|  |
| --- |
| Appliance  SWAP015-01 Induction Cooking with or without Electric Range, Residential |

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Measure Name

Induction Cooking with or without Electric Range, Residential

Statewide Measure ID

SWAP015-01

Technology Summary

Residential cooking appliances include ovens, cooktop, and full ranges. Range technology consists of an oven with a built-in cooktop.[[1]](#footnote-1) Ovens can be categorized as either self-cleaning or manual-clean and be either free-standing or wall configurations. Self-cleaning ovens heat to temperatures around 880oF for up to three hours to decompose food soils. This resultant ash can then be wiped out with a wet cloth. Without this technology, the oven must be cleaned by scrubbing the soilage with soap and water.[[2]](#footnote-2)

An **Induction Range** is an electric oven with a built-in **Induction cooktop**. Induction technology works on the principle of magnetic induction, where excited eddy currents in ferromagnetic cookware within the presence of an oscillating magnetic field dissipate heat through the Joule effect. This heat is directly generated by the cookware and is transmitted to the food within it, lessening thermal conduction heat loss between the heating element and the cookware.[[3]](#footnote-3) Induction cookers are composed of a switching power electronics circuit that delivers high-frequency current to a planar coil of wire embedded in the cooking surface. The cookware is magnetically coupled to the coil by the oscillating magnetic field. Current flows in the cooking vessel due to the low resistance of the metal. Resistance is a function of permeability and resistivity of the cookware as well as the frequency of excitation.[[4]](#footnote-4) Typical induction cookers operate at switching frequency between 25 kHz and 50 kHz, which restricts coupling to ferromagnetic cookware such as cast iron and some alloys of stainless steel.[[5]](#footnote-5) According to manufacturers, induction stoves heat food faster, are easier to clean, are less likely to burn those using them, and have a higher cooking efficiency than electrical resistance stoves.[[6]](#footnote-6)

**Cooking Efficiency** is calculated as the ratio of thermal energy absorbed by the food divided by the energy consumed by the device as it is heating the food.[[7]](#footnote-7) At higher cooking efficiencies and with faster heat-up times, induction cooktops have better heat-up performance and higher heat input compared to electric resistance cooktops.[[8]](#footnote-8) Although induction ranges have a higher initial equipment cost than electrical resistance ranges, the benefits of increased efficiency make them desirable replacement options.

Measure Case Description

The measure case is defined as either the replacement of fully electric range with an electric oven with induction cooktop or a standalone electric resistance cooktop with a standalone induction cooktop.

|  |  |
| --- | --- |
| **Statewide Offering ID** | **Measure** |
| A | Induction Cooktop replacing Electric Resistance Cooktop |
| B | Electric Range with Induction Cooktop replacing Electric Range with Electric Resistance Cooktop |

**Measure Case Technology Characterization**

Measure characterization for this measure is being informed by CASE Plug Load and Lighting Modeling (Measure Number: 2016-RES-ACM-D)[[9]](#footnote-9) and US Energy Efficiency and Renewable Energy Office[[10]](#footnote-10).

Range ovens have separate cooking efficiencies from cooktops. Ranges with induction and electric resistance cooktops both have electric resistance oven components; thus, baseline to measure cooking efficiencies for ovens are equivalent and are not included in the savings calculations of this workpaper. Costing is calculated separately for the two measures as the inclusion of an oven does impact cost.

|  |  |
| --- | --- |
| **Equipment** | **Cooking Efficiency (BTUFOOD/BTUAPPLIANCE)** |
| Electric Induction Cooktop | 84%[[11]](#footnote-11) |

The measure draws from a variety of existing data sources that are used to inform assumptions about the range baselines discussed in the scope of this paper. Based on the estimated age of devices in new homes, energy efficiency standards, and market trends, the statewide CASE Team determined the likely efficiency of ranges to be used in homes built during the 2016 code cycle.

Base Case Description

The base case is defined as an electric range with electric resistance cooktop or a standalone electric resistance cooktop.

Baseline characterization for this measure is being informed by CASE Plug Load and Lighting Modeling (Measure Number: 2016-RES-ACM-D).[[12]](#footnote-12)

**Base Case Technology Characterization**

|  |  |
| --- | --- |
| **Equipment** | **Cooking Efficiency** |
| Electric Resistance Cooktop | 74%[[13]](#footnote-13) |

Code Requirements

Test methods for the measurement of cooking efficiency include standardized DOE procedures for electric cooktops and modified and standardized DOE procedures to test induction cooktops, ASTM 2012 standard F1521, and ANSI standard Z83.11. Each takes a different methodology to obtain cooking efficiency and can be used as verification for each other.[[14]](#footnote-14)

Residential cooking appliances do not fall under California Building Energy Efficiency Standards (Title 24).

This measure is not governed by the California Appliance Efficiency Standards (Title 20) or federal regulations.

|  |  |  |
| --- | --- | --- |
| **Code** | **Applicable Code Reference** | **Effective Date** |
| CA Appliance Efficiency Regulations – Title 20 | N/A | N/A |
| CA Building Energy Efficiency Standards – Title 24 (2019) | N/A | N/A |
| Federal Standards | N/A | N/A |

Normalizing Unit

Each

Program Requirements

Measure Implementation Eligibility

All measure application type, delivery type, and sector combinations that are established for this measure are specified below. Measure application type is a categorization based on the circumstances and timing of the measure installation; each measure application type is distinguished by its baseline determination, cost basis, eligibility, and documentation requirements.  Delivery type is the broad categorization of the delivery channel through which the market intervention strategy (financial incentives or other services) is targeted. This table also designates the broad market sector(s) that are applicable for this measure.

**Implementation Eligibility**

|  |  |  |
| --- | --- | --- |
| **Measure Application Type** | **Delivery Type** | **Sector** |
| NR | DnDeemed | Res |
| NR | DnDeemDI | Res |
| NR | UpDeemed | Res |
| NC | DnDeemed | Res |
| NC | DnDeemDI | Res |
| NC | UpDeemed | Res |

For UpDeemed, Distributor and/or Installer shall provide and track customer information including (a) Resident zipcode where the new equipment is being installed and (b) existing equipment’s make and model and (c) fuel type powering existing appliance.

Eligible Products

**General Eligibility Requirements**

Installed equipment must be an electric range with induction cooktop or a standalone induction cooktop. Existing base equipment must be disposed.

Eligible Building Types and Vintages

This measure is applicable for all residential building types (single family, multifamily, and mobile homes) of both new and existing vintage.

Eligible Climate Zones

This measure is applicable in all California climate zones.

Program Exclusions

Replacement induction cooktop equipment must have either 4 or 5 burners.

Data Collection Requirements

Baseline equipment type and fuel source must be verified for downstream Normal Replacement measures.

Use Category

Appliance or Plug Load

Electric Savings (kWh)

Data Sources

The following sources were used to determine the baseline and measure energy usage and savings for all technologies. CASE ‘Plug Loads and Lighting Modeling’ contains a technical assessment of induction cooking performed by the Electric Power Research Institute (EPRI) for the California Energy Commission (CEC). Frontier Energy ‘Residential Cooktop Performance and Energy Comparison Study’ has substantive cooking efficiency test results for induction and electric resistance cooktops. EPRI ‘Induction Cooking Technology Design and Assessment’ contains a comprehensive description and energy performance assessment of commercial cooking equipment. Energy Efficiency and Renewable Energy Office (EERE) ‘Draft Cooktop Life-Cycle Cost Spreadsheet’ is a database of cooktop costs and lifecycles.

**Codes and Standards Enhancement Initiative (CASE): Plug Loads and Lighting Modeling****[[15]](#footnote-15)**

1. Oven and cooktop energy use disaggregation and per-cycle energy use
2. Estimated Annual Energy Consumption (AEC) of electric ranges, cooktops, and ovens
3. Electric resistance cooktop cooking efficiencies

**Frontier Energy: Residential Cooktop Performance and Energy Comparison Study[[16]](#footnote-16)**

1. Induction cooktop cooking efficiency
2. Electric cooktop cooking efficiencies

**Electric Power Research Institute (EPRI): Induction Cooking Technology Design and Assessment[[17]](#footnote-17)**

1. Electric resistance cooking efficiencies

**Energy Efficiency and Renewable Energy Office (EERE): Draft Stovetop Life-Cycle Cost Spreadsheet[[18]](#footnote-18)**

1. Induction cooktop cooking efficiency

**Cooktop Consumption**

Using the estimated cooking efficiency of 84% the total consumption of an induction stovetop was calculated using the cooking efficiency and consumption of an electric resistance stove as shown below.[[19]](#footnote-19)

|  |  |  |  |
| --- | --- | --- | --- |
| **Technology** | **Fuel Source** | **Efficiency (Cooking)** | **kWh** |
| Electric Resistance Cooktop | Electricity | 74%[[20]](#footnote-20) | 102.00[[21]](#footnote-21) |
| Induction Cooktop | Electricity | 84%[[22]](#footnote-22) | 89.86[[23]](#footnote-23) |

**Total Consumption and Savings**

Saving impacts calculated for electric to induction measures are found below. These exclude HVAC IE or savings due to reduced kitchen hood consumption. Range ovens have separate cooking efficiencies from cooktops. Ranges with induction and electric resistance cooktops both have electric resistance oven components; thus, baseline to measure cooking efficiencies for ovens are equivalent and are not included in the savings calculations of this workpaper. Costing is calculated separately for the two measures as the inclusion of an oven does impact cost

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure** | **Baseline Consumption**  **[kWh]** | **Measure Consumption**  **[kWh]** | **Measure Savings**  **[kWh]** |
| Electric to Induction Cooking Appliance | 102.00 | 89.86 | 12.14 |

Peak Electric Demand Reduction (kW)

Peak demand impacts are expected from this measure. There is an expected decrease in demand when converting from electric resistance to induction technologies. However, no studies could be found with measured peak demand impacts for cooking appliance equipment.

PG&E’s Residential Viewer document includes residential hourly load shapes for ranges (STOVE&OVEN:ALL). In order to estimate the peak demand, the energy savings (kWh) were applied to the load shape. Subsequently, the average of the hourly values for the DEER2020 peak period was calculated for each climate zone. The DEER peak period is calculated for the hours of 4:00 PM to 9:00 PM on three consecutive days specific to each climate zone. The table below shows the DEER Peak Period days for each climate zone.

|  |  |  |  |
| --- | --- | --- | --- |
| **Climate Zone** | **Month** | **Start Day** | **End Day** |
| CZ01 | 9 | 16 | 18 |
| CZ02 | 7 | 8 | 10 |
| CZ03 | 7 | 8 | 10 |
| CZ04 | 9 | 1 | 3 |
| CZ05 | 9 | 8 | 10 |
| CZ06 | 9 | 1 | 3 |
| CZ07 | 9 | 1 | 3 |
| CZ08 | 9 | 1 | 3 |
| CZ09 | 9 | 1 | 3 |
| CZ10 | 9 | 1 | 3 |
| CZ11 | 7 | 8 | 10 |
| CZ12 | 7 | 8 | 10 |
| CZ13 | 7 | 8 | 10 |
| CZ14 | 8 | 26 | 28 |
| CZ15 | 8 | 26 | 28 |
| CZ16 | 7 | 8 | 10 |

Gas Penalty (Therms)

Reduction in cooking energy may result in some increase in natural gas consumption due to HVAC interactive effects. However, calculating this impact is difficult due to additional interactions with kitchen hood exhaust systems. Therefore, therms penalty impacts from HVAC IE are not being calculated for this measure. This aligns with the calculation methodology from SWAP013-01 ‘Residential Cooking Appliances – Fuel Substitution’.

Life Cycle

Effective useful life (EUL) is an estimate of the median number of years that a measure installed through a program is still in place and operable. Remaining useful life (RUL) is an estimate of the median number of years that a technology or piece of equipment replaced or altered by an energy efficiency program would have remained in service and operational had the program intervention not caused the replacement or alteration.

The EUL and RUL are specified below. The EUL was developed in the Energy Conservation Program: Energy Conservation Standards for Residential Conventional Cooking Products; Supplemental notice of proposed rulemaking (SNOPR) [[24]](#footnote-24) and the 2016 SNOPR Analytical Tools: Life-Cycle Cost and Payback Period Analysis Spreadsheet[[25]](#footnote-25). These values were adopted by the CPUC in DEER2020.

**Effective Useful Life and Remaining Useful Life**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **EUL ID** | **Value** | **Source** |
| EUL (yrs) | Appl-Elec\_Cooking | 16.0 | Energy Efficiency and Renewable Energy Office (EERE).2016. Energy Conservation Program: Energy Conservation Standards for Residential Conventional Cooking Products; Supplemental notice of proposed rulemaking (SNOPR). 2016[[26]](#footnote-26)  Energy Efficiency and Renewable Energy Office (EERE). 2016. 2016 SNOPR Analytical Tools: Life-Cycle Cost and Payback Period Analysis Spreadsheet. 2016.[[27]](#footnote-27) |
| RUL (yrs) | N/A | N/A | N/A |

Base Case Material Cost ($/unit)

The base case cost was obtained through online prices research from various retailer websites in the third quarter of 2019. Costing was standardized between equipment types due to large price jumps due to specific add-ons (ie. two-oven ranges, Smart system [a system that includes automated controls and wi-fi connectivity], etc.). Base material costs per range type were restricted to single-oven, five to six cubic ft. oven volume, non-Smart, four or five burner ranges. Costing for standalone cooktops were restricted to four or five burners and at least 1500 cubic in. volume. Standardization was applied to more precisely compare samples.

**Standardized Baseline Cost**

|  |  |  |
| --- | --- | --- |
| **Appliance** | **Standardized Average Appliance Cost[[28]](#footnote-28)** | **Sample Count** |
| Electric Resistance Cooktop | $948.51 | 76 |
| Electric Range with Electric Resistance Cooktop | $708.00 | 23 |

The total equipment cost includes 8.75% tax.

Measure Case Material Cost ($/unit)

The measure case cost was obtained through online prices research from various retailer websites in the third quarter of 2019. Costing was standardized between equipment types due to large price jumps due to specific add-ons (ie. two-oven ranges, Smart system [a system that includes automated controls and wi-fi connectivity], etc.). Electric ranges with induction cooktops were standardized according to single-oven, five to six cubic ft. oven volume, non-SMART ranges. A similar approach was utilized for electric resistance where they were restricted to five to six cubic ft. oven volume and non-SMART criteria. Induction standalone cooktops were normalized to four or five burners and at least 1,500 cubic in. volume. Until more updated studies are done, the online retail point of sales pricing is the best available data to support the measure equipment cost.

**Standardized Measure Cost**

|  |  |  |
| --- | --- | --- |
| **Technology** | **Standardized Average Range Cost[[29]](#footnote-29)** | **Sample Count** |
| Induction Cooktop | $ 1,635.56 | 114 |
| Electric Range with Induction Cooktop | $ 1,657.23 | 24 |

The total equipment cost includes 8.75% tax.

**Cost Methodology/Approach**

The incremental measure cost is the cost differential of the efficient option over the standard option attributable to features related to energy efficiency performance. A robust analysis would involve developing a taxonomy of features and determining the cost of each feature or component. This is generally done through such methods as product teardowns or hedonic price modeling. However, for the applicable technologies, these methods become unwieldy because it is difficult to develop a standardized set of features due to various possible implementations of the technology and we may not find a reliable correlation between features and price. Hence, the standardization of baseline and measure parameters.

**Incremental Measure Cost**

|  |  |  |
| --- | --- | --- |
| **Baseline** | **Measure** | **Incremental Measure Cost** |
| Electric Resistance Cooktop | Induction Cooktop | $687.05 |
| Electric Range with Electric Resistance Cooktop | Electric Range with Induction Cooktop | $949.23 |

Base Case Labor Cost ($/unit)

Labor cost was found from RS Means Online database (2019)[[30]](#footnote-30). All equipment costing included a range of labor hours, thus the average labor hours per equipment was selected.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Description****[[31]](#footnote-31)** | **Min Labor Hours** | **Max Labor Hours** | **Average Labor Hours** | **Residential Electrician Hourly Rate with O&P[[32]](#footnote-32)** | **Total Labor Cost** |
| Cooking Range, Free Standing | 1.6 | 4 | 2.8 | $ 67.55 | $189.14 |
| Countertop Cooktop | 1.333 | 2.667 | 2 | $ 67.55 | $135.10 |

Measure Case Labor Cost ($/unit)

The labor costs for both the measure and base case are assumed to be the same. Labor costs for both cases are based on RS Means Online database (2019).[[33]](#footnote-33)

Net-to-Gross (NTG)

The net-to-gross (NTG) ratio represents the portion of gross impacts that are determined to be directly attributed to a specific program intervention. The default NTG value is based upon the average of all NTG ratios for all evaluated 2006 – 2008 residential programs, as documented in the 2011 DEER Update Study conducted by Itron, Inc. This sector average NTG is applicable to all energy efficiency measures that have been offered through residential sector programs for less than or equal to two years and for which impact evaluation results are not available.

Net-to-Gross Ratios

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** | **Source** |
| All-Default<=2yrs | 0.70 | Itron, Inc. 2011. DEER Database 2011 Update Documentation. Prepared for the California Public Utilities Commission. Page 15-4 Table 15-3. |

Gross Savings Installation Adjustment (GSIA)

The gross savings installation adjustment (GSIA) rate represents the ratio of the number of verified installations of the measure to the number of claimed installations reported by the utility. This factor varies by end use, sector, technology, application, and delivery method.

Gross Savings Installation Adjustment Rates

|  |  |  |
| --- | --- | --- |
| **Parameter** | **GSIA** | **Source** |
| Def-GSIA | 1.0 | California Public Utilities Commission (CPUC), Energy Division. 2013. *Energy Efficiency Policy Manual Version 5*. Page 31. |

Non-Energy Impacts

Non-energy impacts for this measure have not been quantified.

DEER Differences Analysis

This section provides a summary of DEER-based inputs and methods, and the rationale for inputs and methods that are not DEER-based.

DEER Difference Summary

|  |  |
| --- | --- |
| **DEER Item** | **Comment / Used for Workpaper** |
| Modified DEER methodology | No |
| Scaled DEER measure | No |
| DEER Base Case | No |
| DEER Measure Case | No |
| DEER Building Types | Yes |
| DEER Operating Hours | No |
| DEER eQUEST Prototypes | No |
| DEER Version | N/A |
| Reason for Deviation from DEER | The DEER 2019/2020 database does not include induction stove measures. |
| DEER Measure IDs Used | N/A |
| NTG | Source: DEER. The NTG of 0.70 is associated with NTG ID: All-Default<=2yrs |
| GSIA | Source: DEER. The GSIA of 1.0 is associated with GSIA ID: *Def-GSIA* |
| EUL/RUL | Source: DEER. The value of 16 years with EUL ID: Appl-Elec\_Cooking |

Revision History

Measure Characterization Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Revision Number** | **Date** | **Primary Author, Title, Organization** | **Revision Summary and Rationale for Revision**  **Effective Date and Approved By** |
| 01 | 02/26/2020 | Brandon Yamasaki, TRC | First draft of workpaper, using methodology from SWAP013-01 |
| 01 | 05/06/2020 | Andres Fergadiotti / SCE | Removed gas baseline for new construction  Revised EAD Table – Bldg Type identifier |

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