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MEASURE CHARACTERIZATION

Solar Attic Fan, Residential

https://www.caetrm.com/measure/SWHC061/01-draft/

USE CATEGORY
HC - HVAC

COMMITTED
May 17, 2023 5:05 PM

STATUS
Cal TF Staff Review

EFFECTIVE START DATE
May 1, 2023

VERSION
SWHC061-01-draft

DOWNLOADED
May 18, 2023 6:40 AM

Technology Summary

A solar attic fan can be used to exhaust warm attic air outside and keep attics cooler. Unconditioned attics trap heat and consistently get hotter than the exterior of a building. Attic fans replace the hot attic air with cooler outside air, and solar attic fans do so without having to rely on the utility supplied electricity. Solar attic fans only ventilate the attic when the sun is out, which also coincides with the times that an unconditioned attic space will be hottest and get the largest benefit from being ventilated.

Using a solar attic fan to cool an attic can save energy in two ways. The first way is simply by removing the electric load that a standard attic fan uses. When the sun is out, solar attic fans operate and do not draw power. The second method of energy saving is a result of the attic being cooler. A cooler attic means a smaller heat load in the building's conditioned spaces and on any HVAC equipment or ducting that may be located in the attic. This reduces the mechanical cooling load experienced by the HVAC system. Both of these energy saving methods can reduce demand during peak periods for residential buildings in the cooling season.

Although this measure package has currently been developed only for publicly owned utility (POU) customers, the use of solar energy for non-generating equipment for energy efficiency is supported by CPUC Decision 09-12-022 and the *Energy Efficiency Policy Manual.* R1270 (Page 64)

Measure Case Description

The measure case is defined as the installation of a fully solar powered attic fan in a residential single family or multifamily building. Although the measure case equipment is the same for all offerings, the offerings themselves vary based on whether the home has an existing attic fan and/or air conditioning system.

Offering ID

BASE CASE EQUIPMENT	MEASURE APPLICATION TYPE	STATEWIDE MEASURE OFFERING ID (TEXT)	MEASURE OFFERING DESCRIPTION (TEXT)
Existing Attic Fan with AC	NR	**A**	**Solar attic fan in home with AC, NR**
Existing Attic Fan with No AC	NR	**B**	**Solar attic fan in home with no AC, NR**
No Existing Attic Fan with AC	AOE	**C**	**Solar attic fan in home with AC, AOE**

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Base Case Description

The base case systems are differentiated by the existence of either an electrically powered attic fan and/or air conditioning system. Standard powered attic fans are assumed to use minimally compliant fan motor efficiencies based on federal U.S. Department of Energy (DOE) standards (see Code Requirements section).

Offerings that replace an existing powered attic fan use the normal replacement (NR) measure application type, while those that add a solar attic fan where no attic fan existed use the add-on equipment (AOE) measure application type.

Base Case Descriptions

BASE CASE EQUIPMENT	MEASURE APPLICATION TYPE	STANDARD DESCRIPTION (TEXT)	EXISTING DESCRIPTION (TEXT)
Existing Attic Fan with AC	NR	**Existing attic fan in home with AC**	**Existing attic fan in home with AC**
Existing Attic Fan with No AC	NR	**Existing attic fan in home with no AC**	**Existing attic fan in home with no AC**
No Existing Attic Fan with AC	AOE	**Existing attic fan in home with AC**	**Existing attic fan in home with AC**

Code Requirements

The fan motors in attic fan equipment is governed by Federal Regulations which specifies efficiency requirements. No specific California Title 24 or Title 20 code language exists for attic fans.

Applicable State and Federal Codes and Standards

CODE	CODE REFERENCE	EFFECTIVE DATE
CA Appliance Efficiency Regulations – Title 20	None.	n/a
CA Building Energy Efficiency Standards – Title 24	None.	n/a
Federal Standards – Code of Federal Regulations	Subpart X section 431.446 (a)	March 9, 2015 March 9, 2017

Small motors, less than 3 hp and not of specific NEMA designs, are regulated by CFR Title 10 Subpart X section 431.446 (a). R1691 (431.446 (a)) Small electric motors manufactured (alone or as a component of another piece of non-covered equipment) after March 9, 2015, or in the case of a small electric motor which requires listing or certification by a nationally recognized safety testing laboratory, after March 9, 2017, shall have an average full load efficiency of not less than the values shown in the table below.

CFR 431.446 (a) Small Electric Motors Conservation Standards - Average Full-Load Efficiency

MOTOR HORSEPOWER/ STANDARD KILOWATT EQUIVALENT	AVERAGE FULL LOAD EFFICIENCY		
	CAPACITOR-START CAPACITOR-RUN AND CAPACITOR-START INDUCTION-RUN		
	OPEN MOTORS (NUMBER OF POLES)		
	6	4	2
0.25/0.18	62.2	68.5	66.6
0.33/0.25	66.6	72.4	70.5
0.5/0.37	76.2	76.2	72.4
0.75/0.55	80.2	81.8	76.2
1/0.75	81.1	82.6	80.4
1.5/1.1	N/A	83.8	81.5
2/1.5	N/A	84.5	82.9
3/2.2	N/A	N/A	84.1

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.

Note that some of the implementation combinations below may not be allowed for some measure offerings by all program administrators.

Implementation Eligibility

MEASURE APPLICATION TYPE	SECTOR	DELIVERY TYPE
AOE	Res	DnDeemDI
AOE	Res	DnDeemed
AOE	Res	UpDeemed
NR	Res	DnDeemDI
NR	Res	DnDeemed
NR	Res	UpDeemed

PRODUCT AND INSTALLATION ELIGIBILITY

In addition to meeting the measure case requirements (see Measure Case Description section), the following eligibility requirements apply:

- The solar attic fan must be UL certified for relevant UL safety standards by a Nationally Recognized Testing Laboratory (NRTL).
- The solar attic fan must be permanently installed (connected to the roofing/framing of the house)
- Any type of permanently installed solar attic fan is eligible, including but not limited to, through-the-roof, gable, or curb mounted solar attic fans.
- The solar attic fan must come as single product, not assembled from parts from separate manufacturers. Systems where the solar panel is installed remote from the fan system, such as is common for gable fans, are eligible as long as the fan and solar panel are designed to operate together by the manufacturer.
- The solar attic fan must be installed in largely unshaded area.
- Only one solar attic fan can be installed per home, dwelling unit, or tenant space with an attic.

ELIGIBLE BUILDING TYPES AND VINTAGES

This measure is applicable for the single-family and multifamily residential building types of existing vintages.

ELIGIBLE CLIMATE ZONES

This measure is applicable in all California climate zones.

ELIGIBLE UTILITIES

As a POU only measure, this measure package has not been reviewed and approved by the California Public Utilities Commission (CPUC). Therefore, it is only eligible for adoption by POU entities, not investor owned utilities (IOUs).

Program Exclusions

The following building types are excluded:

- All nonresidential building types
- Mobile homes

Data Collection Requirements

For all delivery types, the following site information data must be collected:

PROGRAM DATA FOR ALL DELIVERY TYPES
SiteID
EquipmentID
Solar attic fan equipment manufacturer

PROGRAM DATA FOR ALL DELIVERY TYPES
Solar attic fan equipment model number
Type of air conditioning system currently serving the house (if applicable)
Existence of a powered attic fan in the home (Yes/No)
Invoice of project or cost of installed products

Electric Savings (kWh)

The unit energy savings (UES) for this measure was calculated as the difference between baseline and measure case annual energy consumption (AEC) modelled in Database for Energy Efficient Resources (DEER) version 2024 EnergyPlus prototype building models. R2149 R2156 The baseline prototype models for vintage 1985 one-story single-family (SFm1), two-story single-family (SFm2), and multifamily (MFm) buildings with standard efficiency air conditioners and gas furnaces were altered to simulate the specific base and measure case systems in this measure package.

The analysis utilized the ModelKit scripts provided by the DEER team to make parametric adjustments to the baseline prototypes. For all models, the following parameters were exported on either an hourly or annual basis to calculate the savings.

- Annual energy consumption (AEC) building consumption in kWh and therms
- Attic fan energy consumption in kWh

The following sections describe the updates made for each baseline and measure case in more detail.

Base Case: No Existing Attic Fan with AC

No changes were made to this prototype model to simulate an existing home with an HVAC system and no attic fan.

Base Case: Existing Attic Fan with AC

To simulate the performance of an existing powered attic fan in a home with an air conditioning system, the following updates were made:

First an energy recovery ventilator (ERV) system was inserted to each attic zone in the model. The EnergyPlus object *ZoneHVAC:EnergyRecoveryVentilator* "provides a model for a stand alone energy recovery ventilator (ERV) that is a single-zone HVAC component used for exhaust air heat recover". R2198

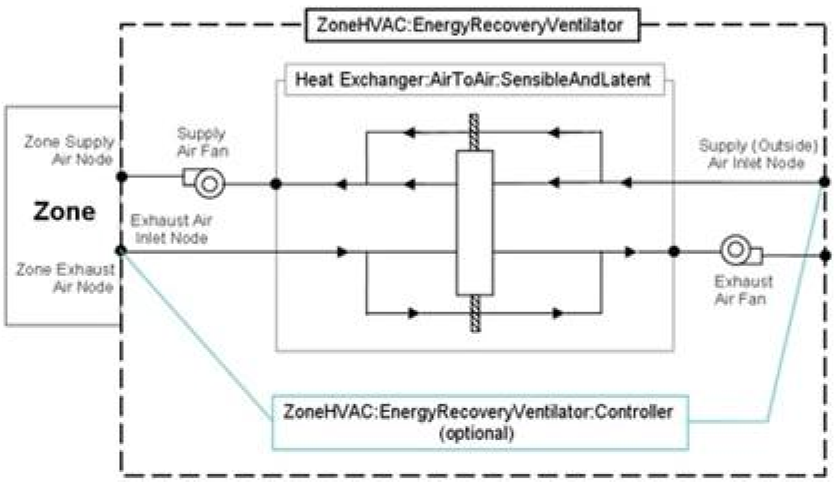

Diagram of an Example ERV System from Big Ladder website

Although this object is intended to be used for heat recovery systems, it was altered to simulate a simple exhaust fan system in the attic zones. The following changes were made to the ERV system to simulate an attic fan:

- All sensible and latent effectiveness values for the heat exchanger were set to 100% and heat exchanger electrical power (*Nominal Electric Power*) was set to 0.0 watts. This removes any heat transfer inefficiencies and energy consumption of the heat exchanger from the model, effectively modelling air mixing in the attic zone.
- The supply and exhaust nodes for the ERV systems for each attic zone were both connect to outdoor air instead of an interior conditioned zone.
- Based on data collected from attic fan manufactures, the ERV airflows were set to 12 air changes per hour (ACH) for the attic zones when in operation. R2152 This was done by automatically calculating zone airflow requirements (*fan_flow*) based on attic zone volumes for each prototype and setting air flow based on that.
- The ERV system includes both a supply and exhaust fan. To balance the airflow in the system, the airflows for both fans were set equal to each other. Furthermore, since the attic fan includes only a single exhaust fan, the supply fan was modelled to draw no power. In EnergyPlus, fan power for a single speed fan is calculated using the formula below. To model a system that has no supply fan, supply fan static pressure rise (*fan_rise*) was set to 0.00 inches w.c., which effectively sets the fan power to zero. R2199

$$\text{Fan Power} = m_{air} * \Delta P_{sp} / (\varepsilon_{fantot} * \rho_{air})$$

m_{air} = *Mass of air flow (kg/s)*
ΔP_{sp} = *Static pressure rise (Pa)*
ε_{fantot} = *Efficiency percent of the full fan system, including both fan mechanical and motor efficiencies*
ρ_{air} = *Density of air (kg/m³)*

- Exhaust fan system inputs were modified so that the calculated watts per cfm were set to 0.10 watts per cfm. This aligns with data found through the online cost research for commercially available powered attic fans. The flow rates, power, and watts per cfm from each building type are shown in the table below. Single family attics all had the same values but multifamily modelled values differed for the various attic zones. Minimum and maximum values for multifamily homes are shown here. R2149

Exhaust Fan System Energy Saving Analysis Inputs

BUILDING MODEL	FLOW (CFM)	FAN POWER (WATTS)	MODEL FAN EFFICIENCY (W/CFM)	ONLINE RESEARCH FAN EFFICIENCY (W/CFM)
Single Family – 1 story	2786	278.6	0.10	0.10
Single Family – 2 story	1087	108.7	0.10	
Multifamily (minimum values)	90	9.0	0.10	
Multifamily (maximum values)	168	16.9	0.10	

- Lastly, the fan operation was controlled using the energy management system program (*EnergyManagementSystem*) to control the ERV to only operate when the attic zone temperature (*Zone Air Temperature*) met or exceeded 80 °F. The activation temperature was selected based on data collected from attic fan manufacturers about their suggested temperature setpoints. R2152

Measure Case: Solar Attic with AC

The following changes were made to the Existing Attic Fan with AC baseline model, in order to simulate a home with a solar attic fan and AC.

- Similar to the ERV supply fan, the static pressure rise across the exhaust fan system (*fan_rise)* was set to 0.00 inches w.c., which effectively sets the fan power to zero.

- The energy management system program was updated to activate the ERV to operate when both the attic zone temperature meets or exceeds 80 °F and the direct solar irradiance (*Site Direct Solar Radiation Rate per Area*) received by the building is greater than 0.0 watts per square meter (W/m^2).

- The use of 0.0 W/m^2 as a shutoff threshold for the solar attic fan is supported by an analysis of the incident direct solar energy provided in the CZ2022 weather files. The analysis reviewed the last hour values of the Normal Solar (Wh/m^2) field, which is analogous to the *Site Direct Solar Radiation Rate per Area* field used to control the attic fan. The analysis found the average Wh/m^2 for each climate zone during the summer months. Using the average solar attic fan motor power from the costing analysis, and assumed values for solar panel size (0.5 m^2) and solar panel efficiency (20%), it was estimated that the final hour of sunlight during the day would provide enough energy power to run the solar attic fan for 32 minutes on average. R2148 R2149 (Solar Analysis tab) Since the weather files are provided on an hourly timestep and do not have the granularity to support less than hourly changes in operation, this average last hour runtime was deemed reasonable to justify the 0.0 W/m^2 shutoff threshold.

Base Case: Existing Attic Fan with No AC & Measure Case: Solar Attic Fan with No AC

Both base and measure cases where there was no existing air conditioning but there was an attic fan used the same methodologies as described above. However, in these models cooling was disabled at all times. This was done by changing cooling coil availability schedule (*cooling_coil_sched*) to be OFF at all times (*alway_off*). Since the attic fans will operate mainly in the cooling season, no changes were made to the heating coils availability schedules.

ANNUAL UNIT ENERGY SAVINGS

UES values were calculated based on model outputs for annual energy consumption (AEC) in kWh and the total number of attic zones in the each model. Energy savings values took the difference between the various base and measure case AECs and then divided by the number of attic zones in order to normalize savings by dwelling unit. R2149

$$UES = (AEC_{base} - AEC_{meas\_SAF}) / Qty_{AZ}$$

AEC_{base} = Annual energy consumption of base case (kWh/yr)
AEC_{meas_SAF} = Annual energy consumption of measure case with solar attic fan (kWh/yr)
Qty_{AZ} = Quantity of attic zones in the model (#)

The table below shows the quantities of attic zones used in the analysis. The quantity of attic zones is used to estimate the number of dwelling units in each model with attics.

Attic Zone Quantity Per Building Type Model

BUILDING TYPE MODEL	QUANTITY OF ATTIC ZONES
SFm1	2
SFm2	2
MFm	26

Peak Electric Demand Reduction (kW)

Peak electric demand reduction was calculated as the average of the electrical power draw between 4:00 p.m. to 9:00 p.m. in conformance with the Database for Energy Efficiency Resources (DEER) peak definition. Peak days were selected in accordance with *Resolution E-5152*. R1503 Savings were derived using the methodology presented in the Electric Savings section.

Gas Savings (Therms)

The gas savings penalty was calculated using the same methodology specified in the Electric Savings section. Therm savings for this measure are negative.

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.

No DEER EUL exists for attic fan equipment. Therefore, the whole house fan EUL was selected to estimate the EUL of a solar attic fan. For AOE offerings, the full EUL of the attic fan is used. Per *Resolution E-5221*, when the host proxy of an AOE measure is a part of a building system the full EUL of the AOE is used to determine measure life. For this measure, the attic fan is installed to the roof of the building, which is expected to last through the building life cycle without scheduled replacement. R2026

Effective Useful Life and Remaining Useful Life

EFFECTIVE USEFUL LIFE ID	EUL DESCRIPTION (TEXT)	SECTOR (TEXT)	EUL YEARS (YR)	START DATE (TEXT)	EXPIRE DATE (TEXT)
HV-WHfan	**Whole House Fans**	**Res**	**20.00**	**2013-01-01**	

Base Case Material Cost ($/Unit)

The base case refers to either an existing attic fan or no existing attic fan. For the base case of no existing attic fan, there is no existing equipment; therefore, the base case material cost is $0.00.

For the base case with a powered attic fan, the estimation of the base case material cost was derived from online prices for powered attic fans retrieved from various online retailers in the fourth quarter of 2022. Costing was restricted to fans with flow rates (cfm) typically seen by Californian installers for typical attic installations. From this dataset, the measure cost was calculated as the average of 45 different sample costs. R2148

Material Costs

MEASURE APPLICATION TYPE	FIRST BASE CASE MATERIAL COSTS (USD)
AOE	**$0.00**
NR	**$175.26**

Measure Case Material Cost ($/Unit)

The estimation of the measure case material cost was derived from online prices for solar attic fans retrieved from various online retailers in the fourth quarter of 2022. Costing was restricted to fans with flow rates (cfm) typically seen by Californian manufacturers and installers for typical attic installations. From this dataset, the measure cost was calculated as the average of 95 different sample costs. R2148

Material Costs

MEASURE APPLICATION TYPE	MEASURE CASE MATERIAL COSTS (USD)
AOE	**$422.13**
NR	**$422.13**

Base Case Labor Cost ($/Unit)

The base case refers to either an existing attic fan or no existing attic fan. For the base case of no existing attic fan, there is no existing equipment; therefore, the base case labor cost is $0.00.

The estimation of the base case labor cost follows the approach to estimate the measure case costs, as summarized in the Measure Case Labor Cost section. However, in addition to consulting Californian manufacturers and installers, the base case labor cost also used home improvement websites to help estimate labor hours. R2148

Labor Cost - Calculation Inputs

MEASURE APPLICATION TYPE	LABOR HOURS - BASE CASE (HR)	2023 RESIDENTIAL ELECTRICIAN LABOR RATE (USD)
AOE	**0.00**	**$92.45**
NR	**2.60**	**$92.45**

Measure Case Labor Cost ($/Unit)

Measure case labor cost was calculated as the product of the average labor hours and labor rate. Labor hours were derived from installation times collected from manufacturers for solar attic fans in the first quarter of 2023. In addition to the installation hours, a trip charge, estimated to be one hour based on online research, was also included. The trip charge is a common base fee associated with residential contractors. Labor rates were obtained from RSMeans 2023 for residential electricians and adjusted to the California region via a 2023 location adjustment index from RSMeans. R2113 R2155 Since the measure offerings are not differentiated between attic fan type (through-the-roof, gable, curb, etc.) the average of all installation types was used. R2148

Labor Cost - Calculation Inputs

MEASURE APPLICATION TYPE	2023 RESIDENTIAL ELECTRICIAN LABOR RATE (USD)	LABOR HOURS - MEASURES CASE (HR)
AOE	**$92.45**	**2.12**
NR	**$92.45**	**2.12**

Net-to-Gross

The net-to-gross (NTG) ratio represents the portion of gross impacts that are determined to be directly attributed to a specific program intervention. This NTG is applicable to all energy efficiency measures that have been offered for less than two years and for which impact evaluation results are not available, as documented in the *2011 DEER Update Study* conducted by Itron, Inc. R103 (Page 15-4, Table 5-3)

Net-to-gross ratios are not required for POU measures. However, the NTG ID is associated with this measure for potential future use in IOU programs.

Net to Gross Ratio

NET TO GROSS RATIO ID	NTG DESCRIPTION (TEXT)	NTG ELECTRIC (RATIO)	START DATE (TEXT)	EXPIRE DATE (TEXT)
All-Default<=2yrs	**Measures not covered by other NTG values and measure technology type has been available in marketplace for 2 years or less. This NTG value shall not be used for higher efficiency products of technology types that have been available in market place for more than 2 years.**	**0.7000**	**2019-01-01**	

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. R1270

Gross Savings Installation Adjustments - Default

GSIA ID	GSIA (RATIO) R1270
Def-GSIA	**1.0000**

Non-Energy Impacts

The installation of solar attic fans results in various non-energy impacts (NEI). As part of this measure package, the NEIs related to greenhouse gas (GHG) reduction and ASHRAE 55 thermal comfort for the LADWP territory were calculated.

GREENHOUSE GAS IMPACTS

LADWP has developed projections for carbon emissions intensities (ton CO2e /kWh) for the years 2023 through 2034. Based on these emissions values, the total lifetime GHG reductions and average annual GHG reduction over the measure lifetime were calculated for each offering, building type, and climate zone in the LADWP region. To do this, the annual electric energy savings were multiplied by the carbon intensity per year and summed over the full EUL of the offerings. Since the GHG emissions projections are only available until 2034, it was conservatively assumed that all following years used the same intensities as 2034. Furthermore, the GHG emissions associated with natural gas impacts were also summed to find the total GHG impacts for the offering. The values in the table below represent the average across each building type and for LADWP climate zones. R2156 R2150

Average Greenhouse Gas Reduction

OFFERING ID	MEASURE DESCRIPTION	BASE CASE DESCRIPTION	AVERAGE LIFETIME GHG REDUCTIONS PER UNIT (METRIC TON CO2E)	AVERAGE ANNUAL GHG REDUCTIONS OVER LIFETIME PER UNIT (METRIC TON CO2E/YR)
A	Solar attic fan in home with AC	Existing attic fan in home with AC	0.332	0.017
B	Solar attic fan in home with no AC	Existing attic fan in home with no AC	0.342	0.017
C	Solar attic fan in home with AC	No existing attic fan in home with AC	0.183	0.009

ASHRAE 55 COMFORT ANALYSIS

ASHRAE 55-2020 *Thermal Environmental Conditions for Human Occupancy* provides a methodology and analysis tools to review the impacts of conditioned spaces on human thermal comfort. ASHRAE 55-2020 includes two primary models to estimate comfort; the predicted mean vote (PMV) and the predicted percentage dissatisfied (PPD) models. This analysis uses the predicted mean vote (PMV) model, which is "an index that predicts the mean value of the thermal sensation votes (self-reported perceptions) of a large group of persons on a sensation scale expressed from –3 to +3 corresponding to the categories "cold," "cool," "slightly cool," "neutral," "slightly warm," "warm," and "hot." R2153

ASHRAE 55-2020 uses a threshold of +/- 0.5 as the indices where an occupant is considered comfortable. For existing buildings, the International Organization for Standardization (ISO), in their standard ISO 7730:2005 *Ergonomics of the thermal environment,* uses +/- 0.7 as the threshold for comfort. R2154 However, one of the intents of implementing this measure is to reduce prolonged exposure to extreme heat conditions which can cause severe health issues. In order to review the impact of this measure on excessive in-home heat exposure, rather than just thermal comfort, this analysis uses a comparison PMV value of 2.0, which would reflect the hours that were considered too warm.

ASHRAE Thermal Comfort Index

ASHRAE 55-2020 PMV INDEX	SENSATION DESCRIPTION
-3	Cold
-2	Cool
-1	Slightly cool
-0.7	Comfortable
0	Neutral (Comfortable)
+0.7	Comfortable
+1	Slightly warm
+2	Warm
+3	Hot

The environmental conditions that affect the PMV index include, dry bulb air temperature, mean radiant temperature (MBT), air speed, relative humidity, metabolic rate, and clothing level. To review the changes in thermal comfort modelled in the EnergyPlus models, the hourly values for representative zones were exported for dry bulb temperature, mean radiant temperature, and relative humidity. For single family homes, all conditioned zones were exported. Since multifamily models include dozens of zones, a sampling of 8 zones on the south and west facing sides and corners of the home were exported as these were assumed to represent the warmest zones. In addition to the values exported from EnergyPlus, the following variables were held constant in the analysis.
R2156

Thermal Comfort Calculation Input Parameters

PARAMETER	VALUE	NOTES
Air speed	0.1 m/s	Typical indoor air speed
Clothing level	0.50 clo	Typical summer indoor clothing
Metabolic Rate	1.0 met	Activity level: Seated, quiet (Table 5-1)

The Center for the Built Environment (CBE) at the University of California, Berkley has developed the CBE Thermal Comfort Tool (https://comfort.cbe.berkeley.edu/). It is an online tool which uses the algorithms provided in *ASHRAE 55-2020* to calculate thermal comfort values using a variety of methods and inputs. CBE also provides a python script (thermalcomfort.py) that that can be used for bulk processing efforts. The PMV model python script was run with the previously mentioned input variables to return hourly comfort values for each base and measure case model.

Additionally, three new weather files were run for the LADWP territory. These weather files were developed by the University of California, Los Angles (UCLA) as part of LADWP's LA100 initiative to simulate extreme weather events in the year 2035. These weather files represented Los Angeles International Airport (LAX), Downtown Los Angeles/University of Southern California (USC), and the Van Nuys Airport, which correspond to climate zones 6, 8, and 9, respectively.

The comfort analysis for the baseline unedited DEER prototype models showed varying levels of uncomfortable hours. Therefore, a percentage change of uncomfortable hours between the base case and measure case was conducted instead of a review of absolute hours changed due to the implementation of the measure. Furthermore, since the solar attic fan measure will only impact thermal comfort during the summer months, this analysis only reviews PMV values for the summer months of June through September. The table below shows the impacts of the comfort analysis averaged across all building types and LADWP climate zones. The rightmost column represents the values for the extreme heat weather files only. R2151 R2156

Based on the analysis, the solar attic fan results in a very small increase in "too warm" hours when replacing powered attic fans in homes. This is likely due to the solar attic fans turning off when the sun sets but when attic is still hot. When installing solar attic fans in homes without existing powered attic fans, there is a small reduction in "too warm" hours. This analysis was also run for a baseline that has no cooling or existing attic fan. As expected, this results in a larger reduction in "too warm" hours. The average reduction of 0.5% in "too warm" hours for the home with previously no cooling or attic fan equates to roughly 15 hours over summer months for LADWP climate zones.

Measure's Effect on Thermal Comfort Hours

OFFERING ID	MEASURE DESCRIPTION	BASE CASE DESCRIPTION	PERCENT CHANGE IN UNCOMFORTABLE HOURS (%) - CZ2022 WEATHER	PERCENT CHANGE IN UNCOMFORTABLE HOURS (%) - LA100 2035 WEATHER
A	Solar attic fan in home with AC	Existing attic fan in home with AC	0.000%	0.000%
B	Solar attic fan in home with no AC	Existing attic fan in home with no AC	0.002%	0.013%
C	Solar attic fan in home with AC	No existing attic fan in home with AC	-0.001%	0.000%
N/A	Solar attic fan in home with no AC	No existing attic fan in home with no AC	-0.500%	-0.148%

DEER Differences Analysis

This section provides a summary of inputs and methods based upon the Database of Energy Efficient Resources (DEER), and the rationale for inputs and methods that are not DEER-based.

DEER Difference Summary

DEER ITEM	COMMENT
Modified DEER methodology	No
Scaled DEER measure	No
DEER Base Case	No
DEER Measure Case	No
DEER Building Types	Yes
DEER Operating Hours	Yes
DEER eQUEST Prototypes	Yes (DEER2024 EnergyPlus for residential buildings, existing vintage)
DEER Version	N/A

Reason for Deviation from DEER	No DEER measures exist for solar attic fans.
DEER Measure IDs Used	N/A

References

R103 Itron, Inc. 2011. *DEER Database 2011 Update Documentation*. Prepared for the California Public Utilities Commission.
Download (PDF, 2.6 MB)

R1270 California Public Utilities Commission (CPUC), Energy Division. 2020. *Energy Efficiency Policy Manual Version 6.* April.
Download (PDF, 1.1 MB)

R1270 California Public Utilities Commission (CPUC), Energy Division. 2020. *Energy Efficiency Policy Manual Version 6.* April. Page 34-35.
Download (PDF, 1.1 MB)

R1503 California Public Utilities Commission (CPUC). 2021. *Resolution E-5152.* August 6. **Download** (PDF, 1.7 MB)

R1691 Code of Federal Regulations at 10 CFR 431 Subpart X.

R2026 California Public Utilities Commission (CPUC). 2022. *Resolution E-5221*. November 3. **Download** (ZIP, 1.5 MB)

R2113 Gordian Group, Inc. 2023. "RSMeans Data Online." MASTERFORMAT City Cost Indexes. Year 2023 Base.

R2148 Los Angeles Department of Water and Power (LADWP). (n.d.) "SWHC061-01 Cost Data_3-18-23.xlsx." **Download** (XLSX, 77.0 KB)

R2149 Los Angeles Department of Water and Power (LADWP). (n.d.) "SWHC061-01 Energy Savings Analysis_4-16-23.xlsx."
Download (XLSX, 2.3 MB)

R2150 Los Angeles Department of Water and Power (LADWP). (n.d.) "SWHC061-01 LADWP GHG Analysis_4-16-23.xlsx."
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