonstrate stronger market performance compared to traditional radiant cooktops. In the presence of the MTI, adoption of induction is projected to substantially outpace that of radiant across all household segments. This trend is similarly reflected in the baseline scenario, where combined induction adoption is estimated to surpass radiant adoption, indicating a market preference for and shift toward induction cooking technology.

Table 21. Adoption of MTI products by California's residential sector between 2024 and 2045 (thousands of cooking appliances)

	Single-family households		Multifamily households		New construction		All households	
	BMA	TMA	BMA	TMA	BMA	TMA	BMA	TMA
120V induction Y^{120V_I}	32	485	21	167	4	26	57	678
240V induction Y^{I}	334	1,687	201	757	76	221	611	2,665
ENERGY STAR radiant Y^{ESR}	1,145	1,388	737	686	258	213	2,140	2,287
Total Y	**1,511**	**3,559**	**958**	**1,610**	**338**	**459**	**2,808**	**5,629**

Source: CalMTA estimates. Note: Any differences in totals are due to rounding.

Table 22 summarizes the annual adoption of efficient MTI cooking products and the competing technologies under both the baseline and MTI scenario. In the presence of the MTI, the annual market share of induction and ENERGY STAR certified radiant cooking products, as a proportion of total category sales, is expected to reach around 41% by 2045. Comparatively, the share is expected to reach around 23% in the baseline by 2045.

Table 22. Annual adoption of cooking products by California's residential sector (thousands of cooking appliances)

Year	BMA			In presence of the MTI (TMA)		
	Annual adoption of MTI products	Annual adoption of other cooking products+	Market share of MTI products	Annual adoption of MTI products	Annual adoption of other cooking products+	Market share of MTI products
2025	25	952	3%	29	979	3%
2030	78	861	8%	176	873	17%
2035	155	801	16%	325	730	31%
2040	190	757	20%	376	653	37%
2045	207	685	23%	382	540	41%

Source: CalMTA estimates. Note: (+) includes gas, coil-based, and non-certified radiant cooking products.

4.8 Incremental impact

Per the attribution approach agreed upon in the MTI Evaluation Framework, net incremental adoption of MTI cooking products attributed to the market transformation efforts by CalMTA may be written as:

$$Y^{N.incremental} = Y^{TMA} - Y^{BMA} - Y^{PA}$$

Where Y represents cumulative adoption of room HPs over the forecast period of 2024 to 2045. The superscripts $N.incremental$, TMA, BMA, and PA represent net incremental adoption attributed to the MTI, TMA, BMA, and PA verified savings respectively.

This section details the approach to estimate units reported by PA initiatives and calculates the incremental adoption of efficient cooking products.

Estimating IOU vs. non-IOU units

Prior to estimating net incremental adoption, CalMTA considered adoption attributed to households in the service territories of IOUs offering electrical service: PG&E, SDG&E, and SCE. The approach summarized above estimated BMA and TMA at a statewide level. To estimate the proportion of adoption by households in the IOU service territories, CalMTA considered three options: (1) number of residential customers, (2) total electricity sales to the residential sector, and (3) revenues from residential electricity sales. Ultimately, CalMTA selected revenue-based allocation as it comprehensively captures both customer numbers and electricity consumption patterns while accounting for factors like pricing that influence cooking product adoption decisions. Based on EIA data, and accounting for both bundled and unbundled customers for the three IOUs, CalMTA allocated around 74% of incremental adoption to the IOUs, with the remaining 26% representing customers outside of the IOU service territories.[28]

Approach to estimating verified PA savings

For each of the three cooking technologies ($TECH$), adoption in year t attributed to PA verified savings may be expressed as:

$$y_t^{TECH,PA} = \rho_t^{TECH} \times (y_t^{TECH,TMA} - y_t^{TECH,BMA})$$

Where:

$TECH$:	Represents one of the three cooking technologies: 120V induction ($120v\_I$), 240V induction (I), and ENERGY STAR Radiation (ESR)
$y_t^{TECH,PA}$:	Number of units of type $TECH$ adopted in year t that may be attributed to PA verified savings claims.
ρ_t^{TECH} :	Fraction of the difference in adoption between TMA and BMA in year t that may be attributed to PAs. For simplicity, we assumed the same value of ρ for all three cooking technologies.

To forecast adoption associated with PA verified savings, CalMTA reviewed existing programs, program claims in CEDARs, IOU business plans, similar MT initiatives in other jurisdictions, and expected funding through IRA incentives. Based on these inputs, CalMTA made the following

[28] U.S. Energy Information Administration. (2023). *Residential Energy Consumption Survey: 2020*. Retrieved from https://www.eia.gov/consumption/residential/data/2020/.

assumptions about ρ_t (Table 23). The segmentation of the program cycle reflects the IOUs' business plan cycle and application cycle or four and eight years, respectively.

Table 23. Estimated PA-verified savings claimed as percentage of incremental adoption by existing households

MTI program years	Assumed ρ_t	Justification for assumption
2024-2027	7.5%	Resource Acquisition programs exist; limited program claims in CEDARs currently.
2028-2031	12.5%	By 2028, IOU programs are assumed to be more widely available, in part because of collaboration with the MTI, providing downstream and midstream incentives.
2032-2050	Decrease annually to 0% in 2045	CalMTA assumes that as the market matures and PA incentives are no longer necessary to drive adoption, the PA verified savings claims will decrease.

Source: CalMTA assumptions.

Table 24 summarizes the statewide TMA, BMA, RA-verified units, and net incremental adoption in terms of units of MTI cooking products adopted. The next-to-last column estimates adoption attributed to households outside the service territories of the IOUs. The final column provides adoption estimates included in the estimation of TSB and cost-effectiveness.

Table 24. Forecast of adoption of MTI cooking products (in thousands, 2024-2045)

	TMA (Y^{TMA})	BMA (Y^{BMA})	PA-verified units (Y^{PA})	Net incremental ($Y^{N.Incremental}$)	Adoption attributed to non-IOU territory	Adoption for TSB and CE estimation
Single-family households	3,559	1,151	124	1,924	492	1,433
Multifamily households	1,610	958	35	617	158	460
New construction	459	338	-	121	31	90
Total	**5,629**	**2,808**	**158**	**2,663**	**681**	**1,982**

Source: CalMTA estimates. Note: Any differences in totals are due to rounding.

4.9 Allocation to counterfactual conditions in the baseline

This section describes CalMTA's approach to allocate net incremental adoption to a set of counterfactual conditions in the absence of the MTI (the baseline modeling scenario). These conditions, henceforth referred to as "installation conditions," represent the combination of MTI technologies and the counterfactual cooking technologies that a household would have adopted in the absence of the MTI, as shown in Table 25. The per-unit savings calculations and cost-effectiveness analysis are conducted by installation conditions.

CalMTA categorized the installation conditions into three broad decision types:

- Adoption of induction or ENERGY STAR certified radiant cooktops with a counterfactual assumption of electric resistance coil or non-ENERGY STAR radiant cooktop or a gas cooktop.
- Adoption of induction or ENERGY STAR certified radiant range with a counterfactual assumption of electric resistance coil or non-ENERGY STAR radiant range or gas range.
- Adoption of 120V battery-equipped induction range with a counterfactual assumption of electric resistance coil or non-ENERGY STAR radiant range or gas range.

Table 25. Allocation of net incremental adoption of efficient cooking equipment to various modeled baseline equipment

Efficient equipment	Counterfactual equipment	Proportion of net incremental adoption
Induction or ENERGY STAR radiant cooktop	Electric resistance coil or non-ENERGY STAR radiant cooktop	1%
	Gas cooktop	12%
Induction or ENERGY STAR radiant range	Electric resistance coil or non-ENERGY STAR radiant range	5%
	Gas range	59%
120V battery-equipped induction range	Electric resistance coil or non-ENERGY STAR radiant range	5%
	Gas range	18%

Source: CalMTA estimates.

The team adopted the following assumptions and heuristics to assign incremental adoption to installation conditions:

For all four population segments: Compared to the baseline, any household in the market for an electric cooktop is more likely to purchase an induction or ENERGY STAR certified radiant product in the presence of the MTI because of increased product availability, more competitive pricing, and greater awareness of the benefits of induction. CalMTA assumed that these households would have purchased a non-certified radiant or coil-based cooking product in the baseline. In other words, CalMTA assigned them the installation condition of radiant/coil.

Additional assumptions for S1 and S4: CalMTA made the following additional assumptions specific to population segment S1 (households with gas cooking currently) and S4 (newly built units):

- Households that switch from gas to electric cooking appliances due to the MTI (differential transitions resulting from the MTI) are assumed to have adopted gas cooking in the baseline in absence of the MTI. Therefore, they are assigned to the installation condition of a gas cooking appliance regardless of the type of electric technology they adopt.
- Similarly, any new units adopting electric appliances instead of gas due to CalMTA interventions are assigned to the installation condition of a gas cooking product.

5 Cost-effectiveness analysis

Evaluating cost-effectiveness and determining the net incremental benefits for an MTI requires the appropriate application of net incremental adoption, initiative costs, IMC, avoided costs, load shapes, and unit energy savings (UES). This analysis considers the installation conditions (the combination of counterfactual and efficient technologies), fuel types, target sector, and costs incurred in MTI implementation. Attachment 2, which follows this document, provides additional details regarding the installation conditions and assumptions used to determine per unit savings for each of these conditions.

Currently, the California Energy Data and Reporting System's Cost-Effectiveness Tool (CET) is the official publicly available tool used to assess cost-effectiveness of energy efficiency programs in California. The CET is used for programs from all utilities and climate zones, using approved 8,760 load shapes and defined avoided costs. However, since the analysis for this MTI involved custom 8,760 load shapes not currently supported by CET-16, the team developed an in-house Excel-based cost-effectiveness tool which allowed for full insight into how the model generated outputs based on dynamic and varying inputs.

5.1 Modeling approach/methodology

The team took a systematic approach to developing the cost-effectiveness model, beginning with determining all the necessary model inputs and outputs for the MTI. The team calculated MTI cost-effectiveness based on six inputs: market adoption, UES, initiative costs, load shape, avoided costs, and IMC. The team developed each of these inputs using product and market definitions documented by the MTI team. For the Induction Cooking MTI, all per unit inputs were in terms of cooktops or ranges.

UEI inputs were analyzed by the three IOUs: PG&E, SCE, SDG&E. Consequently, each installation condition for any MTI had three sets of utility-specific UEIs. The model paired UEI inputs with an 8,760 hourly load shape appropriate for each MTI technology that estimated how likely an end user would use the equipment in any given hour of the year.

All inputs were applied on a yearly basis, over the equipment effective useful life (EUL) and Phases II and III of the MTI.

The analysis used these assumptions for the Induction Cooking MTI:

1) Phase II: 2 years (2024 to 2025)
2) Phase III: 20 years (2026 to 2045)
3) EUL: 16 years.

Input-specific assumptions are described in more detail in their related sections below.

There are four outputs for reporting on the MTI: TSB, TRC, PAC, and SCT, with SCT including two ratios for base SCC and high SCC. The team evaluated and aggregated the TSB for each MTI installation condition, respectively, to determine the MTI total TSB. A similar approach was adopted for TRC, PAC, and base SCT, and high SCT tests. To account for the time value of money, the team applied a discount rate of 7.30% (3% for base and high SCT) to discount benefits and incremental measure cost to first year of the MTI, in line with current guidance from the CPUC. Initiative costs were in real terms and therefore were not discounted. Table 26 lists the terms (based on the CET) used by the model to determine the TSB, TRC, PAC, and SCT ratios.

Table 26. Cost-effectiveness model parameters

Terms	Description	Units
Electric benefits	Net benefits generated through electric savings from the avoided cost calculator (ACC)	Dollars/kWh and Dollars/kW and associated GHG avoided costs
Gas benefits	Net benefits generated through gas savings from ACC	Dollars/therms and associated GHG avoided costs
Other benefits	Benefits generated through non-electric or gas savings. Stage 2 analysis incorporated refrigerant benefits only	Dollars per unit
Refrigerant benefits	Measure benefits generated through refrigerant savings	Dollars/unit (no refrigerant benefits for this MTI)
Electric supply cost	Costs incurred in the supply of electricity	Dollars/kWh; dollars/kW
Gas supply cost	Costs incurred in the supply of gas	Dollars/therms
Refrigerant costs	Costs incurred through refrigerant losses; stage 2 analysis incorporated refrigerant costs only	Dollars/Unit (no refrigerant costs in this MTI)
TRC costs	Costs associated with the TRC test	Dollars (initiative admin./marketing/evaluation and incremental measure costs)
PAC costs	Costs associated with the PAC test	Dollars (initiative admin./marketing/evaluation and flow-down incentives)

Terms	Description	Units
SCT costs	Costs associated with the SCT	Dollars (initiative admin./marketing/evaluation and incremental measure costs)

5.2 Inputs

MTI-driven adoption

The team applied MTI-driven incremental adoption allocated to each of three IOUs (PG&E, SCE, SDG&E) for the duration of the EUL of cooking equipment. For example, if 800 units were projected to be installed in 2027, these units would contribute to the model for 16 years (EUL for induction or ENERGY STAR certified radiant cooking equipment), combined with cooking equipment introduced in the following years.[29]

Initiative costs

Initiative costs are related to the implementation of the MTI. This includes costs, such as administration, research and evaluation, marketing, and other related costs. The team applied initiative costs from 2024 to 2045. The total initiative cost for the Induction Cooking MTI is approximately $37 million. Please refer to Appendix H: Phase III Cost Estimate for more details.

Initiative costs are used as inputs for all cost -effectiveness tests. However, while the PAC test includes all initiative costs, the TRC and SCT tests exclude incentive costs, although there are no planned FDIs for the Induction Cooking MTI.

Incremental measure cost

The team conducted secondary research to develop estimates of incremental costs, researching currently available counterfactual and proposed energy-efficient technology products. Products included electric resistance, coil, ENERGY STAR certified radiant, induction, gas burner, and induction with battery backup, cooktops and ranges (see Table 24 for further details). Product costs were sourced from California retail locations, including The Home Depot and Lowe's. Additionally, CalMTA incorporated the projected cost of upgrading a kitchen outlet to support a 240V ES Radiant or Induction Cooktop or Range where the previous baseline equipment was gas. Per eTRM, this is assumed to be $131 per installation.[30]

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[29] The MT theory for the Induction Cooking MTI assumes an increase in the demand for induction cooking products and that interventions will encourage households to replace their gas cooking products with electric cooking products earlier than the appliances' expected end-of-life. The incremental market adoption includes equipment adopted under both an end-of life, and before end-of-life scenario. The annual adoption associated with early replacement represent units at different stages of their lifetime and have different values of remaining useful life. To reduce complexity in the cost-effectiveness modeling, CalMTA did not use the dual baseline approach to model impacts for these measures and instead treated them as part of normal replacement in terms of baseline equipment assumptions.

[30] https://www.caetrm.com/measure/SWAP013/03/.

The team developed a median price estimate for each efficient and counterfactual equipment case across the range of products researched. For installation cases which included both induction and ENERGY STAR radiant products, CalMTA did not use a simple median, but rather weighted the price of each technology to match the share of that product adopted in each year.

In one of the installation conditions, the equipment cost of the proposed technology was lower than the counterfactual equipment it replaces. The cost research found that gas cooktops were more expensive than ENERGY STAR certified radiant or induction cooktops. Table 27 lists the first-year incremental costs used in this analysis.

Table 27. First year incremental measure costs

Segment	Counterfactual equipment	Efficient equipment	Decision type	First-year IMC
Multi-/single-family	Electric resistance coil or non-ENERGY STAR radiant cooktop	Induction or ENERGY STAR radiant cooktop	NR & NC	$503
Multi-/ single-family	Gas burner cooktop	Induction or ENERGY STAR radiant cooktop	NR & NC	$53
Multi-/ single-family	Electric resistance coil or non-ENERGY STAR radiant range	Induction or ENERGY STAR radiant range	NR & NC	$388
Multi-/ single-family	Gas burner range	Induction or ENERGY STAR radiant range	NR & NC	$450
Multi-/ single-family	Electric resistance coil or non-ENERGY STAR radiant cooktop	Induction range with battery	NR & NC	$3,631
Multi-/ single-family	Gas burner range	Induction range with battery	NR & NC	$3,563

Source: CalMTA estimates. Abbreviations used in the table: NR = normal replacement, NC = new construction.

The team included IMCs in the TRC test, along with non-FDI costs for each year and installation condition. In line with CPUC guidance, IMCs in the TRC test are discounted to the first year of the initiative to determine the present value of future incremental costs.

Trends in incremental measure costs

CalMTA adopted price trends estimated in an analysis of the nationwide impact of ENERGY STAR specifications for cooktops (DOE EERE 2023).[31]

[31] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program. (2022). Technical support document: Energy efficiency program for consumer products and commercial and industrial equipment: Consumer conventional cooking products. Retrieved October 24, 2024, from https://www.regulations.gov/document/EERE-2014-BT-STD-0005-0090.

The DOE study employed the "learning curve" approach to model historical price trends and forecast likely trends from 2025 to 2055. The learning curve, or experience curve, approach is based on the idea that as production volume increases, the cost per unit decreases due to efficiencies and learning over time. This method captures how cumulative experience and improvements in processes lead to cost reductions. In essence, the learning curve quantifies the rate at which costs decline (learning rate) as a function of increased production, often represented as a percentage reduction for each doubling of cumulative output (learning rate). In the DOE study, a fixed industry average markup is applied to these cost reductions to estimate the corresponding price trends for cooking appliances.

The learning curve posits that the cost of producing a product in any given year t may be written as:

$$p_t = p_o X_t^{-b}$$

Where:

p_t : Cost of producing the product in time t
p_0 : Cost of producing the product in the year of introduction when $t = 0$
X_t : Cumulative production (or shipments) of the product in year t
b : Learning rate parameter.

The learning rate parameter in turn is related to learning rate LR in the following way:

$$LR = 1 - 2^{-b}$$

Where the learning rate LR represents the percentage reduction in cost with each doubling of cumulative production. The DOE report estimated the learning rate for cooking products based on shipment and price data spanning 50 years, from 1970 to 2020.

The EIA methodology for annual energy outlook assumes that the maturity of a product influences its learning rate, categorizing products as revolutionary, evolutionary, or mature. Initially, a new product exhibits a high learning rate (revolutionary), which diminishes over time as it approaches a lower, mature learning rate.[32]

The DOE EERE 2023 report estimates three separate learning rates. The default rate considers all available shipment and pricing data. A high learning rate considers price and shipment trends during the early part of product introduction (revolutionary phase). Finally, a low learning rate considers the mature stages of product diffusion. Selection of the three stages involves subjectivity and analyst discretion.

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[32] Assumptions to the Annual Energy Outlook 2022: Electricity Market Module (eia.gov).

CalMTA applied a high learning rate for 240V induction due to relatively early stage of product introduction and limited product adoption,. For ENERGY STAR certified radiant products, a default (medium) learning rate was used. A low learning rate was applied to other technologies, including coil, gas, and non-ENERGY STAR certified radiant products, given their maturity and significant cumulative adoption over the last several decades.

For price trends of the 120V product, CalMTA considered a blended price of 24" and 30" products.[33] The blended price is expected to go from around $4611 in 2024 to $2,500 in 2031. CalMTA additionally assumed that price of the 120V product will decline to 1.25 times the price of 240V induction products by 2045, with linear interpolation used in the intervening periods.

Table 28 includes the assumed price trends for 2035 and to 2045.

Table 28. Assumed trends in prices of cooking products

Equipment			**Price in Base Year (2024)**	**Price in 2045**
	Range	**Cooktop**	**Range**	**Cooktop**
240V induction range	$1,799	$1,381	$1,426	$1,095
ENERGY STAR radiant range	$1,199	$1,199	$1,031	$1,031
Coil	$819	$369	$759	$342
Gas	$1,049	$1,329	$990	$1,254
Non-ENERGY STAR radiant range	$1,099	$1,024	$1,019	$949
120V induction with battery	$4,612	$-	$1,783	-

Note: (+) The value represents the percentage decrease in the price of the product from 2024 to 2035 and 2045 respectively.

Avoided costs

Avoided costs are defined as the marginal costs of energy that the state would avoid in any given hour through lower energy consumption. Electric avoided costs include cap and trade, GHG adder, GHG rebalancing, energy, generation capacity, transmission capacity, distribution capacity, ancillary services, losses, and methane leakage. Gas avoided costs include transmission and distribution, commodity, nitrogen oxides, carbon dioxide, and methane leakage.

The team developed avoided costs using the E3 2024 ACC for PG&E, SCE, and SDG&E. CalMTA developed avoided costs from 2024 to 2054 in each IOU's territory. For years after 2054, the model used 2054 avoided costs to ensure measurement of savings during the full life cycle of

[33] For the base year, CalMTA assumed a price of $5,999 for the 30" product based on current retail price of Copper's 30" range, and $3,000 for the 24" product as quoted by Copper to the NYC Housing Authority https://heatmap.news/sparks/nycha-induction-stoves-copper. Assumes adoption of 24" units by MF households and 30" units by SF households.

each measure. [34]The team used these avoided costs to determine the TSB, as well as TRC and PAC ratios. The team applied avoided costs to the incremental adoption for PG&E, SCE, SDG&E, for each installation condition in each year. The team aggregated and discounted these benefits to determine the MTI TSB in 2024 dollars.

While the methodology of calculating unit impacts was identical for TRC, PAC, base SCT, and high SCT, SCT analysis required additional factors to be considered in the avoided costs. These factors include:

1) Social cost of carbon (SCC)
2) Base SCC (50th percentile of possible climate impacts)
3) High SCC (95th percentile of possible climate impacts)
4) Base value of methane leakage: 2.3% of gas consumption
5) Statewide air quality adder: $14/MWh
6) Societal test-specific discount rate: 3%

The ACC incorporates these societal benefits in their avoided costs. The team applied the base and high SCT specific avoided costs to the incremental adoption for PG&E, SCE, and SDG&E. Like the TRC and PAC analyses, the team aggregated and discounted these benefits to determine the base and high SCT TSB in 2024 dollars.

Load shape

A load shape is defined as the hourly probability of activity for cooking equipment based on a set of variables including equipment runtimes, operating characteristics, and other factors, such as occupancy patterns. General cooking load shapes were utilized from the DEER database for this measure. A detailed description on the load shape used for this analysis can be found in Attachment 2 following this document.

Unit energy savings

To determine the unit energy savings, estimates were developed through a set of energy models comparing different base and efficient cases for each climate zone. A detailed description of these models and their supporting assumptions can be found in Attachment 2 following this document. Table 29 provides electrical (kWh) and gas (therms) savings by segment, baseline installation condition, decision type, and IOU. Under certain installation conditions average annual electric savings are negative as gas equipment is replaced with electric equipment resulting in additional electric consumption.

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[34] The 2024 ACC workbook includes avoided costs through 2054. Equipment with an EUL of 16 years, adopted after 2039 will accrue savings beyond 2054.

Table 29. Unit energy savings

Segment	Counterfactual equipment	Efficient equipment	Decision type	Average annual electric savings (kWh)	Average annual gas savings (therms)
Multi-/ single-family	Electric resistance coil or non-ENERGY STAR radiant cooktop	Induction or ENERGY STAR radiant cooktop	NR & NC	14.9	0
Multi-/ single-family	Gas burner cooktop	Induction or ENERGY STAR radiant cooktop	NR & NC	(192.36)	15.8
Multi-/ single-family	Electric resistance coil or non-ENERGY STAR radiant range	Induction or ENERGY STAR radiant range	NR & NC	14.89	0
Multi-/ single-family	Gas burner range	Induction or ENERGY STAR radiant range	NR & NC	(528.97)	35.53
Multi-/ single-family	Electric resistance coil or non-ENERGY STAR radiant range	Induction range with battery	NR & NC	(78.45)	0
Multi-/ single-family	Gas burner range	Induction range with battery	NR & NC	(622.32)	35.53

Source: CalMTA estimates. Abbreviations used in the table: NR = normal replacement, NC = new construction.

5.3 Outputs

Total System Benefit

TSB is a function of the inputs described in earlier sections. For the Induction Cooking MTI, the team disaggregated the total TSB into three components: energy, grid, and GHG benefits (categorized as refrigerant and non-refrigerant). The team used the following CET-based formula to determine TSB:

$$(Electric\ Benefits + Gas\ Benefits + \ Refrigerant\ Benefits)$$
$$-\ (Electric\ Supply\ Cost + Gas\ Supply\ Cost + \ Refrigerant\ Costs)$$

Total Resource Cost

The TRC test compares the life cycle benefits that the MTI will deliver to the costs associated with achieving those benefits from the perspective of the MTI administrator and the participant. Net benefits, initiative costs (not including FDIs), and IMC are used to determine TRC. The non-FDI initiative costs are summed together with the IMC and discounted over the period of the MTI's implementation. The discounted net life cycle benefits for all installation conditions are divided by the sum of the discounted IMC and non-FDI initiative costs to determine the MTI TRC ratio. Below is the CET-based formula used by the tool to determine TRC.

$$(Electric\ Benefits\ +\ Gas\ Benefits\ +\ Other\ Benefits)\ /\ TRC\ Cost$$

Program Administrator Cost

The PAC test compares the life cycle benefits that the MTI will deliver to the costs associated with achieving those benefits from the perspective of the MTI administrator. Net benefits and Initiative costs (including FDIs) are used to determine PAC. The initiative costs are discounted over the lifetime of the MTI's implementation. The discounted net life cycle benefits for all installation conditions are divided by the sum of the initiative costs to determine the MTI PAC ratio. Below is the CET-based formula used by the tool to determine PAC.

$$(Electric\ Benefits\ +\ Gas\ Benefits\ +\ Other\ Benefits)\ /\ PAC\ Cost$$

Societal Cost Test

The SCT compares the life cycle benefits the MTI will deliver to the costs associated with achieving those benefits from the perspective of California as a whole. Net benefits, initiative costs (not including FDIs), and IMC are used to determine TRC. The non-FDI initiative costs are summed together with the IMC and discounted over the period of the MTI's implementation. The discounted net life cycle benefits for all installation conditions are divided by the sum of the respective discounted IMC and non-FDI Initiative costs to determine the MTI SCT ratio. Below is the formula used by the tool to determine the base SCT Ratio.

$$(Base\ SCT\ Electric\ Benefits\ +\ Base\ SCT\ Gas\ Benefits\ +\ Other\ Benefits)\ /\ SCT\ Cost$$

Below is the formula used by the tool to determine the high SCT ratio.

$$(High\ SCT\ Electric\ Benefits\ +\ High\ SCT\ Gas\ Benefits\ +\ Other\ Benefits)\ /\ SCT\ Cost$$

Results

Total System Benefit

Table 30 shows the TSB estimates disaggregated for energy, grid, and GHG impacts.

Table 30. TRC, PAC, base SCT, and high SCT TSB estimates, 2024-2045

MTI approach	TSB ($M)	Energy ($M)	Grid ($M)	GHG non-refrigerant ($M)	GHG refrigerant ($M)
TRC (standard)	537	36	(125)	626	n/a
SCT base	2,328	90	(295)	2,533	n/a
SCT high	2,325	89	(277)	2,513	n/a

Source: CalMTA estimates.

The Induction Cooking MTI will generate approximately $537 million in TSB using TRC assumptions. The largest share of the benefit can be attributed to mitigated non-refrigerant GHG emissions, with an estimated $626 million in TSB. Energy benefits driven by savings related to electricity and natural gas reductions generate nearly $36 million in lifetime TSB. SCT-based TSB shows substantially higher benefits, largely driven by smaller overall discount rates and greater benefits attributed to GHG emissions reductions. In both SCT TSB approaches, the contribution of GHG benefits to overall TSB is significantly greater than it is under that standard TRC-based approach. The primary driver in the difference in TSB between standard and base and high SCT is the significantly lower discount rate and the added benefits attributed to greenhouse gas reductions. The SCT discount rate of 3% affords greater value to benefits accrued in the latter years of the MTI.

Cost-Effectiveness Ratios

Table 31 provides the cost-effectiveness estimates for the MTI over the period 2024-2045.

Table 31. MTI cost-effectiveness estimates, 2024-2045

TRC	PAC	Base SCT	High SCT
1.12	14.36	3.04	3.04

Source: CalMTA estimates.

Table 32 provides the schedule of TSB and cost-effectiveness estimates for the Induction Cooking MTI.

Table 32. Cost-effectiveness schedule

Forecast metric	2030	2035	2045
TSB	$34M	$142M	$537M
TRC ratio	0.29	0.56	1.12
PAC ratio	1.04	3.90	14.36
Estimated incremental investment required	$33 M	$3M	$1M
Approximate break-even year for TRC: 2042			

Source: CalMTA estimates.

Co-created and statewide TSB

- **Co-created TSB:** Co-created impacts refer to the total impacts (including utility-reported savings) influenced by the MTI. CalMTA estimated market adoption associated with verified savings from PA initiatives (described in the section above, *Approach to estimating verified RA savings*) and subtracted it from incremental market adoption to calculate net incremental adoption for each year of the forecasting period in accordance with guidance in the MTI Evaluation Framework. While the TSB reported in this plan was calculated applying net incremental adoption, CalMTA conducted an additional analysis to estimate "co-created" TSB that included adoption from PA-verified programs, for the three IOUs and on a statewide basis as shown in Table 33.

  Statewide TSB: The Induction Cooking MTI is a California-wide effort. Because avoided costs for PG&E, SCE, and SDG&E do not fully represent the entire state, CalMTA conducted an additional analysis to estimate statewide TSB. The team developed adoption estimates for "non-IOU" territories (described in the section above Estimating IOU vs. non-IOU units) and developed avoided costs for non-IOU adoption by applying population-weighted average avoided costs for the three utilities. The resulting Statewide TSB estimates are shown in Table 33.

Table 33. Co-created and statewide TSB

Scenario	TSB	TRC
Co-created TSB (IOU service territory only)	$ 567M	N.A.[a]
Statewide TSB (excluding PA verified savings)	$722M	1.14
Co-created Statewide TSB	$ 761M	N.A.[a]

[a] Note: CalMTA did not calculate TRC for scenarios that include impacts from IOU verified adoption, because we did not estimate IOU program costs.

Attachment 1: Delphi panel methods and findings

This attachment details the methodology and findings of the Delphi panel conducted by CalMTA to inform the Baseline Market Adoption (BMA) forecast for induction and ENERGY STAR certified cooking products in the California residential sector. This sector includes existing single-family and multifamily households, as well as residential new construction. Panelists, selected for their expertise in California's energy efficiency programs and appliance markets, provided adoption forecasts based on market conditions, technological advancements, and regulatory trends. CalMTA analyzed the panelists' qualitative and quantitative inputs to inform assumptions and parameters within the BMA forecast.

Methodology

Recruitment: Criteria and qualifications

CalMTA selected candidates based on three criteria: knowledge of California energy efficiency programs, knowledge of residential appliance markets in California, and experience with similar market transformation efforts outside California. Candidates were expected to satisfy at least one criterion. To construct a panel that encompassed a range of perspectives while mitigating the risk of bias from any one organizational type, CalMTA recruited panel members from three categories: manufacturers or trade groups; subject matter experts (SMEs) from universities, Department of Energy (DOE) labs, or nonprofits; and utility and Regional Energy Network (REN) program managers (PMs). Ten candidates accepted invitations to participate; however, three panelists dropped out prior to the study, and two others failed to complete Round #2, leaving a final composition of five panelists who completed both rounds (see Table 1).

Table 1. Composition of Delphi Panel

	Manufacturers	SMEs	Utility/REN PMs
Number of panelists	1	3	1

For their time and effort, each panelist was offered a $500 gift card for participating in two rounds of forecasting. Panelists could accept, decline, or elect to donate their compensation to a charity of their choosing.

Confidentiality

To ensure the flow of ideas and mitigate the risk of cognitive biases based on groupthink and perceived pressure to change one's opinions, CalMTA maintained confidentiality throughout the process. Data presented for analysis and reporting could not be linked to any panelist.

The Delphi Panel process

The Delphi panel consisted of two rounds. In Round #1, panelists received a survey link that contained two sections: background information and forecasting. In Round #2, panelists were provided with the forecast from the first round and asked to reassess their initial responses based on the group's forecasts and rationales.

Background information

To help guide panelists in generating their market adoption forecasts, CalMTA provided background information that focused on technology description, the regulatory landscape, the state of the market today, technology trends, and key market players.

Round #1 panel forecasts

Panelists were asked to consider the background information along with any additional insights they had based on their experiences in the field to provide their forecast of naturally occurring (i.e., without CalMTA interventions) market adoption for induction and ENERGY STAR certified electric radiant cooking appliances in California households. Panelists estimated the proportion of households that they believed would have an induction or ENERGY STAR certified electric radiant cooking product installed in their home starting in 2025 and then every five years through 2050. Panelists were asked to provide forecasts for single-family and multifamily households separately and to include a brief explanation of the factors that influenced their decisions. Panelists were then asked to forecast the maximum market potential (defined as the proportion of households that would ultimately adopt each technology) for both single-family and multifamily segments. For each housing type, panelists provided separate adoption forecasts for induction cooktops and ENERGY STAR certified electric radiant cooktops.

Over the course of approximately two weeks, panelists turned in their forecasts. CalMTA collected, reviewed, aggregated, and summarized the data in a report that presented the anonymized Round #1 forecasts and qualitative rationale from all panelists to use in Round #2.

Round #2 panel forecasts

In Round #2, CalMTA provided each panelist with their own Round #1 forecast and the anonymized Round #1 forecasts and qualitative rationale from all panelists. The panelists then had the option to submit revised forecasts for adoption up to 2050 and the maximum market potential, if desired, along with additional rationale for their Round #2 estimates.

Delphi Panel findings

This section describes the quantitative analysis for Round #2 forecasts for both induction and ENERGY STAR certified electric cooking products across single-family, multifamily, and new construction segments. We present the median and ranges of scores for 2050 projections and market potential. Adoption rates for each technology varied substantially depending on housing segment.

For single-family housing, panelists projected higher saturation for induction than for ENERGY STAR certified electric radiant cooking products. The median for induction was 40% with a range of 20% to 56%, with four panelists at or above 40% (Figure 1). The median for ENERGY STAR certified electric radiant cooking products was 15% with a range of 4% to 20% (Figure 2).

Figure 1. Forecast of adoption of induction by existing single-family households (saturation)

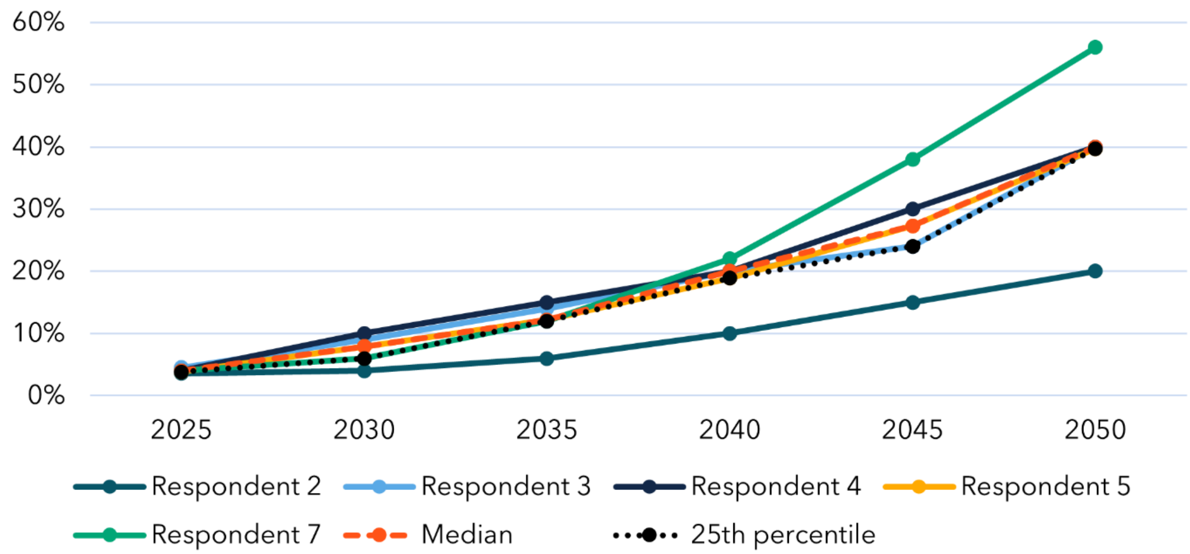
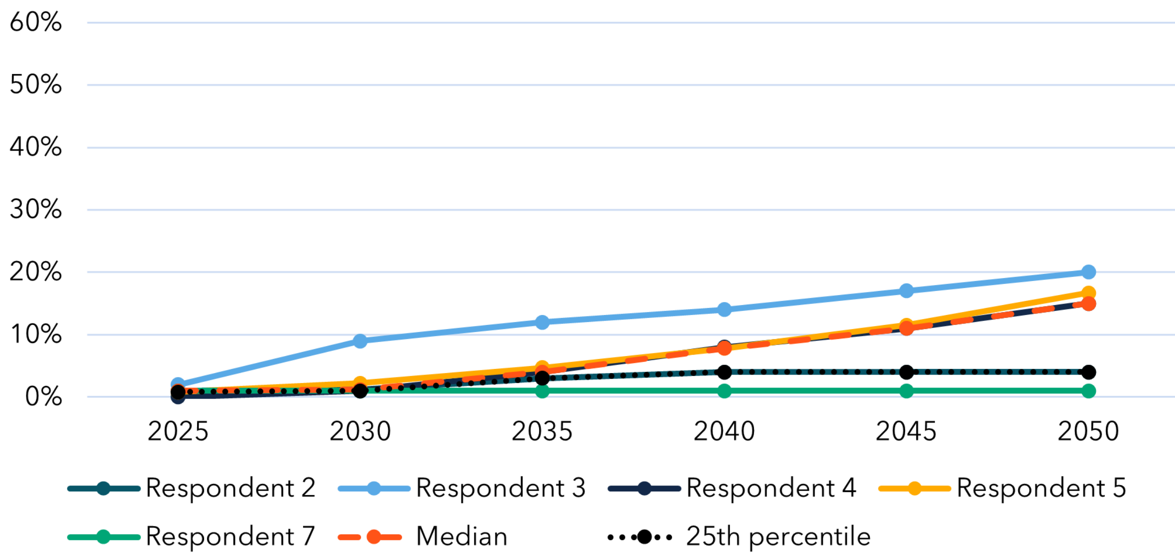


Figure 2. Forecast of adoption of electric radiant by existing single-family households (saturation)



For multifamily housing, projections flipped. Among single-family households, induction was predicted to be more popular; however, in multifamily housing, ENERGY STAR certified electric radiant cooking products were predicted to be slightly more popular than induction. The median for ENERGY STAR certified electric radiant cooking products was 25% with a range of 5% to 26%, of which three panelists projected 2050 values between 25% to 26% (Figure 3). Conversely, the median for induction was 18% with a range of 10% to 45%, of which three panelists projected 2050 medians under 20% (Figure 4).

Figure 3. Forecast of adoption of electric radiant by existing multifamily households (saturation)

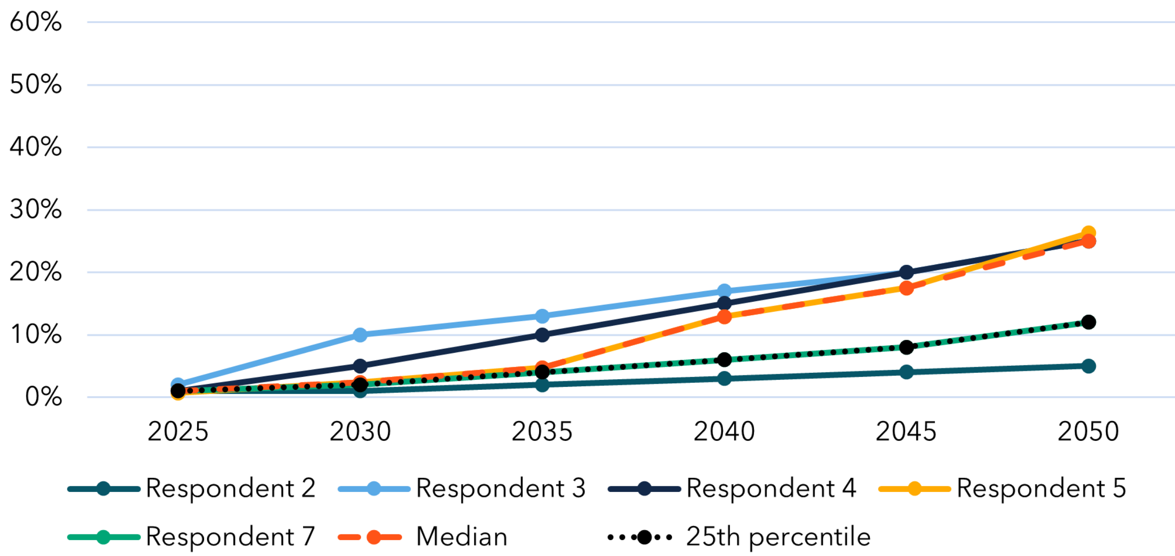
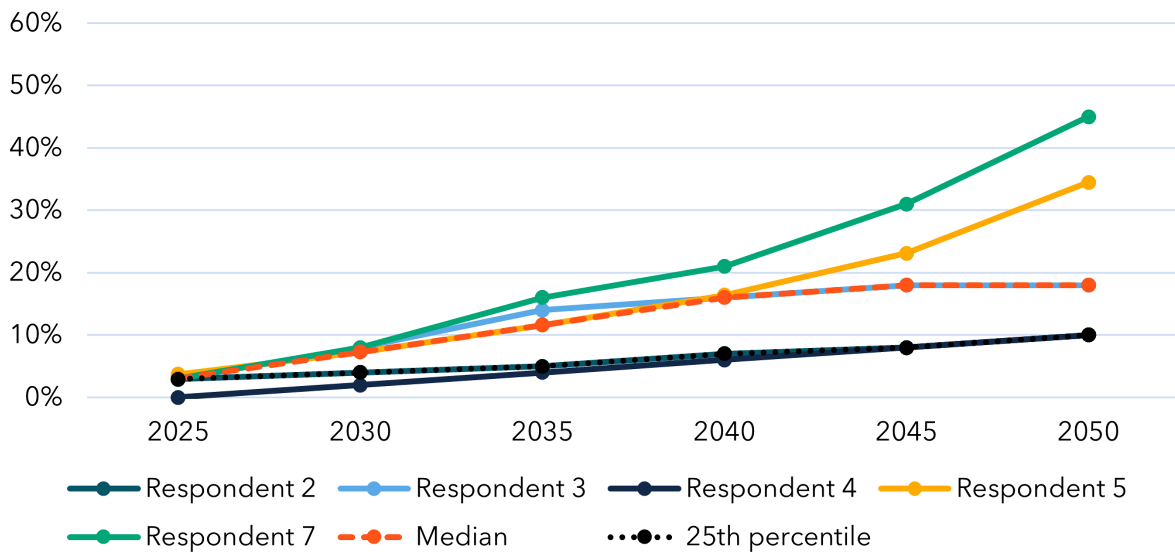


Figure 4. Forecast of adoption of induction by existing multifamily households (saturation)



For new construction, 2050 median projections favored induction substantially more than ENERGY STAR certified electric radiant cooking products. The median for induction was 70% with a range of 45% to 75%, of which four panelists' projections were greater than 65% (Figure 5). For ENERGY STAR certified electric radiant cooking products, the median was 25% with a range of 24% to 35% (Figure 6).

Figure 5. Forecast of adoption of induction by new construction (market share)

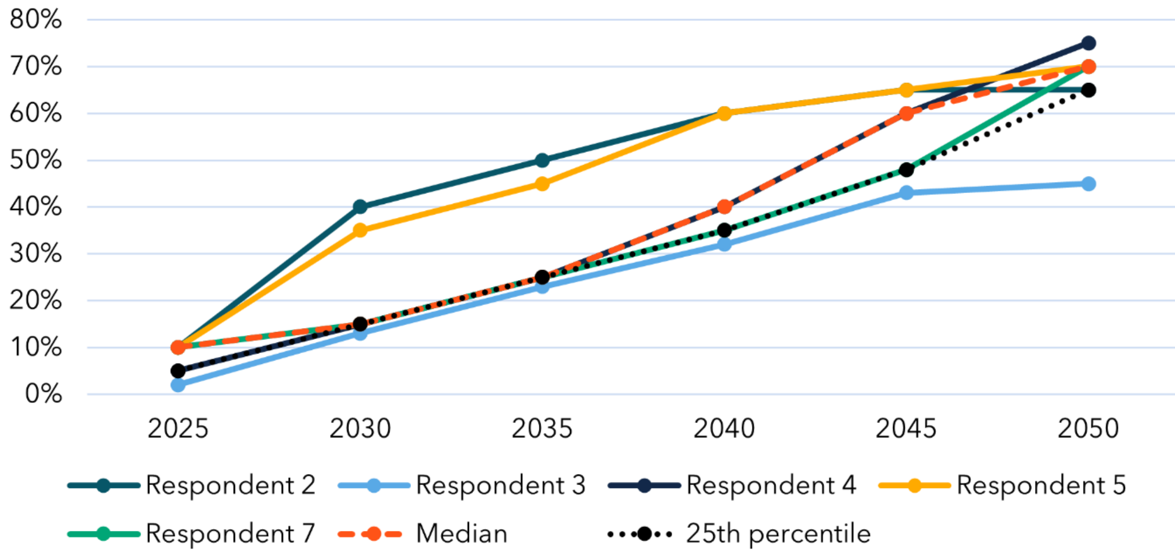
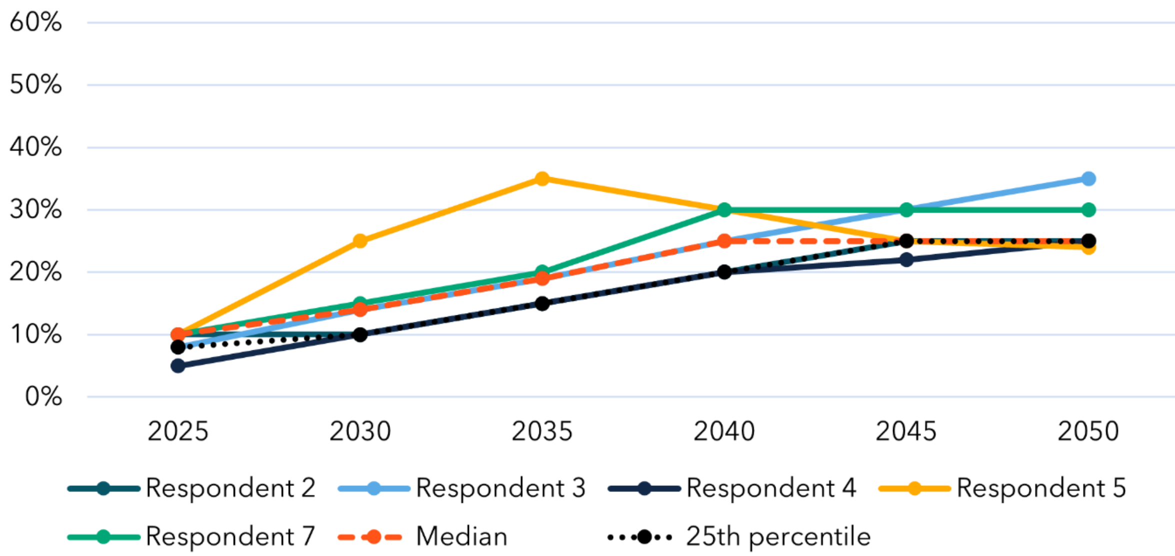


Figure 6. Forecast of adoption of electric radiant by new construction (market share)



Panelists were asked to forecast the maximum market potential for each technology - for both single-family and multifamily segments. For each housing type, panelists provided separate adoption forecasts for two technologies: induction cooktops and ENERGY STAR certified electric radiant cooktops.

Panelists tended to be more bullish on the ultimate market potential for induction in single-family households, and more bullish on ENERGY STAR certified electric radiant cooking products in multifamily households (see Table 2).

Table 2. Market potential for induction and ENERGY STAR certified electric radiant cooking products across housing segments

	Single-family		Multifamily	
	Induction	Electric radiant	Induction	Electric radiant
Minimum	20%	15%	14%	8%
25th percentile	40%	20%	30%	25%
Median	**60%**	**20%**	**31%**	**42%**
Maximum	80%	30%	58%	70%

Note. Panelists were asked to estimate the proportion of households in California (single-family and multifamily households) that they believe would ultimately install an induction or electric radiant cooking appliance, given existing and projected market, technology and regulatory trends (i.e., naturally occurring market adoption) without any CalMTA market transformation investment. Panelists were asked to consider a long-term perspective that may extend beyond 2050.

Factors that drive adoption

The team analyzed the panelists' qualitative comments and rationale for their forecasts and observed several themes across housing segments. The most prominent factors mentioned by panelists were related to environmental and health awareness, market evolution and regulatory support, perception of superior technology, and price trajectory, each described in more detail below.

Environmental and health awareness

Per the Delphi panel, climate change and health concerns are becoming significant drivers pushing consumers away from gas towards electric cooking options. One panelist noted that "deepening concerns with climate change will also raise the profile of home decarbonization, and health impacts will continue to drive choices." Another panelist commented that "climate change will get worse and awareness of fossil fuels in the home will be greater, driving more people to want to transition off gas." Panelists predicted that general awareness of climate and health issues will continue to increase as "the widespread consumer education about climate, health, and safety benefits of electrification will hold weight in California."

Market evolution and regulatory support

Currently, gas options continue to be more abundant than electric options. Per the Delphi panel, as more manufacturers research, design, and develop new products, the market will become flush with more electric options. One panelist pointed out that "introduction of entry-level induction cooktops and ranges by Frigidaire and Samsung, two established mass market appliance manufacturers, will begin to gather more market share as existing gas and electric appliances burn out and are replaced." Regulatory trends will also play a major role in shaping how manufacturers produce and how retail distributors market and sell products to consumers. For instance, panelists mentioned the Inflation Reduction Act (IRA) as a vehicle for incentivizing consumers to purchase induction units as well as anticipated gas stove health warning labels that could influence consumers' decision-making processes. Per panelists, California is on a clear path towards 100% adoption of electric appliances and the decommissioning of the gas system. The policy environment will inevitably guide and require new construction to be 100% electric statewide for cooking before establishing similar policy frameworks for existing buildings.

Perception of superior technology

Qualitative comments from panelists suggest that they consider induction as superior technology compared to ENERGY STAR certified electric radiant cooking. Most were bullish on the prospect of induction in single-family or high-end housing settings. One panelist predicted that "induction will capture 70% of the [single-family housing] market due to [induction's] superior cooking experience," while another went so far as to describe electric radiant as a low performance product and generally undesirable [compared to induction] and said that "induction is the best cooking technology."

Price trajectory

Panelists expect the cost differential between induction and other cooking technologies to decrease over time, driving greater adoption. One panelist noted that "induction will get cheaper and better" while another mentioned that "manufacturing costs coming down" will make induction cooktops more popular. The introduction of entry-level induction cooktops by major manufacturers like Frigidaire and Samsung is already making these products more cost-competitive with traditional options. Additionally, incentive programs through the IRA will help to offset the initial cost premium, particularly for low- and moderate-income households.

Factors that temper adoption

Panelists also highlighted factors that could temper adoption, with specific attention to accessibility and consumer habits. Electric radiant options are currently more widely available than induction options. Multiple panelists noted that property owners and property managers will likely choose radiant over induction, based on affordability and on considerations such as familiarity and comfort. Panelists also shared their perception that many people have entrenched cooking habits and may scoff at the prospect of having to alter the way they prepare meals by having to purchase the specialized cookware required for cooking with induction.

Housing-specific segment considerations

Although the rationale for panelists' forecasts were similar for single-family and multifamily households, as well as new construction, there were a few discernible differences between the housing segments.

Single-family housing

Per the Delphi panel, people who live in single-family housing or high-end luxury homes have, on average, greater resources and flexibility to choose products and appliances for their homes. These people will more likely make purchase decisions based on considerations beyond price, such as product quality and health impact. One panelist projected that "single-family and higher end multifamily will favor induction over radiant based on the speed, efficiency, and control offered by induction." Other panelists noted that consumers will opt for induction because "they will prefer state-of-the-art [appliances]" and "the only places where radiant cooking will be used is in the cheapest constructions, and customers with a choice will avoid that."

Multifamily housing

Unlike consumers in single-family households, multifamily residents tend to be renters and are restricted either financially or in their decision-making capacity. In such cases, landlords or property managers are often the ones who make the decisions on appliances. Essentially all panelists commented that landlords are typically motivated by minimizing cost and, according to one panelist, "will ultimately continue to opt for the lowest cost option." Multifamily cooking product purchases are more price-sensitive, and user preference is less likely to matter than with single-family households. Other panelists noted that "the requirement for specialized pans will be unattractive for the transient rental market, especially low-income," and that "multifamily households are dominated by rentals and property owners are more likely to purchase the lowest upfront cost options, which is much more likely to be ENERGY STAR radiant cooking products rather than induction." Finally, panelists stated that buildings that are wired for electric units are not likely to rewire to accommodate induction.

New construction

Panelists expect new construction to play a pivotal role in driving electric cooking adoption. By 2035, panelists expect virtually all new construction to be all-electric and dominated by either induction or ENERGY STAR radiant options. Single-family and higher-end multifamily new construction will predominantly favor induction due to its superior performance characteristics and the ability to incorporate costs into the overall home price. State and regional programs are expected to bring down the price of induction for new construction. Building codes, including reach codes, will continue to drive new construction towards electrification, with some panelists predicting that by 2040, the ability to install or purchase a gas stove may not be possible due to policy requirements

Observed rationale issues and omissions

CalMTA considered the forecasts by panel members and found them to be very optimistic. An analysis of the panelists' qualitative responses reveals that they did not consider several critical market barriers that CalMTA identified in its Phase II research, and they may not have accounted for these in their forecasts.

- **Electric infrastructure.** First, panel members did not discuss the widespread infrastructure challenges in existing homes - particularly that approximately 30% of single-family homes and 60% of multifamily units would require electrical panel upgrades to accommodate 240V electric cooking appliances.[35] While 120V battery-equipped induction cooktops exist as a potential solution to avoid panel upgrades, these products are substantially more expensive than standard 240V induction options and are expected to remain a niche product, limiting their viability as a widespread solution to the infrastructure barrier.
- **Potential bill impacts.** Additionally, the panel's qualitative responses suggest that they may not have considered the bill impacts of transitioning from gas to electric cooking, particularly for low-income or environmental and social justice (ESJ) communities. While panelists discussed incentive programs like the Inflation Reduction Act, the absence of comments highlighting bill impacts as a fundamental market barrier suggests their forecasts may not fully account for these significant adoption challenges.
- **Limited panel size.** Although CalMTA recruited 10 panelists to participate in the study, only five panelists completed both rounds of the Delphi process. This limited sample size suggests the need to be cautious when interpreting the forecasts, as they represent the views of a small group of experts rather than a broad consensus from the industry. While the qualitative insights from these experts align with findings from our broader market research and helped inform our baseline assumptions, the small panel size may have limited the diversity of viewpoints.

The qualitative comments from the Delphi panel provided valuable insights that helped inform our baseline assumptions, particularly regarding electrification trends in both existing homes and new construction. The panel's observations about headwinds and tailwinds aligned with findings from our market research including property manager and household surveys. While we found the panel's adoption forecasts to be optimistic due to their limited consideration of infrastructure barriers, high-cost premiums, and bill impacts, their commentary about market dynamics and decision-maker behavior provided an important foundation for developing more defensible assumptions for baseline. The panel's insights were particularly valuable in understanding how different market segments might respond to emerging technologies, regulatory changes, and incentive programs, helping to create a more measured projection of adoption trends.

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[35] Fournier, E. D., Cudd, R., Smithies, S., & Pincetl, S. (2024). Quantifying the electric service panel capacities of California's residential buildings. *Energy Policy*, *192*, 114238. Retrieved October 24, 2024, from https://www.ioes.ucla.edu/wp-content/uploads/2024/06/2024-Quantifying-the-electric-service-panel-capacities-of-Californias-residential-properties.pdf.

Attachment 2: Documentation of unit energy savings and avoided cost calculations for induction cooking

This document is a reference of the scenarios developed and methodology used to develop unit energy savings shapes and avoided cost calculations that serve as inputs to the cost-effectiveness and total system benefit models for the Induction Cooking MTI.

Product information

The two main appliance types considered in this analysis are ranges (cooktops combined with an oven) and cooktops. We considered several different types of cooktop technologies as described below.

Baseline equipment

The two baseline cooktop technologies considered are gas and standard electric models. The standard electric baseline includes electric coil and electric radiant, non-ENERGY STAR® certified cooktops and ranges. For ranges, we assume an electric resistance oven combined with the standard electric cooktop and a gas oven combined with a gas cooktop.

A representative standard electric cooktop has four heating zones using either smooth-top radiant or electric coils and is powered by 240V with a maximum current of 30A. A representative standard electric coil range has a similar cooktop with an added electrical resistance oven that is powered by 240V with a current rating of 40A.

A representative gas cooktop has four or five heating zones and a total heating power of 40-50 kBTU/h. It also requires a 120V 15A circuit that powers features such as electric ignition and safety features. A representative gas range has four or five heating zones and a total heating power of approximately 50 kBTU/h. It includes a gas convection oven and requires a 120V 15A circuit for similar reasons as the gas cooktop.

Proposed equipment

The MTI's product definition includes ovens and cooktops using induction heating technology as well as ENERGY STAR certified electric radiant products. As mentioned in Appendix C: Product Assessment Report, the test data used to generate the ENERGY STAR specification showed the differences in energy consumption between these two product categories was relatively small, and thus will be considered as one proposed technology category.

A representative induction cooktop includes four heating zones and is powered by a 240V 30A circuit. A representative induction range has a similar cooktop with an electric resistance oven and is powered by a dedicated 240V 40A circuit.

A secondary proposed equipment type is 120V battery-equipped cooktops and ranges. These products will have cooking features similar to a conventional 240V induction appliance, but with the inclusion of an integrated battery which provides the cooking power and is charged by a 120V circuit.

Effective useful life

The effective useful life for electric cooking appliances was set to 16 years. This was taken from the U.S. Department of Energy (DOE) supplemental notice of proposed rulemaking (SNOPR) for Energy Conservation Standards for Consumer Conventional Cooking Products and aligns with the value used for the California eTRM Induction Cooking Top with or without Electric Range, Residential measure package.[36,37]

Climate zones

Because building energy modeling was not used for unit energy consumption estimates, no weather data is used in this analysis. Climate zones were used to determine avoided cost factors in the avoided cost calculator (ACC) workbook. One climate zone was chosen per Investor-Owned Utility (IOU) providing electrical service: Climate Zone 12 was used for Pacific Gas & Electric (PG&E), Climate Zone 10 was used for Southern California Edison (SCE), and Climate Zone 7 was used for San Diego Gas & Electric (SDG&E). In the gas-avoided cost worksheet, the Southern California Gas Company (SoCalGas) with SCE in Climate Zone 10. PG&E and SDG&E were used for both electric and gas avoided costs in their respective climate zones.

Scenarios

For the Induction Cooking MTI, both normal replacement and new construction scenarios were considered. Both multifamily and single-family building types were considered, although there was no building energy modeling performed, so the unit energy consumption values are independent of building type (and weather). We used the same unit energy savings for normal replacement and new construction scenarios.

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[36] U.S. Department of Energy (DOE), Energy Efficiency and Renewable Energy Office (EERE). 2016. 2016 SNOPR Analytical Tools: Life-Cycle Cost and Payback Period Analysis Spreadsheet. "Cooking_Pds_LCC_SNOPR_DOE_2016_publication.xlsm." Docket EERE-2014-BT-STD-0005

[37] https://www.caetrm.com/measure/SWAP015/02/.

Table 1. Induction cooking savings scenarios

Savings shape	Climate zones	Sector	Segment	Decision type	Proposed equipment type	Baseline equipment type
1	7, 10, 12	Res.	MF & ES	NR & NC	Induction or ES radiant cooktop	Std. electric cooktop
2	7, 10, 12	Res.	MF & SF	NR & NC	Induction or ES radiant cooktop	Gas cooktop
3	7, 10, 12	Res.	MF & SF	NR & NC	Induction or ES radiant range	Std. electric range
4	7, 10, 12	Res.	MF & SF	NR & NC	Induction or ES radiant range	Gas range
5	7, 10, 12	Res.	MF & SF	NR & NC	120V battery-equipped induction range	Std. electric range
6	7, 10, 12	Res.	MF & SF	NR & NC	120V battery-equipped induction range	Gas range

Abbreviations used in the table: Res = Residential, MF = multifamily, SF = single-family, NR = normal replacement, NC = new construction, ES = ENERGY STAR. Std = standard.

Unit energy savings methodology

To develop unit energy savings (UES) shapes we generated two independent hourly load shapes of the proposed and baseline equipment. The savings shape is the difference between these two load shapes over one year. This creates an 8,760-hour profile of electricity consumption (kWh) and natural gas consumption (therms).

Proposed technology energy and emissions

To establish baseline energy consumption and emissions, the team leveraged existing data sources to model a natural gas range and an inefficient electric resistance range, which were then compared to a model representing induction appliances, the proposed technology.
Since the MTI product definition includes both efficient radiant and induction electric cooking appliances per the ENERGY STAR specification, the proposed design used for the calculation represents a level of performance consistent with most electric induction ranges as well as best-in-class radiant electric ranges (i.e., those capable of achieving ENERGY STAR certification). Therefore, while gas appliances only represent a baseline technology and induction appliances only represent the target technology, electric resistance products can represent either the

baseline (electric coils or non-ENERGY STAR radiant) or the target (ENERGY STAR certified radiant).

Modeling methodology and data sources

Annual energy consumption for both baseline and target technologies was estimated based on Residential Building Stock Assessment (RBSA) Load Shapes from the Electric Power Research Institute (EPRI).[38] This load shape represents field data from 39 households that was used to generate a composite annual hourly load shape. The load shape was then scaled to the Integrated Annual Energy Consumption (IAEC) for each appliance type provided by the DOE in a recent life cycle cost and payback analysis.[39]

The DOE reported a baseline energy consumption for electric cooking tops of 237 kWh/year based upon a market-weighted average of 74.4% smooth-top electric and 25.6% electric coil. The team instead set the annual energy consumption for standard electric at the federal minimum level of 207 kWh/year, which comes into effect in January 2028. The annual energy consumption for the proposed equipment of either induction or ENERGY STAR certified radiant is set to 192.5 kWh/year which is just below the current ENERGY STAR level of 195 kWh/year. This consumption level is consistent with the average of all induction products testing, excluding two high outliers with high standby power consumption that would not meet the 2028 federal efficiency standards.

No data sets were available for the energy consumption profile of a 120V battery-equipped induction range. The team assumed that an induction range uses the same amount of electricity as a conventional 240V induction range but that an additional 15% loss occurs during round-trip charging/discharging. Without data available on the efficiency of appliance charging, the team used data from electric vehicle charging to develop an estimate.[40] CalMTA then assumed the charging time is set up for a window with low electricity rates and low avoided costs of electricity usage. CalMTA identified a single point that optimizes the avoided cost benefit over the 31-year time period of the avoided cost calculation and set that as the charging window. CalMTA assumed charging occurs at a rate of 12.5A on a 15A 120V circuit with the primary charging event of the day always occurring between 2:00-3:00 p.m. If additional charging is required based upon the previous day's consumption, the secondary charging event occurs between 11:00 a.m. and 12:00 p.m.

There is a small amount of electrical power consumed from the ignition, sensors, and extra features such as the clock in gas cooking appliances. This was neglected in the current load shape

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[38] Electric Power Research Institute. "Residential Building Stock Assessment (RBSA)." https://loadshape.epri.com/rbsa.

[39] https://www.regulations.gov/document/EERE-2014-BT-STD-0005-12820.

[40] J. Sears, D. Roberts and K. Glitman, "A comparison of electric vehicle Level 1 and Level 2 charging efficiency," 2014 IEEE Conference on Technologies for Sustainability (SusTech), Portland, OR, USA, 2014, pp. 255-258, doi: 10.1109/SusTech.2014.7046253.

development but could be added as the load shapes are refined and more field data is collected in the future program phase. CalMTA estimated the electrical power consumption for gas appliances represents approximately 2% of the energy consumption for the gas cooktop and approximately 1% of the energy consumption for the gas range.

Interactive effects due to space conditioning and vent hood energy consumption were investigated and ultimately neglected due to the complexity and wide range of energy impacts that vary with assumptions and scenarios.

Table 2: Energy consumption values for each appliance type

Appliance type	Annual electricity consumption (kWh)	Annual natural gas consumption (Therms)
Proposed Equipment		
Electric induction cooktop	192.5	-
Electric induction range	528.7	-
Battery-equipped induction range	622.0	-
Baseline equipment		
Electric resistance cooktop	207.0	-
Gas cooktop	-	15.8
Electric resistance range	543.6	-
Gas range	-	35.5

Avoided Cost Calculations

The CPUC's Avoided Cost Calculator (ACC) [41] provides a robust framework for evaluating the benefits of distributed energy resources such as energy efficiency and fuel switching measures. The ACC estimates system-level costs of providing electric or gas service on an hourly basis in $/kWh and $/therm.[42] The calculator is comprised of three parts: an electric avoided cost calculator, a natural gas avoided cost calculator, and a refrigerant calculator. Since the calculator converts gas and electricity consumption to dollars of avoided cost, it provides a metric to calculate the impact of fuel switching measures' and pure efficiency measures' technology value from the baseline value to calculate the avoided costs for how much money is saved in the electrical grid and associate emissions through the adoption of one unit. The avoided cost factors

[41] Per the CPUC, "The primary benefits of demand-side resources are the avoided costs related to generation and distribution of energy. The avoided costs of electricity are modeled based on the following components: generation energy, generation capacity, ancillary services, transmission and distribution capacity, and decarbonization policy compliance. The Avoided Cost Calculator was established in 2005 and is updated biennially to improve the accuracy of how the benefits of demand-side resources are calculated."

[42] 2024 Distributed Energy Resources Avoided Cost Calculator Documentation. https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/demand-side-management/acc-models-latest-version/2024-acc-documentation-v1b.pdf.

(in $/kWh and $/therm) are applied to a unit energy savings shape on an hourly basis to calculate the avoided cost benefit per scenario, which is an input for the estimate of the MTI's cost-effectiveness and total system benefit (TSB).

The previous TSB calculations for Induction Cooking in the CalMTA Advancement Plan used the 2022 version of the ACC workbook. Since then, the 2024 version has been released and all calculations in this analysis use the newly updated version. There are significant changes in the factors between the 2022 and 2024 ACC workbooks, including the following, per E3:[43]

- Energy value is more time-dependent (lower midday and higher overnight and early morning)
- Higher greenhouse gas (GHG) value concentrated in evenings and early mornings
- Lower annual generation capacity value spread out over more hours
- Gas avoided costs are slightly higher, with the largest increases in winter months.

We used both the electric and gas ACC workbooks. The ACC workbook settings used to produce hourly factors are shown in Table 3.[44]

Table 3. Avoided cost workbook settings

Cost test	Total Resource Cost (TRC)	Societal Cost Test (SCT)
ACC workbook version	2024	2024
Discount rate	7.30%	3%
Social cost of carbon	-	Base and high
Start year	2024	2024
End year	2054	2054
IOU climate zones		
PG&E	12	12
SCE	10	10
SDG&E	7	7
Electric components to include		
Cap & trade	TRUE	TRUE
GHG adder	TRUE	TRUE
GHG rebalancing	TRUE	TRUE
Energy	TRUE	TRUE
Generation capacity	TRUE	TRUE
Transmission capacity	TRUE	TRUE

[43] https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/demand-response/cost-effectiveness/2024-draft-acc-workshop---final.pdf.

[44] The final air quality adders for both electric and gas are FALSE for TRC and TRUE for SCT, as these are hard-coded settings in the workbook that adjust based on the chosen cost test.

Cost test	Total Resource Cost (TRC)	Societal Cost Test (SCT)
Distribution capacity	TRUE	TRUE
Ancillary services	TRUE	TRUE
Losses	TRUE	TRUE
Methane leakage	TRUE	TRUE
Air quality adder	TRUE	TRUE
Final air quality adder	FALSE	TRUE
Gas main inputs		
Class	Residential	Residential
End use	Residential furnace	Residential furnace
Emission control	Uncontrolled	Uncontrolled
Gas components to include		
Market	TRUE	TRUE
T&D	TRUE	TRUE
Environment	TRUE	TRUE
Upstream methane leakage	TRUE	TRUE
Behind-the-meter methane leakage	TRUE	TRUE
Air quality adder	TRUE	TRUE
Final air quality adder	FALSE	TRUE

6 Attachment 3: Sensitivity analysis

CalMTA ran sensitivity analyses reflecting changes to key model inputs, including product prices, electrification rates, and rates of induction cooking adoption, to assess the sensitivity of TSB and cost-effectiveness to market performance.

Description of analysis and results

CalMTA ran seven sensitivity analyses, as summarized in Table 1.

Table 1. Sensitivity analysis scenarios

Variable	Low market outcome scenario	High market outcome scenario
1. Price – 120V Battery-equipped products	10% increase in the assumed price of 120V battery-equipped induction ranges from 2027-2045	A 10% decrease in the assumed price of 120V battery-equipped induction ranges from 2027-2045
2. Price – All efficient cooking products	10% increase in the assumed price of all efficient cooking products for 2024-2045	10% decrease in the assumed price of all efficient cooking products for 2024-2045
3. Rate of electrification	Slower rate of electrification assumed for both single-family and multifamily households. By 2045, the number of households transitioning out of gas is 10% lower	Faster rate of electrification assumed for both single-family and multifamily households; by 2045, the number of households transitioning out of gas is 10% higher
4. Price	Slower rate of reduction in prices of all efficient products starting in 2024	-
5. Rate of electrification, price	Scenarios 2 and 3, combined – low outcomes	Scenarios 2 and 3, combined – high outcomes
6. Rate of electrification, market share	Smaller share of induction cooking products and low scenario 3, combined	Larger share of induction cooking products and high scenario 3, combined
7. Rate of electrification, market share, price	Scenarios 6 and 2, combined – low outcomes	Scenarios 6 and 2, combined – high outcomes

Price of 120V battery-equipped induction ranges

To understand the impacts of deviations in the modeled 120V battery-equipped induction range prices on TSB and cost-effectiveness, CalMTA analyzed the impacts of a 10% price increase and a 10% price decrease for 120V battery-equipped induction ranges starting in 2027 (the first year of expected price reductions).

The results of this analysis are summarized in Table 2.

Table 22. Changes to TSB and cost-effectiveness resulting from an update to the price of 120V battery-equipped induction ranges

Scenario	Metric	10% increase in price	Base case	10% decrease in price
Price of 120V battery-equipped range	TSB	No change	$537M	No change
	TRC	1.05	1.12	1.21
	PAC	No change	14.36	No change

Prices of all efficient products

CalMTA ran two additional pricing analyses to understand the impact of changes in pricing for all efficient cooking products starting 2024.

The results of this analysis are summarized in Table 3.

Table 33. Changes to TSB and cost-effectiveness resulting from an update to the prices of all efficient products

Scenario	Metric	10% increase in price	Base case	10% decrease in price
Price of all efficient products	TSB	No change	$537M	No change
	TRC	0.90	1.12	1.50
	PAC	No change	14.36	No change

Rate of electrification

To understand the impact of the trajectory of electrification on the MTI's adoption and TSB and cost-effectiveness results, CalMTA ran four analyses with adjustments to the trajectory of electrification among single-family and multifamily gas cooking product owners starting in 2024.

The results of this analysis for single-family households are summarized in Table 4.

Table 44. Changes to TSB and cost-effectiveness resulting from an update to the rate of electrification in single-family households

Scenario	Metric	Slower rate of electrification	Base case	Faster rate of electrification
Rate of electrification in single-family households	TSB	$451M	$537M	$624M
	TRC	1.03	1.12	1.20
	PAC	12.04	14.36	16.68

The results of this analysis for multifamily households are summarized in Table 5.

Table 55. Changes to TSB and cost-effectiveness resulting from an update to the rate of electrification in multifamily households

Scenario	Metric	Slower rate of electrification	Base case	Faster rate of electrification
Rate of electrification in multifamily households	TSB	$503M	$537M	$572M
	TRC	1.09	1.12	1.15
	PAC	13.43	14.36	15.28

Trajectory of prices for efficient products

To understand the impacts of variation in the assumed decrease in prices of qualified products over time, CalMTA modeled a decrease in the trajectory of prices for efficient products starting in 2024. The original analysis applied a default "learning rate" for ENERGY STAR certified radiant products and a high "learning rate" for induction.[45] CalMTA ran this analysis with a "Low" learning rate for ENERGY STAR radiant instead of a "Default" or mid learning rate and a "Default" or mid-learning rate for induction cooking instead of "High."

The results of this analysis are summarized in Table 6.

Table 6. Changes to TSB and cost-effectiveness resulting from an update to the Trajectory of prices for efficient products

Scenario	Metric	Base Case	Slower rate of reduction in prices
Trajectory of prices for efficient products	TSB	$537M	No change
	TRC	1.12	1.02
	PAC	14.36	No change

Rate of electrification and prices of efficient products

CalMTA conducted two analyses including changes to both the rate of electrification among gas cooking product owners combined with a favorable/unfavorable change in the prices of all efficient products starting in 2024.

[45] As described in Section 5.2 above, Inputs, CalMTA used the learning rate, or experience curve, approach which is based on the idea that as production volume increases, the cost per unit decreases due to efficiencies and learning over time (U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program. 2022).

The results of this analysis are summarized in Table 7.

Table 7. Changes to TSB and cost-effectiveness resulting from an update to the rate of electrification and prices of efficient products

Scenario	Metric	Slower rate of electrification and an increase in prices	Base case	Faster rate of electrification and decrease in prices
Rate of electrification and prices of efficient products	TSB	$416M	$537M	$659M
	TRC	0.79	1.12	1.65
	PAC	11.11	14.36	17.6

Rate of electrification and share of Induction Cooking products

CalMTA ran two analyses to understand the combined impact of varying the rate of electrification and the share of induction cooking equipment. The first analysis assumes a slower rate of electrification and a lower induction share of electrified products (and a greater adoption of ENERGY STAR and non-ENERGY STAR radiant products) compared to the base case. The second analysis assumes a faster rate of electrification and a higher induction share of electrified products compared to the base case. The results of this analysis are summarized in Table 8.

Table 8. Changes to TSB and cost-effectiveness resulting from an update to the rate of electrification, share of induction products and prices of efficient products

Scenario	Metric	Smaller share of induction cooking products and slow rate of electrification	Base case	Larger share of induction cooking products and fast rate of electrification
Rate of electrification and share of induction products	TSB	$378M	$537M	$706M
	TRC	0.97	1.12	1.22
	PAC	10.10	14.36	18.88

Rate of electrification, share of induction products, and price of products

To understand the combined impact of higher or lower prices, rate of electrification, and share of adoption that is induction products, CalMTA developed two scenarios reflecting changes to these three variables.

The results of this analysis are summarized in Table 9.

Table 9. Changes to TSB and cost-effectiveness resulting from an update to the rate of adoption of Induction Cooking products and rate of electrification, and price of products

Scenario	Metric	Smaller share of induction cooking products and slow rate of electrification, and increase in prices	Base case	Larger share of induction cooking products and fast rate of electrification, and decrease in prices
Rate of electrification and smaller share of Induction Cooking products, and price of products	TSB	$378M	$537M	$706M
	TRC	0.80	1.12	1.59
	PAC	10.10	14.36	18.88

Summary of results and implications

The sensitivity analysis shows that MTI cost-effectiveness is most sensitive to the assumed price of induction cooking products (Figure 1). While cost-effectiveness is somewhat sensitive to the price of 120V battery-equipped products, the analysis shows that it is more sensitive to the assumed price of 240V products (reflected in analysis 2), which is due to the higher incremental market adoption represented by those products. These results underscore the importance of the MTI's work with manufacturers to reduce the price of induction products, and of closely tracking pricing as a market progress indicator.

TSB is most sensitive to the rate of market adoption of qualified products and to the rate of electrification, which is correlated with market adoption (Figure 2). In a scenario where higher market price of induction cooking products is accompanied by lower market adoption, the negative impact to cost-effectiveness is enhanced; likewise, if the MTI can successfully accelerate the reduction in prices and market adoption of induction cooking products – per the MTI program theory – there is substantial upside opportunity in terms of cost-effectiveness and TSB.

Figure 1. TRC findings by sensitivity analysis

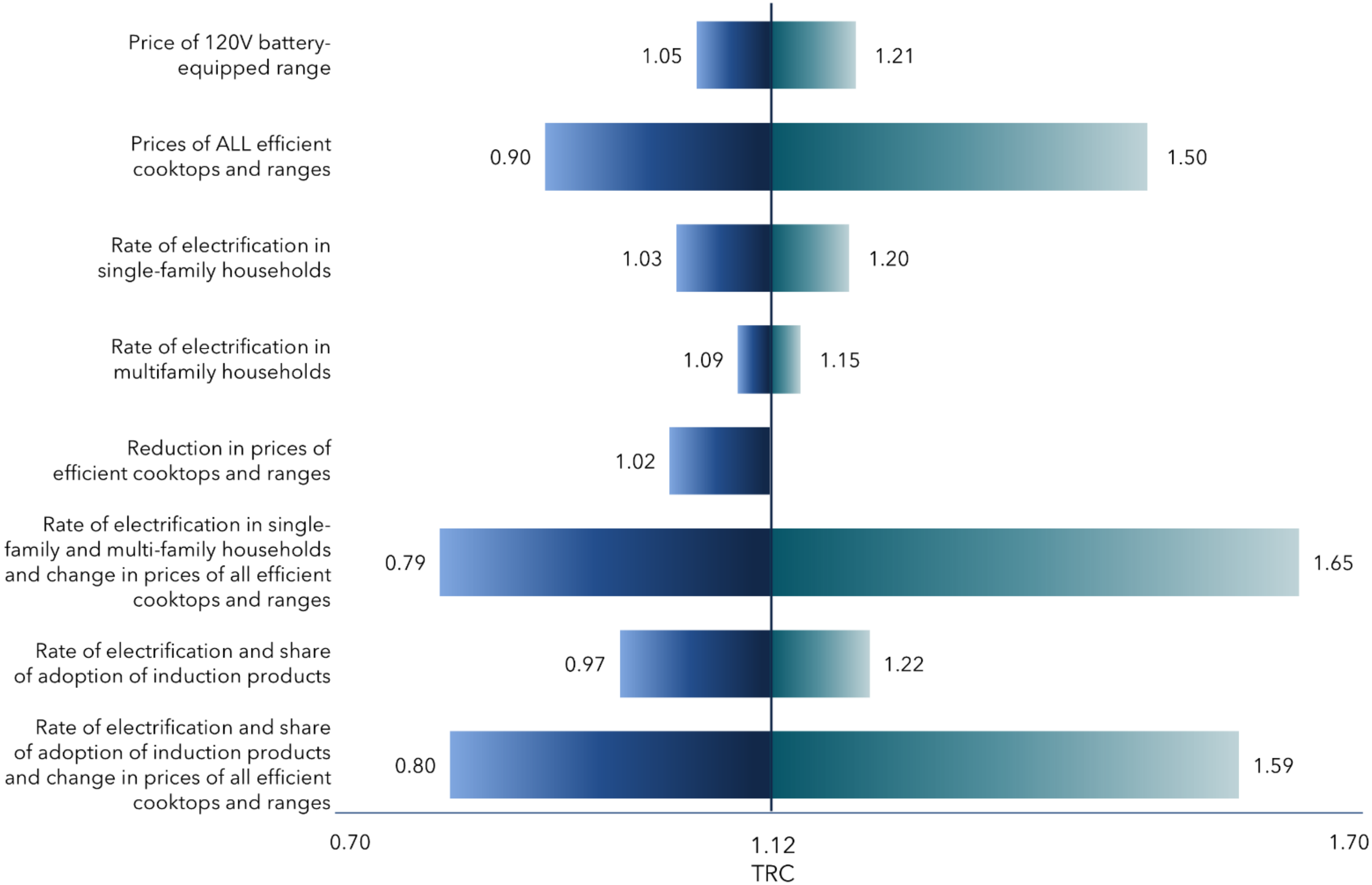

Figure 2. TSB ($M) findings by sensitivity analysis