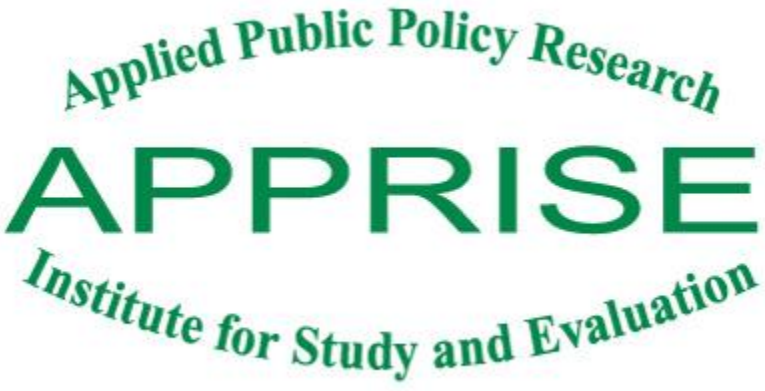

California Energy Savings Assistance Program
Non-Energy Benefits
Final Report

January 2021

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Executive Summary

The California Energy Savings Assistance Program (ESA) provides no-cost, direct installed weatherization and energy efficiency measures to provide energy savings and improved health, comfort, and safety to eligible low-income households served by the Investor-Owned Utilities (IOUs) (PG&E, SCE, SoCalGas, and SDG&E[1]). The IOUs use a set of non-energy benefit (NEB) calculations in their ESA cost-effectiveness tests to account for benefits in addition to the energy savings that accrue to the utilities, society, and ESA participants.

The IOUs contracted with APPRISE, a nonprofit research institute that specializes in energy research, to conduct this study of NEBs that arise from the ESA program. This report provides findings and recommendations from a review and assessment of the previous ESA NEB study that was conducted in 2019[2], and review of additional NEB research conducted around the country. This study recommends alternative calculations for the NEBs, develops a simplified model (in an accompanying Excel Workbook), and proposes additional research to further improve NEB measurement in the future.

Study Overview

The California IOUs sponsored this project to review and verify the NEBs proposed in the Skumatz Navigant 2019 Study, as many of the NEB assumptions, inputs, and calculations from that study had not been sufficiently vetted and accepted by the IOUs and other stakeholders. Because the NEBs are used in the ESA cost-effectiveness tests, it is critical to provide a rigorous analysis and update of the benefits included, the calculation formulas, and the assumptions made when performing the calculations. NEBs included as inputs to the cost-effectiveness tests must be reasonable, verifiable, and defensible. The model that is implemented must be clean, reliable, and transparent to ensure that it is consistently applied; that the NEBs are not otherwise captured in the avoided costs or other inputs to the tests; and that the value of the ESA program to the utility, participants, and ratepayers is estimated in a reasonable and justifiable manner.

This report reviews the NEBs proposed and included in the 2019 study and the revised calculations in this current 2020 study in a much more detailed manner than was done in the 2001 Low-Income Public Purpose Test (LIPPT)[3] or the 2019 study. The goal is to provide transparency with respect to the data and methodology, as well as with respect to the limitations in the previous and current research. Upon this detailed review, it becomes clear that current NEB measurement must rely on studies that are too old, that were conducted in other jurisdictions with different weather patterns, and that relate to energy efficiency

[1]Pacific Gas and Electric, Southern California Edison, Southern California Gas, and San Diego Gas & Electric.
[2]Skumatz Economic Research Associates, Inc. and Navigant Consulting Inc., Non-Energy Benefits and Non-Energy Impact (NEB/NEI) Study for the California Energy Savings Assistance (ESA) Program, Volumes 1 and 2, August 2019. https://pda.energydataweb.com/#!/documents/2295/view
[3] TecMarket Works et al, The Low Income Public Purpose Test Updated for Version 2.0, May 25, 2001, available at: http://calmac.org/publications/Final_LIPPT_Report_v4.pdf and
Equipoise Consulting Incorporated, LIEE Program and Measure Cost Effectiveness, March 28, 2002, available at: http://calmac.org/publications/Final_LIEE_CE_Report_V2.pdf

programs that differ significantly from the CA ESA program. Therefore, ESA-specific research is recommended to provide better NEB estimates for the ESA program.

Key Changes from 2019 Model

Many changes were made to the previous model, with the goals of transparency, simplicity, and improved accuracy. These changes were made based on the following information.

- Methodology: Many of the changes were differences in the calculations based on an assessment of how the program impacts the ESA participant household.

- Data: When available, data used in the 2019 model were updated with the most recent data available. Examples of data updates include utility collections costs and ESA evaluation impacts.

- Literature Sources: Many of the 2019 NEB calculations used data that were up to 20 years old, from jurisdictions outside of CA with different weather patterns, and with very small sample sizes. These sources were removed from the model in most cases.

Key changes to the NEB model are summarized below.

- Bill Savings: One important input in the Payment-Related NEBs; the Economic NEB; and the Health, Safety, and Comfort NEBs is the energy bill savings that result from the ESA program. These savings are equal to the kWh or therm ESA savings multiplied by the retail rate paid by participants in the California Alternate Rates for Energy (CARE) program that provides discounts on energy bills for income-qualified customers.

  The 2019 model used measure-level energy savings multiplied by the average number of measures installed per participant. The advantage of this method is that it utilizes the average number of measures installed in the most recent year, which best represents the current average installation package. The measure-level energy savings are developed by running a regression of energy savings (developed through a billing analysis) on each installed measure. However, it is not possible to develop a good estimate of the savings achieved by each individual measure because the sample is not large enough, the variation in measures installed is not large enough, and the savings achieved for some measures is too small to develop a statistically significant estimate. For those measures where good regression estimates were not developed, the previous model used projected savings for individual measures. As a result, the sum of the measure-level savings greatly overstates the energy savings achieved by the program as compared to the energy savings estimated in the billing analysis. Therefore, the energy bill savings is well overstated and results in overstated NEBs. If the reported savings are used as an input in the NEB analysis, they should first be adjusted by the realization rate.

  The model proposed in this study uses the total electric and natural gas savings estimated in the most recent impact evaluation billing analysis to overcome this problem of overstated savings. The advantage of this method is that it provides a much more accurate estimate of energy savings. The disadvantage of this model is that it can only provide savings from the most recent impact evaluation, and the measure mix may have changed

between the most recent evaluation and the current NEB study. For example, the current model uses energy savings from the 2017 ESA impact evaluation. (Note that in some cases, utilities used disaggregated measure savings that sum to the whole house evaluated savings. The use of measure-level savings is another option in these cases.)

- Payment-Related NEB Methodology: The 2019 study used the percentage reduction in the payment-related indicator as the reduction achieved in the ESA program. For example, the 2019 report used the arrearage reduction estimated in a referenced 2002 CT study. The 2002 study found a 32 percent reduction in arrearages, so they valued the ESA arrearage reduction as 32 percent of the average CARE participant arrearage, which was a reduction of $70. The amount of energy cost savings achieved by the ESA program is not factored into this estimate.

  This 2020 study maintains that the percent reduction in arrearages should relate to the bill reduction achieved by the ESA program. For example, over several studies of low-income households, when bills were reduced by an average of $564, arrearages were reduced by an average of $238, or 37 percent of the bill reduction. The average ESA bill reduction was $19, so the average ESA arrearage reduction was calculated as 37 percent of $19, equal to $7 (and the carrying cost is equal to that reduction multiplied by the interest rate).

  Table ES-1 summarizes how the payment-related impacts were developed in the 2019 study and in this study.

Table ES-1
Payment-Related NEB Impact Calculation

Payment-Related NEB	2019 Impact Method	2020 Method
Reduced Arrearage Carrying Cost	2002 CT wx participant arrearage reduction percentage	Arrearage reduction as a percent of bill reduction (lit review)
Reduced Bad Debt Write-Off		
Fewer Shutoffs	2002 CT wx participant shutoff reduction percentage	Shutoff reduction relative to bill reduction (lit review)
Fewer Notices	2014 National WAP notice reduction percentage	Collections notice reduction relative to bill reduction (lit review)
Fewer Collections Calls	2002 CT wx participant arrearage reduction percentage	Collections call reduction relative to bill reduction (lit review)

- Economic Benefits: The Economic Impact NEB was developed for the 2019 model but was not included. This study includes the Economic Impact NEB. The ESA program expenditures increase economic output in California because spending on the ESA program has a greater multiplier effect than the alternative spending and because ESA participants' spending with their energy bill savings has a greater multiplier effect than the alternative spending.

- NEB Inclusion: Many changes were made to the NEBs included in the model as compared to the 2019 study. Table ES-2A shows that ten NEBs were kept, all with modifications

in data and methodology. Table ES-2B shows the four NEBs that were added in the 2020 model. While these NEBs were proposed in some form in the 2019 model, they were not ultimately included. Table ES-2C shows the eight NEBs that were included in the 2019 model but that were not included in the 2020 model. They were excluded because they are not supported by the literature, they are already accounted for in other NEBs, or there are no data available to provide a reasonable calculation. More detail on the excluded NEBs is provided in the Appendix.

Table ES-2A
NEBs from the 2019 Model that were Retained in the 2020 Model

Benefit	Type	Category
Arrearage Carrying Cost	Utility	Payment-Related
Shutoffs (& Reconnections)	Utility	Payment-Related
Collections Notices	Utility	Payment-Related
Collections Calls	Participant	Payment-Related
Water / Wastewater Bills	Participant	Other Cost
Operations & Maintenance	Participant	Home Operation & Value
Health*	Participant	Health, Safety, & Comfort
Safety**	Participant	Health, Safety, & Comfort
Comfort	Participant	Health, Safety, & Comfort
Noise Reduction (Inside & Outside)	Participant	Health, Safety, & Comfort

*Health includes CO Poisonings, Asthma Incidents, Reduction in Allergies from 2019 model.
** Safety includes Fires and Scalding from 2019 model.

Table ES-2B
NEBs that were Added in the 2020 Model

Benefit	Type	Category
Bad Debt Write-Off	Utility	Payment-Related
Collections Calls	Utility	Payment-Related
Economic Output	Societal	Economic
Shutoffs	Participant	Payment-Related

Table ES-2C
NEBs that were Removed from the 2019 Model

Benefit	Type	Category
Water / Wastewater Infrastructure	Societal	Other Cost
Fires	Participant	Health & Safety
CO Poisonings	Participant	Health & Safety

Benefit	Type	Category
Asthma Incidence	Participant	Health & Safety
Allergies	Participant	Health & Safety
Scaldings	Participant	Health & Safety
Detergent Usage	Participant	Home Op. & Value
Home Appearance	Participant	Home Op. & Value

The NEBs proposed for inclusion in this study are summarized in Table ES-3. The 2019 NEB value (for SDG&E) was $66.46 compared to an average value of $55.95 across the four utilities with updated inputs in the model developed in this study. While utility and participant benefits are lower in the 2020 model, societal benefits are higher due to the large value of the economic benefit.

Table ES-3
ESA Non-Energy Benefits Included with Modification

Utility Benefits	Societal Benefits	Participant Benefits
Reduced Arrearage Carrying Cost	Economic Output	Fewer Shutoffs
Reduced Bad Debt Write-Off		Fewer Calls to Utility
Fewer Shutoffs		Reduced Water / Wastewater Bills
Fewer Notices		Operation & Maintenance Cost Changes
Fewer Collections Calls		Improved Health*
		Improved Safety**
		Improved Comfort
		Reduced Noise***
2019 Non-Energy Benefit First Year Value per ESA Participant = $66.46#		
Utility Benefits	**Societal Benefits**	**Participant Benefits**
$6.68	$16.65	$43.13
2020 Non-Energy Benefit First Year Value per ESA Participant = $55.95##		
Utility Benefits	**Societal Benefits**	**Participant Benefits**
$2.46	$35.27	$18.22

*Improved Health includes CO Poisonings, Asthma Incidents, Reduction in Allergies from 2019 model. **Improved Safety includes Fires and Scalding from 2019 model. ***Reduced Noise includes indoor noise and outdoor noise. #The 2019 NEB value is the SDG&E value. ##The 2020 NEB value is the average of the four IOUs. Updated inputs are used where available.

- NEB Allocation to Measures: There was a significant change in the method used to allocate NEB value to the contributing measures. The change was partially made to greatly simplify the calculation. Given the level of uncertainty even in the overall NEB values, and even more so in the responsibility of each measure, developing an overly complex model provides a false sense of precision in the results.

- 2019 Model: The model developed a complicated system for allocating NEB value across the measures. The following values were used for the allocations.
  - Measure contribution to savings, with negative and zero measure savings values included.
  - Measure contribution to savings, with negative measure savings values set to zero.
  - Measure share of spending.
  - Measure share of water savings.

- 2020 Model: The model developed in this study allocates the NEB value to measures in proportion to the percentage of costs that the measures represent out of all responsible measures for the particular NEB.

Non-Energy Benefit Review

APPRISE reviewed and assessed the 46 NEBs from the 2019 Skumatz Navigant Study. For each NEB, we developed the following information to the maximum extent possible. In some cases, references were not provided for studies, website links did not work[4], or reports did not document assumptions and methodologies.

- Data: What data were used as inputs in the research?
- Assumptions: What simplifying assumptions were made?
- Methodology: How were the impacts calculated?
- Limitations: What were the limitations of the NEB calculations?
- Applicability: Do the estimates represent California ESA participants and the benefits that they could be expected to obtain from the ESA program, or are they appropriated from other jurisdictions or programs that are not applicable?
- Duplication: Do the NEBs duplicate one another or duplicate other benefits that are already accounted for in the ESA cost-benefit analysis?

Non-Energy Benefit Allocation

We reviewed and assessed the 2019 study's allocation of NEBs to program measures and proposed a simplified, alternative allocation method. The approach includes two steps.

- Step 1: Determine which measures are responsible for each NEB. This is performed based on an understanding of the relationship between the measures installed and the benefit that is estimated. For example, payment-related benefits result from reductions in energy bills. Therefore, all measures that reduce energy usage (and therefore result in energy cost reductions) are allocated to the payment-related NEBs. The water and wastewater NEB is only allocated to the measures that reduce water usage and costs.

- Step 2: Determine the percent of the NEB to allocate to each measure. We propose to allocate NEB value to measures in proportion to the percentage of costs that the measures represent out of all responsible measures for the particular NEB. The rationale for this approach within each NEB category is discussed below.

[4] It is understandable that website links may not work a year or more following publication of the study, however, additional internet searches were unable to locate the referenced research.

- Economic Output: The impact of the ESA program on economic activity is directly related to ESA expenditures. While ESA measures may have variable rates of labor inputs (and therefore have different output multipliers), the exact labor percentages are unknown and the percent of the total measure cost is the most accurate way to assess the impact of each ESA measure on the economic output NEB.

- Payment-Related: These NEBs depend on the energy usage reduction and cost reduction that result from ESA measure installation. If good estimates of measure-level savings were available, the best allocation method would use the energy bill savings resulting from each measure. However, accurate measure-level savings are not available. Therefore, a more reliable way to allocate the NEBs is to assume that energy cost reductions are related to investments in ESA measures to achieve a similar Savings to Investment Ratio (SIR) for each measure. The investments in the responsible measures are thus the most reliable means of determining the measure-level NEBs.

- Other Cost Reduction – Water & Wastewater Costs: This NEB will depend on the water usage reduction and cost reduction that result from ESA measure installation. The water savings used to generate the NEB estimate could be used for the allocation. However, this method would be more complicated than using the measure costs and would not provide increased accuracy. Therefore, a more straightforward approach to allocate the NEBs is to assume that water cost reductions are related to investments in ESA measures.

- Home Operation and Value: This NEB results from the reduction in appliance repairs due to appliance replacements. No good estimate of the relative impact of the various appliance replacements on repair costs is available. The best proxy for this impact is the total amount spent on each appliance relative to all appliance replacement costs.

- Health, Safety, and Comfort: These NEBs are valued based on participants' reports of the relative value of the NEB compared to the energy savings. As with the other NEBs, since good estimates of measure-level savings are not available, the best proxy is the relative amount spent on each responsible measure.

Non-Energy Benefit Model Contributions and Limitations

The 2019 NEB value was $66.46 (for SDG&E) compared to an average value of $55.95 across the four utilities with updated inputs in the model developed in this study.

This study makes the following contributions toward improving the CA ESA NEB estimates.

- NEB Inclusion Improvements
  - Includes only those NEBs that are relevant to the CA ESA program measures.
  - Excludes NEBs that were double counted.
  - Excludes NEBs with data that cannot be justified.

- NEB Data Improvements
  - Data sources are clearly identified.
  - Data are updated with the most recently available information.

- NEB Calculation Improvements
  - Calculation methodology is transparent.
  - NEB data from other jurisdictions with different savings were adjusted for applicability to the CA ESA program.
  - Calculation errors were identified and removed.
  - NEB allocation was simplified.

- Overall Model Improvements
  - False precision is reduced in this model.
  - Increased transparency is provided with respect to data inputs and calculations.

Despite improvements made based on this research, the model has limitations and additional research is recommended to improve the NEB calculation.

- Data Inputs: Some of the data used in the NEB calculations may require additional research or improved proxy data.

- IOU Data: In some cases, the IOUs do not use consistent data tracking. As a result, utility results may not be directly comparable.

- Payment Literature: The payment-related benefit calculations refer to unpublished studies conducted by APPRISE. These studies cannot be provided due to client confidentiality. However, the information provided includes key data to assess reliability and applicability including program type, program year, sample size, and comparison groups used in the analysis. This provides greater transparency than in the 2019 study.

- Water Savings: These data should be re-assessed to determine applicability to CA and additional research should be conducted to develop water savings estimates for ESA participants.

- Health, Safety, and Comfort Multipliers: These multipliers are from dated studies with small sample sizes in jurisdictions that differ from CA. Additional research should be conducted to develop multipliers for ESA participants.

- Uncertainty: There remains considerable uncertainty in the NEB values used in this report due to both the data inputs and the calculations. The uncertainty is present at the NEB level, and even more so at the measure level. It is important to acknowledge the uncertainty that is present in these estimates and not place a false sense of precision on the results.

Many limitations and imperfections of the prior model have been rectified, but the NEB values still include uncertainty. The uncertainty that remains is present at the NEB level, and even

more so at the measure level. It is important to acknowledge the uncertainty in the estimates and not place a false sense of precision on the results.

Non-Energy Benefit Research Recommendations

We recommended research to be conducted to provide more robust NEB calculations and potentially assess additional NEBs.

- Impact Evaluation: Each type of impact evaluation should include pre-post analysis with a comparison group. Except in the case of the water impact, the IOUs should be able to develop the necessary data from their billing systems.
  - ESA Usage Impact Evaluation: Continue to update energy savings estimates based on billing analysis.
  - ESA Payment Impact Evaluation: Analyze the impact of ESA energy savings on bills and arrearages for ESA participants.
  - ESA Collections Impact Evaluation: Analyze the impact of ESA energy savings on collections actions and costs for ESA participants.
  - ESA Water Impact Evaluation: Analyze the impact of ESA water savings on water and wastewater bills for ESA participants.
- ESA Benefit Perception Survey: Conduct a survey with ESA program participants. Ask participants to value NEBs relative to ESA energy bill savings.
- ESA Impact Survey: Conduct a pre- and post-treatment survey with ESA participants and a comparison group to estimate the impact of the ESA program on health, safety, comfort, and other indicators, as was done in the National WAP Evaluation Occupant Survey[5].
- Excel Model: Continue to improve the Excel Model.

[5] National Weatherization Assistance Program Evaluation. Analysis Report. Non-Energy Benefits of WAP Estimated with the Client Longitudinal Survey Final Report. January 2018. http://www.appriseinc.org/wp-content/uploads/2018/02/WAP-Non-Energy-Benefits-Analysis-Report.pdf

I. Introduction

The California Energy Savings Assistance Program (ESA) provides no-cost, direct installed weatherization and energy efficiency measures to provide energy savings and improved health, comfort, and safety to eligible low-income households served by the Investor-Owned Utilities (IOUs) (PG&E, SCE, SoCalGas, and SDG&E[6]). The IOUs use a set of non-energy benefit (NEB) calculations in their ESA cost-effectiveness tests to account for benefits in addition to the energy savings that accrue to the utilities, society, and ESA participants. This report provides findings and recommendations from a review and assessment of the Low-Income Public Purpose Test (LIPPT) originally developed in 2001 and the ESA NEB research that was conducted in 2019.[7]

The California IOUs sponsored this project to review and verify the NEBs proposed in the Skumatz Navigant 2019 Study, as many of the NEB assumptions, inputs, and calculations from that study had not been sufficiently vetted and accepted by the IOUs and other stakeholders. Because the NEBs are used in the ESA cost-effectiveness tests, it is critical to provide a rigorous analysis and update of the benefits included, the calculation formulas, and the assumptions that are made when performing the calculations. NEBs included as inputs to the cost-effectiveness tests must be reasonable, verifiable, and defensible. The model that is implemented must be clean, reliable, and transparent to ensure that it is consistently applied; that the NEBs are not otherwise captured in the avoided costs or other inputs to the tests; and that the value of the ESA program to the utility, participants, and ratepayers is estimated in a reasonable and justifiable manner.

The Skumatz Navigant 2019 study primarily utilized secondary research to update the ESA NEB calculations that were done in the 2001 Low-Income Public Purpose Test (LIPPT)[8] and recommended additional NEBs for inclusion in the ESA cost-effectiveness calculations. A key challenge with this work is that most NEB studies are too old and are based upon research in other jurisdictions with weather and energy efficiency programs that differ significantly from those in California. Additionally, many of the NEB calculations are not sufficiently documented. This study recommends alternative calculations for the NEBs, develops a simplified model, and proposes additional research to further improve NEB measurement in the future.

A. Research Summary

This study included the following research.

1. NEB Review: We reviewed and assessed the 46 NEBs from the 2019 Skumatz Navigant Study. For each NEB, we developed the following information to the maximum extent possible. In some cases, references were not provided for studies, website links did not work, or reports did not document assumptions and methodologies.

[6]Pacific Gas and Electric, Southern California Edison, Southern California Gas, and San Diego Gas & Electric.

[7]Skumatz Economic Research Associates, Inc. and Navigant Consulting Inc., Non-Energy Benefits and Non-Energy Impact (NEB/NEI) Study for the California Energy Savings Assistance (ESA) Program, Volumes 1 and 2, August 2019. https://pda.energydataweb.com/#!/documents/2295/view

[8] TecMarket Works et al, The Low Income Public Purpose Test Updated for Version 2.0, May 25, 2001, available at: http://calmac.org/publications/Final_LIPPT_Report_v4.pdf and
Equipoise Consulting Incorporated, LIEE Program and Measure Cost Effectiveness, March 28, 2002, available at: http://calmac.org/publications/Final_LIEE_CE_Report_V2.pdf

- Data: What data were used as inputs in the research?
- Assumptions: What simplifying assumptions were made?
- Methodology: How were the impacts calculated?
- Limitations: What were the limitations of the NEB calculations?
- Applicability: Do the estimates represent California ESA participants and the benefits that they could be expected to obtain from the ESA program, or are they appropriated from other jurisdictions or programs that are not applicable?
- Duplication: Do the NEBs duplicate one another or duplicate other benefits that are already accounted for in the ESA cost-benefit analysis?

2. NEB Calculation Adjustments: We reviewed the NEB calculations and proposed adjustments where appropriate. In some cases, we recommended alternative data sources or assumptions. We also recommended primary research activities that are needed to improve the estimates.

3. NEB Allocation Review: We reviewed and assessed the 2019 study's allocation of NEBs to program measures and proposed a simplified, alternative allocation method.

4. NEB Excel-based Tool: We developed an Excel-based tool for the recommended NEBs based on the calculations recommended in this study. The spreadsheet provides one-year results and the present discounted value over the lifetime of the NEBs. Instructions are included for updating data inputs, adding measures, and revising the measure allocation.

B. Report Organization

Four sections and an appendix follow this introduction.

- Section II – Non-Energy Benefit Review: This section provides a review of the NEB calculations for the NEBs that were retained from the 2019 model (with changes in the calculation methodology and/or data).

- Section III – Non-Energy Benefit Calculations: This section provides an overview of the NEBs that were proposed for inclusion and exclusion, and a detailed review of the proposed calculations.

- Section IV – Non-Energy Benefit Allocation: This section provides a proposed methodology to allocate NEBs to measures, and a justification for that methodology.

- Section V – Non-Energy Benefit Research Recommendations: This section recommends research to be conducted to provide more robust NEB calculations and potentially assess additional NEBs.

- Appendix – Excluded Non-Energy Benefit Review: This section reviews the NEBs from the 2019 study that were not recommended for inclusion in this report.

APPRISE prepared this report under contract to San Diego Gas & Electric (SDG&E) on behalf of the CA IOUs. The IOUs facilitated this research by furnishing program data to APPRISE. Any errors or omissions in this report are the responsibility of APPRISE. Further, the statements, findings, conclusions, and recommendations are solely those of analysts from APPRISE and do not necessarily reflect the views of the IOUs.

II. Non-Energy Benefit Review

This section provides a review of the NEB calculations for the NEBs that were retained from the 2019 model (with changes in the calculation methodology and/or data). Review for the excluded NEBs is included in the Appendix of this report.

A. NEBs Reviewed

The 2019 Non-Energy Benefits and Non-Energy Impact (NEB/NEI) Study for the California Energy Savings Assistance Program[9] revised the previous LIPPT model with an updated and expanded list of NEBs, updated calculations of the valuations, and a revised measure-specific allocation system. The study added 24 new NEBs and eliminated six NEBs from the original 2001 LIPPT. Overall, the 2019 study recommended 46 NEBs and 20 of those NEBs were accepted.

This study recommended inclusion of 14 of the benefits from the 2019 study. Some of the NEBs proposed in this study combined several 2019 NEBs into one NEB. The benefits that were included in the 2019 model and are included in the new model are discussed in this section. The excluded benefits are reviewed in the Appendix of this report. All calculations reviewed in this section use the SDG&E data from the 2019 model.

Table II-1
2019 ESA Non-Energy Benefits

Utility Benefits	Societal Benefits	Participant Benefits
Reduced Arrearage Carrying Cost	Economic Output	Fewer Shutoffs
Reduced Bad Debt Write-Off		Fewer Calls to Utility
Fewer Shutoffs		Reduced Water / Wastewater Bills
Fewer Notices		Improved Health*
Fewer Collections Calls		Improved Household Safety**
		Improved Comfort
		Noise Reduction***
		Operations & Maintenance Cost Changes

*Improved Health includes CO Poisonings, Asthma Incidents, Reduction in Allergies from 2019 model. The 2019 calculations of these NEBs are reviewed in the Appendix.
**Improved Safety includes Fires and Scalding from 2019 model. The 2019 calculations of these NEBs are reviewed in the Appendix.
***Reduced Noise includes indoor noise and outdoor noise.

[9]Skumatz Economic Research Associates, Inc. and Navigant Consulting Inc., Non-Energy Benefits and Non-Energy Impact (NEB/NEI) Study for the California Energy Savings Assistance (ESA) Program, Volumes 1 and 2, August 2019. https://pda.energydataweb.com/#!/documents/2295/view

B. Utility NEBs Reviewed

This section reviews the NEBs that provide benefits to the utility. The following benefits are discussed.

- Reduced Arrearage Carrying Cost
- Reduced Bad Debt Write-Off
- Fewer Shutoffs
- Fewer Notices
- Fewer Collections Calls

1. Reduced Arrearage Carrying Cost

The ESA program can reduce arrearages and the carrying cost of that debt by reducing customer bills. The 2019 report noted that there are dozens of studies from the late 1990s to 2018 that value this NEB.

- ESA Impact: The 2019 study stated that the installation of ESA measures will reduce energy cost and improve payment behavior. They estimated a $5.58 average annual benefit per participant.

  While the ESA program reduces customer usage, it is unclear whether that reduction is enough to have a significant impact on utility bill payment and arrearages, and that such a benefit can clearly result from the ESA program.

  The most recent 2019 ESA Impact Evaluation for program years 2015 through 2017 found that average 2017 electric savings ranged from 30 to 187 kWh (varied by utility) and average 2017 gas savings ranged from three therms to nine therms.[10] At a rate of $0.12 per kWh and $1.26 per Therm[11], this results in an average annual savings of $3.60 to $22.44 on the electric bill and an average annual savings of $3.78 to $11.34 on the gas bill.

  In the calculation section of this report we propose adjustments to this NEB impact based on a review of studies that show the relationship between the reduction in the energy bill and the reduction in arrearages for low-income households. Because there are few energy efficiency programs that include this analysis, we also review studies that show the relationship between reductions in bills that result from energy bill payment discount programs and reductions in arrearages.

- Data: Table II-2A displays the data that were used as inputs in the 2019 study, as well as the sources of those data.

[10] DNV-GL, Energy Savings Assistance Program Impact Evaluation Program Years 2015-2017, Southern California Gas Company, April 2019.

[11] Skumatz Economic Research Associates, Inc. and Navigant Consulting Inc., Non-Energy Benefits and Non-Energy Impact (NEB/NEI) Study for the California Energy Savings Assistance (ESA) Program, Spreadsheet Model.

Table II-2A
Reduced Arrearage Carrying Cost Data Inputs

	Input	Source	Value	Notes
A	Average Low-Income Arrearage	Utilities	$218	
B	Inflation Factor	CPI	1.00	Assumed current
C	ESA Arrearage Impact	Skumatz, CT WRAP, 2002[12]	32%	No normalization
D	Interest Rate	Utilities	8%	
E	Weighted Measure Life (Years)	Utilities	14.4	Sum (Measure Lifetime * # of Measure)/Total # of Measures
F	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life is less than one.
G	Adjustment Factor # of Measures	Utilities	1	Reduced to less than one if average # of causal measures per household is less than one.

- Average Low-Income Arrearage: The average low-income arrearage was included as $218 based on utility inputs. An accompanying input requiring the source year for this data was set to 2001.

- ESA Arrearage Impact: The ESA program impact on customer arrearages was estimated as a 32 percent reduction based on the Skumatz 2002 CT WRAP Study.

  - Skumatz 2002 CT Study: This study used credit history data from 1999 Connecticut Light and Power (CL&P) participants in their Weatherization Residential Assistance Partnership (WRAP) Program and a sample of eligible nonparticipants. The nonparticipants were assumed to be eligible based on a hardship code identifier as a proxy for income eligibility.

    The WRAP provides energy conservation measures to CL&P customers with income below 150 percent of the Federal Poverty Guidelines (FPG). The services are provided through local Community Action Agencies (CAAs). The program provides the following measures.
    - CFLs and light fixtures
    - Water heater wraps
    - Low-flow showerheads and aerators
    - Waterbed insulated covers
    - Door sweeps
    - Thermostats
    - Caulking and insulation
    - Refrigerators and freezers
    - Minor repairs
    - Burner and furnace replacement

[12]Skumatz, Lisa and Nordeen, Trevor. "Connecticut WRAP Program Non-Energy Benefits, March 2002.

The arrearage results from the study are displayed in Table II-2B. The average impact of a 32 percent reduction in arrearages was used, and the insignificant comparison group adjustment was not applied.

Table II-2B
CT WRAP Arrearage Impact Results

	Pre	Post	Change		Significant (95% Confidence Level)
			$	%	
Participants	$79.40	$54.31	-$25.09	-32%	Yes
Nonparticipants	$86.34	$97.78	$11.44	13%	No

The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.

- Initial sample size and attrition rate: The reliability of the study cannot be assessed without knowing what percent of participants had usable arrearage data and the sample size used for analysis.

- Measure installation rate: Comparability to the ESA program cannot be known without understanding whether the measure installation rates were similar to those in the ESA program.

- WRAP energy savings: Comparability to the ESA program cannot be known without understanding whether the energy savings achieved by the program were similar to those in the ESA program.

- Other program participation: No information was provided on enrollment in low-income bill payment assistance programs. Customers are often targeted for low-income energy efficiency programs following enrollment in low-income payment assistance programs. If this is the case, the resulting reduction in arrearages may be due to reductions in energy bills from the low-income energy bill discount, or arrearage forgiveness, rather than the energy efficiency program.

The 2019 report spreadsheet model noted that the arrearage impact value should be reduced if program spending is less than the CT spending of $368.66 per household. The spreadsheet shows average spending of $548.85 per household, so the percentage reduction in arrearages was not normalized.

While the CA ESA estimate used the 32 percent value from CT, it noted the following other estimates. However, these studies were not available for reference, so their reliability cannot be assessed.

- Puget Power, 2012: 29%
- PSE, 2005: 31%

- Rocky Mountain: 31%

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for utility NEBs (8%) is less than one.

  Factor = minimum of 1 or
  pmt(discount rate, yr horizon, PV(discount rate, measure life, 1))

  - Discount Rate = 8% (utility data)

  - Year Horizon = 10 years (utility data)

  - Weighted Measure Life = $\frac{\sum(Measure\ Lifetime * \#\ of\ Measures)}{Total\ \#\ of\ Measures}$=14.4

  - pmt(discount rate, yr horizon, PV(discount rate, measure life, 1)) = 1.25
    If the weighted measure life was less than the program horizon, this function would determine the amount by which the NEB should be reduced.

Table II-2C displays the measures included in the calculation of weighted measure life. This same calculation was used in all of the other Utility NEBs in this section.

Table II-2C
Measures Included in Reduced Arrearage Carrying Cost Calculation

Measure Name	Measure Lifetime	# of Measures	Lifetime * # Measures
High Efficiency Clothes Washer (with electric water heating)	11	21	231
High Efficiency Clothes Washer (with gas water heating)	11	405	4,455
Refrigerator	14	1,002	14,028
Low-flow showerhead & thermostatic valve (with electric water heating)	10	135	1,350
Low-flow showerhead & thermostatic valve (with gas water heating)	10	4,365	43,650
Domestic Hot Water Bundle (with electric water heating)	10	4,054	40,540
Domestic Hot Water Bundle (with gas water heating)	10	16,202	162,020
Heat pump water heater	13	25	325
Tub diverter (with electric water heating)	10	75	750
Tub diverter (with gas water heating)	10	2,425	24,250
Water Heater Repair/Replace	11	1,154	12,694
Enclosure bundle (with electric space heating and A/c)	11	2,258	24,838
Enclosure bundle (with gas space heating and A/c)	11	3,161	34,771
Enclosure bundle (with gas space heating and no A/c)	11	5,870	64,570
Blower motor retrofit	10	0	0

Measure Name	Measure Lifetime	# of Measures	Lifetime * # Measures
Central AC Replacement	18	0	0
Central AC tune-up	10	3	30
Duct Testing & Sealing (with electric space heating and A/c)	18	1	18
Duct Testing & Sealing (with gas space heating and A/c)	18	136	2,448
Duct Testing & Sealing (with gas space heating and no A/c)	18	251	4,518
Evaporative cooler new install	15	0	0
Evaporative cooler replacement	15	0	0
Fan control	11	25	275
Gas Furnace Clean and Tune	5	3,634	18,170
Gas furnace pilot light conversion	13	18	234
Gas Furnace Repair/Replace	20	4,933	98,660
Heat pump replacement	15	0	0
High efficiency gas furnace	20	0	0
PCT (with CAC and gas heat)	11	875	9,625
PCT (with gas heat and no CAC)	11	1,625	17,875
Room AC Replacement	9	203	1,827
Exterior Hard wired LED fixtures	16	2,734	43,744
Interior Hard wired LED fixtures	16	8,419	134,704
LED A-lamps	16	0	0
LED BR lamps	16	0	0
LED diffuse bulb	16	148,722	2,379,552
LED reflector bulb	16	8,045	128,720
LED Torchiere	16	14,817	237,072
Vacancy sensor	8	0	0
Pool motor replacement	10	0	0
Smart Power Strip	8	9,456	75,648
Smart strip Tier 2	8	7,501	60,008
Variable speed pool pump	10	500	5,000
Total	546	253,050	3,646,600
Average Measure Life = 14.4 Years			

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household is less than one.

  Factor = minimum of 1 or average number of causal measures

  - Total Number of Measures = 253,050
  - Total Number of Participants = 23,518

- Average Number of Causal Measures = $\frac{\sum(\#\ of\ Measures)}{Total\ \#\ of\ Participants}$=10.76

This adjustment factor can be turned on or off by utilities in the sensitivity options.

- Assumptions: Key assumptions that were made.
  - ESA arrearage impact of 32%, equal to finding from the 2002 CT study.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	D	*	F	*	G		
Year	Arrears		Inflation		Impact		Int. Rate		Adjust Program Horizon		Adjust # Measures	=	Annual Participant Impact
2020	$218		1.00		32%		8%		1		1		$5.58
2021	$218		1.00		32%		8%		1		1		$5.58
2022	$218		1.00		32%		8%		1		1		$5.58
2023	$218		1.00		32%		8%		1		1		$5.58
2024	$218		1.00		32%		8%		1		1		$5.58

- Limitations
  - Use of 32% reduction in arrearages.
  - Reduction in arrearages should relate to bill reduction rather than starting arrearage value.

- Applicability
  - Magnitude of arrearage impact may not apply to the level of savings achieved by the ESA program.

- Duplication: This NEB does not duplicate another benefit calculated in this NEB analysis or other benefits that are already accounted for in the ESA cost-benefit analysis.

2. Reduced Bad Debt Write-Off

Bad debt write-offs reduce utility revenue, which increases costs for all ratepayers. The 2019 report noted that there are more than a dozen studies from the late 1990's to 2018 that value this NEB, but the Excel tool calculated the reduction in bad debt write-off using the ESA arrearage impact because they assessed that there were few applicable studies on bad debt.

- ESA Impact: The 2019 study stated that the installation of ESA measures will improve payment behavior and thus reduce the amount of bad debt that needs to be written off. They estimated a $3.34 average annual benefit per participant in 2020 and adjusted that value for inflation in the following years.

  ESA measures can reduce customer usage, but it is unclear whether the reduction is large enough to have a significant impact on arrearages, and since bad debt write-offs will only occur for a fraction of those with an arrearage, it seems even less likely that

the ESA program would have a significant impact on write-offs. The appropriate impact estimate will be analyzed in the Calculation section of this report.

- Data: Table II-3A displays the data that were used as inputs in the 2019 study, as well as the sources of those data.

Table II-3A
Reduced Bad Debt Write-Off Data Inputs

	Input	Source	Value	Notes
A	Average Bad Debt	Skumatz, CT WRAP, 2002[13]	$7.08	
B	Inflation Factor	Bureau of Labor Statistics	1.47-1.62	
C	ESA Arrearage Impact	Skumatz, CT WRAP, 2002	32%	No normalization
D	Weighted Measure Life (Years)	Utilities	14.4	Sum (Measure Lifetime * # of Measure)/Total number of Measures
E	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life is less than one.
F	Adjustment Factor # of Measures	Utilities	1	Reduced to less than one if average # of causal measures per household is less than one.

  - Average Bad Debt: The average bad debt per household was $7.08 based on the Skumatz 2002 CT WRAP Study, adjusted for inflation.
    - Skumatz 2002 CT Study: See discussion in the Reduced Arrearage Carrying Cost review for the full details regarding this study.

      The value of $7.08 per household is equal to the average bad debt write-off in the 1999 data provided by Connecticut Light and Power (CL&P). Further information regarding the calculation of this figure was not provided.

  - ESA Bad Debt Impact: The ESA impact on customer bad debt was approximated as a 32 percent reduction based on the reduction in arrearages in the Skumatz 2002 CT WRAP Study.
    - Skumatz 2002 CT Study: See discussion in the Reduced Arrearage Carrying Cost review for the full details regarding this study.

  - Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for utility NEBs (8%) is less than one. This is the same calculation as in the Reduced Arrearage Carrying Cost review. No adjustment was made.

[13]Skumatz, Lisa and Nordeen, Trevor. "Connecticut WRAP Program Non-Energy Benefits, March 2002.

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household is less than one. This is the same calculation as in the Reduced Arrearage Carrying Cost review. No adjustment was made.

- Assumptions: Key assumptions that were made.
  - Average bad debt write-off of $7.08, equal to finding from the 2002 CT study.
  - ESA bad debt write-off impact of 32%, from the 2002 CT study arrearage impact.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	E	*	F		
Year	Bad Debt		Inflation		Arrearage Impact		Adjust Prog. Horizon		Adjust # Measures	=	Annual Participant Impact
2020	$7.08		1.47		32%		1		1		$3.34
2021	$7.08		1.51		32%		1		1		$3.42
2022	$7.08		1.54		32%		1		1		$3.50
2023	$7.08		1.58		32%		1		1		$3.58
2024	$7.08		1.62		32%		1		1		$3.67

- Limitations
  - Use of $7.08 as average household write-off.
  - Use of 32% reduction in arrearages as an approximation for the bad debt write-off reduction.

- Applicability
  - Average bad debt per household (CT 1999) may not apply to ESA participants in 2020.
  - Magnitude of impact may not apply to the level of savings achieved by the ESA program.

- Duplication: This NEB does not duplicate another benefit calculated in this NEB analysis or other benefits that are already accounted for in the ESA cost-benefit analysis.

3. Fewer Shutoffs

Shutoffs, caused by a customer's failure to pay, result in an additional cost to the utility. The 2019 report noted that there are more than a dozen studies from the late 1990s to 2018 that value this NEB, making it important to include, but they also noted that the expected benefit combined with that of reducing reconnects is usually less than $1.00 per household and can be as low as $0.00 per household.

- ESA Impact: The 2019 study stated that the installation of ESA measures will improve payment behavior and thus reduce the number of shutoffs that occur every year. They estimated a $0.12 average annual benefit per participant in 2020 and adjusted that for inflation in the following years.

ESA measures can reduce customer usage and bills, improve payment behavior, and reduce arrearages. However, it is unclear whether that reduction will have a significant impact on the number of shutoffs. The appropriate impact estimate will be analyzed in the Calculation section of this report.

- Data: Table II-4A displays the data that were used as inputs in the 2019 study, as well as the sources of those data.

Table II-4A
Reduced Shutoff Data Inputs

	Input	Source	Value	Notes
A	Average Shutoffs per CARE customer	Utilities	.0241	
B	ESA Shutoff Impact	Skumatz, CT WRAP, 2002[14]	16%	No normalization
C	Utility Shutoff Cost	Skumatz, CT WRAP, 2002	$20.87	
D	Inflation Factor	Bureau of Labor Statistics	1.47-1.62	
E	Weighted Measure Life (Years)	Utilities	14.4	Sum (Measure Lifetime * # of Measure)/Total # of Measures
F	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life is less than one.
G	Adjustment Factor # of Measures	Utilities	1	Reduced to less than one if average # of causal measures per household is less than one.

  - Average Number of Shutoffs: The average number of shutoffs per low-income customer per year, 0.0241, was based on 2018 utility California Alternate Rates for Energy (CARE) data. CARE provides discounts on energy bills for income-qualified households. Data for CARE participants was used as an estimate for ESA participants because 83 percent of ESA participants received the CARE discount.

  - ESA Shutoff Impact: The ESA impact on shutoffs was estimated to be a 16 percent reduction, based on the Skumatz 2002 CT WRAP Study.
    - Skumatz 2002 CT Study: See the discussion in the Reduced Arrearage Carrying Cost review for the full details regarding this study.

      The shutoff results from the study are displayed in Table II-4B. They estimated a 16 percent reduction in shutoffs, but the result was not statistically significant.

[14]Skumatz, Lisa and Nordeen, Trevor. "Connecticut WRAP Program Non-Energy Benefits, March 2002.

Table II-4B
CT WRAP Shutoff Impact Results

	Pre	Post	Change		Significant (95% Confidence Level)
			$	%	
Participants	0.200%	0.017%	-0.003%	-16%	No

The 2019 report spreadsheet model noted that the shutoff impact value should be reduced if program spending is less than the CT spending of $368.66 per household. The spreadsheet showed average spending of $548.85 per household, so the percentage reduction in shutoffs was not normalized.

- Utility Shutoff Cost: The average shutoff cost to the utility was $20.87, based on the Skumatz 2002 CT WRAP Study, adjusted for inflation.
  - Skumatz 2002 CT Study: See discussion in the Reduced Arrearage Carrying Cost review for the full details regarding this study.

    The value of $20.87 per household is equal to the average shutoff cost in the 1999 data provided by Connecticut Light and Power (CL&P) for participants in their Weatherization Residential Assistance Partnership (WRAP) Program and a sample of eligible nonparticipants. Further information regarding the calculation of this figure was not provided.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for utility NEBs (8%) is less than one. This is the same calculation as in the Reduced Arrearage Carrying Cost review. No adjustment was made.

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household is less than one. This is the same calculation as in the Reduced Arrearage Carrying Cost review. No adjustment was made.

- Assumptions: Key assumptions that were made.
  - ESA shutoff impact of 16%, equal to the finding from the 2002 CT study.
  - Average cost to the utility of $20.87, equal to the value used in the 2002 CT study.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	D	*	F	*	G		
Year	Shutoffs		Shutoff Impact		Inflation		Shutoff Cost		Adjust Program Horizon		Adjust # Measures	=	Annual Participant Impact
2020	.024		16%		1.47		$20.87		1		1		$0.12
2021	.024		16%		1.51		$20.87		1		1		$0.12
2022	.024		16%		1.54		$20.87		1		1		$0.12
2023	.024		16%		1.58		$20.87		1		1		$0.13
2024	.024		16%		1.62		$20.87		1		1		$0.13

- Limitations
  - Use of 16% as an estimate of the shutoff reduction. This result was not statistically significant in the 2002 CT study.
  - Use of $20.87 as cost to utility per shutoff.

- Applicability
  - The 16% shutoff impact may not apply to the level of savings achieved by the ESA program.
  - The average cost of $20.87 per shutoff in CT in 2002 may not apply to California utilities in 2020.

- Duplication: This NEB does not duplicate another benefit calculated in this NEB analysis or other benefits that are already accounted for in the ESA cost-benefit analysis.

4. Fewer Collections Notices

Sending collections notices to customers who do not pay their bills is an extra cost for the utility. The 2019 report noted that there are more than a dozen studies from the late 1990s to 2018 that value this NEB, making it important to include.

- ESA Impact: The 2019 study stated that the installation of ESA measures will improve payment behavior and thus reduce the number of collections notices sent to participants for nonpayment. They estimated a $0.94 average annual benefit per participant in 2020 and adjusted that for inflation in the following years.

  ESA measures can reduce customer usage and bills and improve payment behavior, but it is unclear whether that reduction will have a significant impact on the number of notices that a utility sends out. The appropriate impact estimate will be analyzed in the Calculation section of this report.

- Data: Table II-5A displays the data that were used as inputs in the 2019 study, as well as the sources of those data.

Table II-5A
Reduced Notices Data Inputs

	Input	Source	Value	Notes
A	Average Notices per CARE customer	Utilities	1.205	
B	ESA Notice Impact	Tonn, WAP, 2014[15]	38%	
C	Utility Notice Cost	Skumatz, WI, 2005[16]	$1.60	
D	Inflation Factor	Bureau of Labor Statistics	1.28-1.41	
E	Weighted Measure Life (Years)	Utilities	14.4	Sum (Measure Lifetime * # of Measure)/Total number of Measures
F	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life is less than one.
G	Adjustment Factor # of Measures	Utilities	1	Reduced to less than one if average # of causal measures per household is less than one.

  - Average Number of Notices: The average number of notices per low-income customer per year, 1.205, was based on 2018 utility CARE data. Data for CARE participants were used as an estimate for ESA participants because 83 percent of ESA participants received the CARE discount.

  - ESA Notice Impact: The ESA impact on notices was estimated as a 38 percent reduction, based on the Tonn ORNL 2014 Study. However, a more detailed review of that study and an alternative APPRISE report that provided another assessment of the evaluation data suggests that this was not the correct result from the referenced study.
    - Tonn ORNL 2014 Study: This study used data from the Weatherization Assistance Program (WAP) Evaluation. Results from the evaluation's national occupant survey were used to develop this estimate.

      WAP provides weatherization measures through grantees and subgrantees to households with income at or below 150 percent of the federal poverty level or 60 percent of state median income.

      The program provides the following measures.
      - Air Sealing
      - Insulation
      - Baseloads
      - Water-Heating System

[15]ORNL, Tonn et al., "Weatherization Works - Summary of Findings from the Retrospective Evaluation of the U.S. Department of Energy's Weatherization Assistance Program," September, 2014, Reference ORNL/TM-2014/338.
[16]Skumatz, Lisa and Gardner, John. 2005, "The Non-energy Benefits of Wisconsin's Low-income Weatherization Assistance Program: Revised Report", submitted to the State of Wisconsin Department of Administration Division of Energy.

- Space-Heating System
- HVAC Accessories
- Windows
- Doors
- Ventilation
- Air-Conditioning Systems

The National WAP Evaluation included a national occupant survey with a subset of the WAP participants and a comparison group of earlier WAP participants.[17]

- Treatment Group: The pre-treatment survey was conducted with this group just prior to completion of the home energy audit in Program Year 2011 or 2012. The post-treatment survey was conducted approximately two years later, at the same time of the year.

- Comparison Group: This was a group of earlier WAP participants who received WAP services in Program year 2010. The quasi pre-treatment survey was conducted with this group one year later. The quasi post-treatment survey was conducted approximately 18 months following the initial survey.

The Tonn report stated that the first wave of the survey included 665 homes in the Treatment Group and 802 in the Comparison Group and that the response rate was 70 percent. The post-treatment survey obtained responses from 398 respondents in the Treatment Group and 430 in the Comparison Group.

The results from the ORNL study are displayed in Table II-5B. The study found a 38 percent reduction in notices for the Treatment Group and a 23 percent reduction in notices for the comparison group, with a net percent reduction of 21.2 percent.

Table II-5B
ORNL Notices Impact Results

	Pre	Post	Percentage Point Change	% Change
Treatment Group	19.3%	12.0%	-7.3%	-37.8%
Comparison Group	13.9%	10.7%	-3.2%	-23.0%
Net Change			-4.1%	-21.2%

The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.

[17]Additional information on the survey is available in National Weatherization Assistance Program Evaluation. Analysis Report. Non-Energy Benefits of WAP Estimated with the Client Longitudinal Survey Final Report. January 2018. http://www.appriseinc.org/wp-content/uploads/2018/02/WAP-Non-Energy-Benefits-Analysis-Report.pdf

- Energy savings by climate type: The Tonn ORNL study provides energy savings by climate but does not break down the impact on collections notices received by climate. Comparability to the ESA program cannot be known without understanding whether the national findings apply to the level of savings resulting from the ESA program in California.

- Other program participation: Customers are often targeted for low-income energy efficiency programs following enrollment in other programs. This study states that about 50 percent of the respondents in the national occupant study received LIHEAP the previous year. New LIHEAP recipients are often targeted for WAP, so part of this impact could result from the LIHEAP benefit. The comparison group was not used to adjust for that and other exogenous impacts.

The 2019 spreadsheet noted that the impact should be adjusted since average WAP spending was $4,000 per household, greater than the CA ESA average spending, but no adjustment was made.

The methodology used in the ORNL analysis differed from the initial study plan for the WAP Occupant Survey. APPRISE provided a separate analysis of the results from the WAP National Occupant Survey and a comparison of the ORNL and APPRISE results in two separate reports.[18] One key difference that specifically applies to the results shown above is the use of a longitudinal framework. ORNL did not use a longitudinal sample with a matched pre-post comparison analysis, and APPRISE used the matched sample.

The Baseline interviews were completed with 1,094 Treatment Group clients and 803 Comparison Group clients, for a total of 1,897. Of those 1,897 households, 139 households' treatment status could not be verified and were deemed ineligible and 15 households had moved. The remaining 1,743 respondents were contacted by phone. The Follow-up Survey was able to determine that 66 treatment households had not completed weatherization and only 454 of the treatment group clients received WAP services, continued to live in the weatherized housing unit, and could be contacted for follow-up interviews.

Similarly, 430 of the Comparison Group households who continued to live in their weatherized homes could be contacted. That group of 454 Treatment Group households and 430 Comparison Group households served as the analysis population for the APPRISE analysis.

[18]National Weatherization Assistance Program Evaluation. Results Report. Non-Energy Benefits of WAP Estimated with the Client Longitudinal Survey Final Report. January 2018. http://www.appriseinc.org/wp-content/uploads/2018/02/WAP-Non-Energy-Benefits-Results-Report.pdf and National Weatherization Assistance Program Evaluation. Analysis Report. Non-Energy Benefits of WAP Estimated with the Client Longitudinal Survey Final Report. January 2018. http://www.appriseinc.org/wp-content/uploads/2018/02/WAP-Non-Energy-Benefits-Analysis-Report.pdf

Table II-5C
WAP Evaluation Survey Attrition

Population	Treatment Group		Comparison Group	
	#	%	#	%
Baseline Survey	1,094	100%	803	100%
Treatment Status Determined	955	87%	803	100%
Complete	454	48%	430	54%
Incomplete	501	40%	373	46%
Final Follow-Up Sample	454		430	

The APPRISE report focused on the percent that received a disconnect notice almost every month. Table II-5D shows that there was a four-percentage point reduction or a 25 percent reduction in notices almost every month for the treatment group and no statistically significant net change in this indicator. While this report focused on a different indicator, it is important to note that the use of a matched sample and comparison group could impact the result used in the 2019 study. The appropriate impact estimate will be analyzed in the Calculation section of this report.

Table II-5D
APPRISE Analysis of WAP Notice Impact
Received Disconnect Notice Almost Every Month

Treatment Group			Comparison Group Change			Net Change
Pre	Post	Percentage Point Change	Pre	Post	Percentage Point Change	
16%	12%	-4%**	13%	11%	-2%	-1%

**Statistically significant at the 95 percent level.

- Utility's Cost per Notice: The average cost per notice to the utility was $1.60, the same cost is used in the Skumatz 2005 WI study. The 2005 WI study noted this cost in a footnote but did not explain how the cost was calculated. The value was then adjusted for inflation.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for utility NEBs (8%) is less than one. This is the same calculation as in the Reduced Arrearage Carrying Cost review. No adjustment was made.

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household is less than one. This is the same calculation as in the Reduced Arrearage Carrying Cost review. No adjustment was made.

- Assumptions: Key assumptions that were made.
  - ESA collections notices impact of 32%, equal to the finding from the 2014 Tonn ORNL study.
  - Notices cost of $1.60, adjusted for inflation, based on 2005 WI study.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	D	*	F	*	G		
Year	Average Notices		Notice Impact		Notice Cost		Inflation		Adjust Program Horizon		Adjust # Measures	=	Annual Participant Impact
2020	1.205		38%		$1.60		1.28		1		1		$0.94
2021	1.205		38%		$1.60		1.31		1		1		$0.96
2022	1.205		38%		$1.60		1.34		1		1		$0.98
2023	1.205		38%		$1.60		1.37		1		1		$1.01
2024	1.205		38%		$1.60		1.41		1		1		$1.03

- Limitations
  - Use of 38% as an estimate of the reduction in the number of notices.
  - Use of $1.60 as an estimate of the cost of each notice.

- Applicability
  - The 38% notice reduction may not apply to the level of savings achieved by the ESA program. The 2019 spreadsheet noted that this should be adjusted since average WAP spending was $4,000 per household, greater than the CA ESA average spending, but no adjustment was made.
  - The notice cost may not apply to California utilities in 2020.

- Duplication: This NEB does not duplicate another benefit calculated in this NEB analysis or other benefits that are already accounted for in the ESA cost-benefit analysis.

5. Fewer Collections Calls

Outbound collections calls to customers who do not pay their bills is a cost for the utility. The 2019 report noted that there were more than a dozen studies from the late 1990s to 2018 that valued this NEB, making it important to include, but they also noted that it is usually valued at less than $1.00 per household.

- ESA Impact: The 2019 study stated that the installation of ESA measures will improve payment behavior and thus reduce the number of customer calls that need to be made to participants for nonpayment. They estimated a $0.93 average annual benefit per participant in 2020 and adjusted that impact for inflation in the following years.

  ESA measures can reduce customer usage and bills and improve payment behavior, but it is unclear whether that reduction will have a significant impact on the number of calls that the utility makes. The appropriate impact estimate will be analyzed in the Calculation section of this report.

- Data: Table II-6A displays the data that were used as inputs in the 2019 study, as well as the sources of those data.

Table II-6A
Reduced Collections Calls Data Inputs

	Input	Source	Value	Notes
A	Average Calls per Customer	Skumatz, CT WRAP, 2002[19]	1.73	
B	ESA Call Impact	Skumatz, CT WRAP, 2002	32%	No normalization
C	Average Call Length (Minutes)	Skumatz, CT WRAP, 2002	4.67	
D	Median CA 2016 Hourly Wage	Bureau of Labor Statistics	$19.67	For all occupations.
E	Minutes per Hour	Conversion Factor	60	
F	Inflation Factor	Bureau of Labor Statistics	1.10-1.21	
G	Weighted Measure Life (Years)	Utilities	14.4	Sum (Measure Lifetime * # of Measure)/Total # of Measures
H	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life is less than one.
I	Adjustment Factor # of Measures	Utilities	1	Reduced to less than one if average # of causal measures per household is less than one.

- Average Number of Calls: The average number of customer calls per household was 1.73 based on the Skumatz 2002 CT WRAP Study.
  - Skumatz 2002 CT Study: See discussion in the Reduced Arrearage Carrying Cost review for the full details regarding this study.

    The value of 1.73 per household is equal to the average number of calls in the 1999 data provided by Connecticut Light and Power (CL&P). Further information regarding the calculation of this number was not provided.

- ESA Customer Calls Impact: The ESA impact on customer calls was a 32 percent reduction based on the reduction in arrearages in the Skumatz 2002 CT WRAP Study.

- Average Call Length: The average call length was 4.67 minutes, based on the Skumatz 2002 CT WRAP Study. The value of 4.67 minutes is equal to the average call length in the 1999 data provided by Connecticut Light and Power (CL&P). Further information regarding the calculation of this figure was not provided.

[19]Skumatz, Lisa and Nordeen, Trevor. "Connecticut WRAP Program Non-Energy Benefits, March 2002.

- Median Hourly Wage: The 2019 study stated that the hourly wage is the utility's average wage, but the spreadsheet clarified that the median wage for all California occupations in 2016 was used. The median CA 2016 hourly wage of $19.67 was from the U.S. Bureau of Labor Statistics, based on data collected from employers in all industry sectors in metropolitan and nonmetropolitan areas of California.

  The median wage in 2016 was adjusted for inflation but did not consider annual increases in the California minimum wage that began in 2017 and are scheduled to continue through 2023.[20]

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for utility NEBs (8%) is less than one. This is the same calculation as in the Reduced Arrearage Carrying Cost review. No adjustment was made.

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household is less than one. This is the same calculation as in the Reduced Arrearage Carrying Cost review. No adjustment was made.

- Assumptions: Key assumptions that were made.
  - Average number of collections calls per household per year of 1.73, equal to the finding from the 2002 CT study.
  - ESA collections call impact of 32%, equal to the finding from the 2002 CT study for arrearages.
  - Collection calls last 4.67 minutes, equal to the finding for CT utilities in 2002.
  - Average utility wage from 2020 through 2024 of $19.67 per hour, equal to the 2016 CA median hourly wage.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	(D	/	E)	*	F	*	H	*	I		
Year	Avg Calls		Call Impact		Call Length		Wage		Min /Hr		Inflation		Adjust Prog. Horizon		Adjust # Measures	=	Annual Participant Impact
2020	1.73		32%		4.67		$19.67		60		1.10		1		1		$0.93
2021	1.73		32%		4.67		$19.67		60		1.13		1		1		$0.96
2022	1.73		32%		4.67		$19.67		60		1.15		1		1		$0.98
2023	1.73		32%		4.67		$19.67		60		1.18		1		1		$1.00
2024	1.73		32%		4.67		$19.67		60		1.21		1		1		$1.03

- Limitations
  - Use of 1.73 as an estimate of the average number of collection calls.
  - Use of 32% as an estimate of the reduction in the number of collection calls.
  - Use of 4.67 minutes as an estimate of the average call length.

[20]State of California, Department of Industrial Relations, https://www.dir.ca.gov/dlse/FAQ_MinimumWage.htm.

- Use of $19.67, adjusted for inflation, as an estimate of the average hourly wage for utility call center representatives.

- Applicability
  - The 32% collections call reduction may not apply to the level of savings achieved by the ESA program.
  - The number of collections calls may not apply to the average number of calls made by California utilities in 2020.
  - The length of collections calls may not apply to the average call length of collections calls made by California utilities in 2020.
  - The hourly wage may not apply to CA utility call center representatives in 2020.

- Duplication: This NEB does not duplicate another benefit calculated in this NEB analysis or other benefits that are already accounted for in the ESA cost-benefit analysis.

C. Societal NEBs Reviewed

This section reviews the NEBs that provide benefits to society. The following benefit was reviewed.

- Economic Output

1. Economic Output

The manufacture and installation of ESA measures creates additional spending in local, regional, and national economies. The 2019 report noted that dozens of studies from the late 1990s to 2018 valued this NEB, making it important to include.

- ESA Impact: The 2019 study stated that the manufacture and installation of ESA measures will lead to changes in economic activity. They estimated a $24.99 average annual benefit per participant every year from 2020 to 2024.

- Data: The following data were used as inputs in the research.

Table II-7A
Reduced Economic Output Data Inputs

	Input	Source	Value	Notes
A	Average ESA Cost	Utilities	$548.85	
B	Inflation Factor	Bureau of Labor Statistics	1.00	Assumed current
C	Net Output Multiplier	RIMS II Run, Skumatz unpub., 2016 CA Data	.40	
D	Weighted Measure Life (Years)	Utilities	1	Sum (Measure Lifetime * # of Measure)/Total # of Measures = 14.4 but NEB calculation notes that it is overridden with 1.0.
E	Adjustment Factor Program Horizon	Utilities	.11	Reduced to less than one if discounted remaining weighted measure life is less than one.

	Input	Source	Value	Notes
F	Adjustment Factor Number of Measures	Utilities	1	Reduced to less than one if average number of causal measures per household is less than one.

- Average ESA Cost: The ESA expenditures per participant were calculated from utility data by dividing the estimated cost of all measures installed in a year by the number of participants in that year. The total spent on each measure is displayed in Table II-7B.

  - Total Cost of All Measures: $12,907,744
  - Total Number of Participants: 23,518
  - Average ESA Cost $= \frac{Total\ Cost\ of\ All\ Measures}{Total\ Number\ of\ Participants} =$ $548.85

Table II-7B
Measure Costs Included in Average ESA Cost Calculation[21]

Measure Name	# of Measures	Cost per Measure	Total Measure Cost
High Efficiency Clothes Washer (with electric water heating)	21	$825	$17,325
High Efficiency Clothes Washer (with gas water heating)	405	$825	$334,125
Refrigerator	1,002	$850	$851,700
Low-flow showerhead & thermostatic valve (with electric water heating)	135	$40	$5,400
Low-flow showerhead & thermostatic valve (with gas water heating)	4,365	$40	$174,600
Heat pump water heater	25	$2,100	$52,500
Tub diverter (with electric water heating)	75	$115	$8,625
Tub diverter (with gas water heating)	2,425	$115	$278,875
Water Heater Repair/Replace	1,154	$1,200	$1,384,800
Central AC tune-up	3	$160	$480
Duct Testing & Sealing (with electric space heating and A/c)	1	$250	$250
Fan control	25	$150	$3,750
Gas Furnace Clean and Tune	3,634	$65	$236,210
Gas Furnace Repair/Replace	4,933	$700	$3,453,100
Room AC Replacement	203	$850	$172,550
Exterior Hard wired LED fixtures	2,734	$75	$205,050
Interior Hard wired LED fixtures	8,419	$50	$420,950
LED diffuse bulb	148,722	$17	$2,528,274
LED reflector bulb	8,045	$28	$225,260
LED Torchiere	14,817	$65	$963,105
Smart Power Strip	9,456	$40	$378,240

[21] These are the measures that were included in the 2019 SDG&E model.

Measure Name	# of Measures	Cost per Measure	Total Measure Cost
Smart strip Tier 2	7,501	$75	$562,575
Variable speed pool pump	500	$1,300	$650,000
Total	253,050	$825	$12,907,744

- Net Output Multiplier: The net output multiplier per dollar spent was calculated as 0.4 using the Regional Input-Output Model System (RIMS II)[22] run by Skumatz with 2016 CA data.

  The RIMS II estimates the impact of spending on regional economies. It uses national input-output accounts of the goods and services produced and used by industries and final users to estimate the final impact on additional economic activity. RIMS II adjusts these national accounts to apply to regional supply conditions.

  RIMS II requires the following inputs.
  - Final Demand Change: The additional purchases and investments that constitute the increased economic activity. For the ESA program, this is the cost of the measures installed.
  - Industry and Region: RIMS II provides an option for the user to enter the applicable industry and region.

  The output from the model are the RIMS II outputs multipliers, which are multiplied by the final demand change to estimate the total economic impact resulting from the expenditures.

  The specifications and output for this model were not included in the 2019 report or spreadsheet tool. The 2019 report stated that the RIMS II multipliers were developed for another study and included as draft/proxy values for the ESA analysis. The spreadsheet did not state which study the RIMS II was run for, but that it used 2016 California data. The report recommended the development of new RIMS II models for each utility's region within CA.

  The spreadsheet tool noted that the RIMS II results were similar to an IMPLAN[23] model run at an earlier date but did not state when that model was run. IMPLAN is another input-output model that produces economic multipliers. The 2019 report and spreadsheet tool did not specify what study this model was run for but stated that it used 1999 California data.

[22] Bureau of Economic Analysis, U.S. Department of Commerce, https://www.bea.gov/sites/default/files/methodologies/RIMSII_User_Guide.pdf
[23] Implan.com

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for societal NEBs (3%) is less than one.

  Factor = minimum of 1 or
  pmt(discount rate, yr horizon, PV(discount rate, measure life, 1))

  - Discount Rate = 3% (utility data)
  - Year Horizon = 10 years (utility data)
  - Weighted Measure Life = $\frac{\sum(Measure\ Lifetime * \#\ of\ Measures)}{Total\ \#\ of\ Measures}$ = 14.4

    This value was overridden with one in the spreadsheet model. The 2019 report and spreadsheet model did not discuss why this override was performed. It is assumed that the life was adjusted to one year because the model estimated the economic benefits from a one-time ESA expenditure.

  - pmt(discount rate, yr horizon, PV(discount rate, measure life, 1)) = 0.11
    Since the weighted measure life was assumed to be one year, which is less than the program horizon, this function determines the amount by which the NEB should be reduced.

  Table II-2C displays the measures included in the calculation of weighted measure life (before it is overridden to one). This NEB includes those same measures.

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household is less than one. This is the same calculation as in the Reduced Arrearage Carrying Cost review. No adjustment was made.

- Assumptions: Key assumptions that are made.
  - The ESA output multiplier is equal to the previously calculated RIMS II multiplier that used 2016 CA data.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	E	*	F		Annual
Year	Expenditures		Inflation		Output Multiplier		Adjust Prog. Horizon		Adjust # Measures	=	Participant Impact
2020	$548.85		1.00		.40		.11		1		$24.99
2021	$548.85		1.00		.40		.11		1		$24.99
2022	$548.85		1.00		.40		.11		1		$24.99
2023	$548.85		1.00		.40		.11		1		$24.99
2024	$548.85		1.00		.40		.11		1		$24.99

- Limitations
  - Use of a RIMS II multiplier calculated in a previous study.
  - Use of all measure costs, as opposed to those that were incurred in CA.
  - Exclusion of other ESA costs including administration and evaluation.

- Applicability
  - We cannot assess whether the net output multiplier is applicable to the 2020 ESA impact because information on the model specification and the model output was not available.

- Duplication: This NEB may duplicate the impact of other NEBs.
  - The economic output multiplier may include duplication of benefits in the Labor Output and Tax Impact multipliers that were included in the 2019 study. Since neither the 2019 report nor the spreadsheet tool detailed the model specifications or output, this cannot be assessed.

D. Participant NEBs Reviewed

This section reviews the NEBs that provide benefits to ESA participants. The following benefits were reviewed.

- Fewer Shutoffs
- Fewer Calls to Utility
- Reduced Water / Wastewater Bills
- Thermal Comfort
- Household Safety
- Outside Noise Reduction
- Inside Noise Reduction (appliances)
- Operations & Maintenance Cost Changes

1. Fewer Shutoffs

Shutoffs, caused by a customer's failure to pay, result in an additional cost to the customer. The 2019 report noted that there are about a dozen studies from the late 1990s to 2011 that valued this NEB at about $0.50 per household.

- ESA Impact: The 2019 study stated that the installation of ESA measures improved payment behavior and thus reduced the number of shutoffs that occur every year. They estimated an $0.18 average annual benefit per participant in 2020 and adjusted that for inflation rates in the following years.

  ESA measures can reduce customer usage and bills, improving payment behavior, but it is unclear whether that reduction will have a significant impact on the number of shutoffs.

  The calculation of this NEB included the following components.
  - Customer's Value per Avoided Shutoff

- Value of a Rental Home While Power Is Shutoff
- Customer's Value of Time to Reconnect
- Cost to the Customer of a Reconnect
- Value of Loan Needed to Reconnect

- Data: The following data were used as inputs in the research.

Table II-8A
Reduced Shutoffs Data Inputs

	Input	Source	Value	Notes
A	Average Shutoffs per CARE customer	Utilities	0.0241	
B	ESA Shutoff Impact	Skumatz, CT WRAP, 2002[24]	16%	No normalization
Customer's Value per Avoided Shutoff				
C	Customer's Value per Shutoff	No strong source	$0.00	
D	Inflation Factor	Bureau of Labor Statistics	1.49-1.64	
Value of a Rental Home While Power Is Shutoff				
E	Monthly Rent	Skumatz, CT WRAP, 2002	$600	
F	Inflation Factor	Bureau of Labor Statistics	1.47-1.62	
G	Service Terminations	Skumatz, CT WRAP, 2002	20%	
H	Percent of Month Power Shutoff	Skumatz, CT WRAP, 2002	3%	Assumed to be 1 day.
Customer's Value of Time to Reconnect				
I	Hours Spent Getting Power Returned	Skumatz, CT WRAP, 2002	2	2002 CT study used 8 hours.
J	Minimum Wage	CA Utility Data Sheet[25]	$12.00-$15.00	
K	Inflation Factor	Bureau of Labor Statistics	1.02	Unclear why inflation factor is required for up to date minimum wage numbers.
L	Households Time Value Relative to Minimum Wage	No strong source	100%	
Cost to the Customer of a Reconnect				
M	Utility Cost for Reconnect	Utilities	$17.36	
N	Inflation Factor	CPI	1.00	Assumed current.
O	Households that Reconnect	Utilities	92%	

[24] Skumatz, Lisa and Nordeen, Trevor. "Connecticut WRAP Program Non-Energy Benefits, March 2002.
[25] State of California, Department of Industrial Relations, "Minimum Wage", 2020, https://www.dir.ca.gov/dlse/FAQ_MinimumWage.htm

	Input	Source	Value	Notes
Value of Loan Needed to Reconnect				
P	Amount Borrowed for Reconnect	No source	$0.00	
Q	Interest Rate		18%	Conservative Credit Card Rate.
Adjustment Factors				
R	Weighted Measure Life (Years)	Utilities	14.4	Sum (Measure Lifetime * # of Measure)/Total # of Measures
S	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
T	Adjustment Factor Number of Measures	Utilities	1	Reduced to less than one if average # of causal measures per household was less than one.

The following inputs were used to calculate the reduction in the number of shutoffs.

- Average Shutoffs per CARE customer: The average number of shutoffs per low-income customer per year, 0.0241, was based on 2018 utility California Alternate Rates for Energy (CARE) data.

- ESA Shutoff Impact: The ESA impact on shutoffs was estimated to be a 16 percent reduction, based on the disconnect impact estimate in the Skumatz 2002 CT WRAP Study.
  - Skumatz 2002 CT Study: See the discussion in the Reduced Arrearage Carrying Cost review for the full details regarding this study.

    The shutoff results from the study are displayed in Table II-8B. They estimated a 16 percent reduction in shutoffs, but the result was not statistically significant.

Table II-8B
CT WRAP Shutoff Impact Results

	Pre	Post	Change		Significant (95% Confidence Level)
			$	%	
Participants	0.200%[26]	0.017%	-0.003%	-16%	No

The following input was used to calculate the customer's value of avoiding a shutoff.

- Customer's Value per Shutoff: The customer's value for a shutoff was included as $0.00 because no good estimate of this figure could be found.

The following inputs were used to calculate the customer's value of not being able to live in their home while power was shut off.

- Rental Value of Home per Month: The rental value of a home for a month was estimated as $600 based on the value used in the Skumatz 2002 CT WRAP Study.

[26] This is the value reported in the study, but given the other values in the table it may have been an error.

- Skumatz 2002 CT Study: See the discussion in the Reduced Arrearage Carrying Cost review for the full details regarding this study. The study stated that the value of $600 was the value found in previous research by the authors, but a specific citation was not provided.

- Home's Service Lost through Shutoff: The percentage of the home's service lost because of the shutoff was estimated to be 20 percent based on the Skumatz 2002 CT WRAP Study.
  - Skumatz 2002 CT Study: See the discussion in the Reduced Arrearage Carrying Cost review for the full details regarding this study. The study stated that the estimate of 20 percent was the value found in previous research by the authors, but a specific citation was not provided.

- Percent of Month Power Shutoff: The percentage of a month that the shutoff lasted was estimated to be three percent (or one day) based on the Skumatz 2002 CT WRAP Study.
  - Skumatz 2002 CT Study: See the discussion in the Reduced Arrearage Carrying Cost review for the full details regarding this study. The study stated that the estimate of three percent was the value found in previous research by the authors, but a specific citation was not provided.

The following inputs were used to calculate the customer's value of the time needed to reconnect.

- Hours Spent Getting Power Returned: The number of hours spent getting power returned was estimated as two hours, which the 2019 spreadsheet tool stated was a conservative estimate based on the value of eight hours found in the Skumatz 2002 CT WRAP Study.
  - Skumatz 2002 CT Study: See the discussion in the Reduced Arrearage Carrying Cost review for the full details regarding this study. The study stated that the estimate of eight hours was the value found in previous research by the authors, but a specific citation was not provided.

- Minimum Wage: The minimum wage in California was included as $12.00 per hour in 2020 from the California Department of Industrial Relations and reflects the planned increase in minimum wage scheduled through 2024. The 2019 spreadsheet tool adjusted this value for inflation but did not explain why.

- Households Time Value Relative to Minimum Wage: The value of a household's time relative to the minimum wage was included as 100 percent.

The following input was used to calculate the customer's direct cost to reconnect.

- Utility Cost for Reconnect: The previous utility reconnect NEB stated that the utility cost for reconnections was $17.36 and the cost charged to the customer was $5.85 based on utility inputs. However, this NEB used the full utility cost of $17.36 as the participant cost. It is not clear why this cost was used.

  An accompanying input requiring the source year for these data was set to 2018. This date was used to update the reconnect fee for inflation.

The following inputs were used to calculate the customer's value of the cost to reconnect.

- Amount Borrowed for Reconnect: The amount borrowed to fund the reconnection was included as zero since there is no good source of information for this data point.

- Interest Rate: The interest rate on any money borrowed to reconnect was estimated as 18 percent based on credit card interest rates.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for participant NEBs (18%) was less than one.

  Factor = minimum of 1 or
  pmt(discount rate, yr horizon, PV(discount rate, measure life, 1))

  - Discount Rate = 18% (utility data)
  - Year Horizon = 10 years (utility data)
  - Weighted Measure Life = $\frac{\sum(Measure\ Lifetime * \#\ of\ Measures)}{Total\ \#\ of\ Measures}$ = 14.4
  - pmt(discount rate, yr horizon, PV(discount rate, measure life, 1)) = 1.12
    If the weighted measure life was less than the program horizon, this function would determine the amount by which the NEB should have been reduced.

  Table II-2C displays the measures included in the calculation of weighted measure life. This NEB included those same measures.

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one. This is the same calculation as in the Reduced Arrearage Carrying Cost review. No adjustment was made.

- Assumptions: Key assumptions that were made.
  - ESA shutoff impact of 16%, equal to the finding from the 2002 CT study.
  - Rental value of home for a month of $600, equal to the finding from the 2002 CT study.
  - Home's lost service through the shutoff of 20 percent, equal to the finding from the 2002 CT study.
  - Shutoff period of one day, equal to the finding from the 2002 CT study.
  - Reconnect time of two hours, adjusted from the 2002 CT study of eight hours.
  - Value for a household's time equal to the minimum wage.

- Calculation: This NEB was calculated by first calculating the following benefits.
  - Customer's Value of Avoided Shutoff
  - Rental Value of Home During Shutoff
  - Value of Time Required to Reconnect
  - Avoided Direct Cost
  - Avoided Loan

	A	*	B	*	C	*	D	=	Customer's Value of Avoided Shutoff Benefit
Year	Average Shutoffs		ESA Impact		Customer's Value		Inflation		
2020	0.0241		16%		$0.00		1.49		$0.00
2021	0.0241		16%		$0.00		1.53		$0.00
2022	0.0241		16%		$0.00		1.56		$0.00
2023	0.0241		16%		$0.00		1.60		$0.00
2024	0.0241		16%		$0.00		1.64		$0.00

	A	*	B	*	E	*	F	*	G	*	H	=	Rental Value During Shutoff Benefit
Year	Average Shutoffs		ESA Impact		Value of Rental Home		Inflation		Service Lost		% of Month Shutoff		
2020	0.0241		16%		$600		1.47		20%		3%		$0.02
2021	0.0241		16%		$600		1.51		20%		3%		$0.02
2022	0.0241		16%		$600		1.54		20%		3%		$0.02
2023	0.0241		16%		$600		1.58		20%		3%		$0.02
2024	0.0241		16%		$600		1.62		20%		3%		$0.02

	A	*	B	*	I	*	J	*	K	*	L	=	Value of Time to Reconnect Benefit
Year	Average Shutoffs		ESA Impact		Hrs to Reconnect		Min Wage		Inflation		Time Value		
2020	0.0241		16%		2		$12		1.02		100%		$0.09
2021	0.0241		16%		2		$13		1.02		100%		$0.10
2022	0.0241		16%		2		$14		1.02		100%		$0.11
2023	0.0241		16%		2		$15		1.02		100%		$0.12
2024	0.0241		16%		2		$15		1.02		100%		$0.12

	A	*	B	*	M	*	N	*	O	=	Avoided Direct Cost Benefit
Year	Average Shutoffs		ESA Impact		Utility Reconnect Cost		Inflation		HH that Reconnect		
2020	0.0241		16%		$17.36		1.00		92%		$0.06
2021	0.0241		16%		$17.36		1.00		92%		$0.06
2022	0.0241		16%		$17.36		1.00		92%		$0.06
2023	0.0241		16%		$17.36		1.00		92%		$0.06
2024	0.0241		16%		$17.36		1.00		92%		$0.06

		*	(1	+	P	*	Q)	=	Avoided Direct Cost and Loan Benefit
Year	Avoided Direct Cost Benefit				$ Loan		Int %		
2020	92%		1		$0.00		18%		$0.06
2021	92%		1		$0.00		18%		$0.06
2022	92%		1		$0.00		18%		$0.06
2023	92%		1		$0.00		18%		$0.06
2024	92%		1		$0.00		18%		$0.06

	(	+		+		+	)	*	S	*	T	=	
Year	Customer's Value Benefit		Rental During Shutoff Benefit		Value of Time to Reconnect Benefit		Value of Direct Cost		Adjust Program Horizon		Adjust # Measures		Annual Participant Impact
2020	$0.00		$0.02		$0.09		$0.06		1		1		$0.18*
2021	$0.00		$0.02		$0.10		$0.06		1		1		$0.18
2022	$0.00		$0.02		$0.11		$0.06		1		1		$0.19
2023	$0.00		$0.02		$0.12		$0.06		1		1		$0.20
2024	$0.00		$0.02		$0.12		$0.06		1		1		$0.20

*All dollar values presented here were rounded to the nearest cent. Final values reflect those in the 2019 spreadsheet tool, not the sum of the rounded values above.

- Limitations
  - Use of 16% as the shutoff reduction.
  - Use of $600 as the rental value of a home for a month.
  - Use of 20% as an estimate of lost service.
  - Use of 3% of a month as the amount of time service was shut off.
  - Use of 2 hours for amount of time to reconnect.
  - Use of minimum wage as a valuation of the customer's time.

- Applicability
  - Monthly home rental value may not apply to California in 2020 even when adjusted for inflation.
  - Lost service percent may not apply to ESA participants in 2020.
  - Shutoff time may not apply to ESA participants in 2020.
  - Time to reconnect may not apply to California utilities.
  - Valuation of a customer's time may not apply to ESA participants.

- Duplication: This NEB may have duplicated the effect of another NEB.
  - The calculation of this participant NEB included the cost to the utility to reconnect the individual of $17.36, which was already included in the utility NEB for Reduced Shutoffs instead of the fee of $5.85 charged to the customer.

  - The calculation for this NEB included values related to reconnections rather than shutoffs.
    - The participant NEB for Fewer Reconnects discussed in the following section also included the fee charged for reconnecting, which duplicates this NEB.
    - The customer's time to reconnect, the fee to reconnect, and the loan required to reconnect are components more applicable to the participant NEB for reconnects rather than shutoffs. This does not lead to duplication because they

were not included in the participant NEB for reconnects, but the final values of both NEBs may be misleading because of their inclusion here.

2. Reduced Time on Utility Collections Calls

Calls from the utility to resolve payment issues cost customers' time. The 2019 report noted that there were fewer than a dozen studies from the mid-2000s to 2018 that valued this NEB at about $5.00 per household.

- ESA Impact: The 2019 study stated that the installation of ESA measures improved payment behavior and thus reduced the number of calls that need to be made to customers for nonpayment. They estimated a $0.53 average annual benefit per participant in 2020 and adjusted that for inflation rates in the following years.

  ESA measures can reduce customer usage and bills, improving payment behavior, but it is unclear whether that reduction will have a significant impact on the number of calls.

- Data: The following data were used as inputs in the research.

Table II-9A
Reduced Calls to Utility Data Inputs

	Input	Source	Value	Notes
A	Average Collection Calls per Customer	Skumatz, CT WRAP, 2002[27]	1.73	
B	ESA Call Impact	Skumatz, CT WRAP, 2002	32%	No normalization.
C	Average Length of Call	Skumatz, CT WRAP, 2002	4.67	
D	Minimum Wage	Utility Data Sheet	$12.00-$15.00	
E	Minutes per Hour	Conversion Factor	60	
F	Inflation Factor	Bureau of Labor Statistics	1.02	
G	Households Time Value Relative to Min Wage		100%	
H	Weighted Measure Life (Years)	Utilities	14.4	Sum (Measure Lifetime * # of Measure)/Total # of Measures
I	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
J	Adjustment Factor Number of Measures	Utilities	1	Reduced to less than one if average # of causal measures per household was less than one.

  - Average Calls per Customer: The average number of collection calls per household was 1.73 based on the Skumatz 2002 CT WRAP Study.
    - Skumatz 2002 CT Study: See discussion in II-B1: Reduced Arrearage Carrying Cost for the full details regarding this study.

[27] Skumatz, Lisa and Nordeen, Trevor. "Connecticut WRAP Program Non-Energy Benefits, March 2002.

The value of 1.73 per household was equal to the average number of calls in the 1999 data provided by Connecticut Light and Power (CL&P). Further information regarding the calculation of this figure was not provided.

- ESA Calls Impact: The ESA impact on the number of customer calls per household was 32 percent based on the reported impact on arrearages in the Skumatz 2002 CT WRAP Study.
  - Skumatz 2002 CT Study: See discussion in the Reduced Arrearage Carrying Cost review for the full details regarding this study. The arrearage results from the study are displayed in Table II-9B. The average 32 percent reduction in arrearages was used, and the insignificant comparison group adjustment was not applied.

Table II-9B
CT WRAP Arrearage Impact Results
Used to Approximate Call Impact

	Pre	Post	Change		Significant (95% Confidence Level)
			$	%	
Participants	$79.40	$54.31	-$25.09	-32%	Yes
Nonparticipants	$86.34	$97.78	$11.44	13%	No

- Average Length of Call: The average call length was 4.67 minutes, based on the Skumatz 2002 CT WRAP Study.
  - Skumatz 2002 CT Study: See discussion in the Reduced Arrearage Carrying Cost review for the full details regarding this study.

    The value of 4.67 minutes was equal to the average call length in the 1999 data provided by Connecticut Light and Power (CL&P). Further information regarding the calculation of this figure was not provided.

- Minimum Wage: The minimum wage in California was included as $12.00 per hour in 2020 from the California Department of Industrial Relations and reflected the planned increase in minimum wage scheduled through 2024. The 2019 spreadsheet tool adjusted this value for inflation but did not explain why.

- Households Time Value Relative to Minimum Wage: The value of a household's time relative to the minimum wage was included as 100 percent.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for participant NEBs (18%) was less than one. This is the same calculation as in the Participant Fewer Shutoffs review. No adjustment was made.

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one. This is the same calculation as in the Reduced Arrearage Carrying Cost review. No adjustment was made.

- Assumptions: Key assumptions that were made.
  - ESA customer calls impact of 32%, equal to the finding from the 2002 CT study for arrearages.
  - Average number of customer calls per household per year of 1.73, equal to the finding from the 2002 CT study.
  - Collection call length of 4.67 minutes, equal to the finding for CT utilities in 2002.
  - Value for a household's time equal to the minimum wage.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	(D	/	E)	*	F	*	G	*	I	*	J	=	
Year	# Calls		Call Impact		Call Length		Min Wage		Min /Hr		Inflation		HH Time Value		Adjust Prog. Horizon		Adjust # Measures		Annual Participant Impact
2020	1.73		32%		4.67		$12.00		60		1.02		100%		1		1		$0.53
2021	1.73		32%		4.67		$13.00		60		1.02		100%		1		1		$0.57
2022	1.73		32%		4.67		$14.00		60		1.02		100%		1		1		$0.62
2023	1.73		32%		4.67		$15.00		60		1.02		100%		1		1		$0.66
2024	1.73		32%		4.67		$15.00		60		1.02		100%		1		1		$0.66

- Limitations
  - Use of 32% as the reduction in the number of collection calls.
  - Use of 1.73 as the average number of collection calls.
  - Use of 4.67 minutes as the average length of calls.
  - Use of minimum wage as a valuation of the customer's time.

- Applicability
  - Reduction in calls may not apply to the level of savings achieved by the ESA program.
  - Number of calls may not apply to the average number of calls made by California utilities in 2020.
  - Length of calls may not apply to the average call length of calls made by California utilities in 2020.

- Duplication: This NEB did not duplicate another benefit calculated in this NEB analysis or other benefits that are already accounted for in the ESA cost-benefit analysis.

3. Reduced Water/Wastewater Bills

Some ESA measures reduce energy usage by reducing water usage, which decreases the amount of energy needed to heat that water. The 2019 report noted that there were dozens of studies from the early 2000s to 2018 that valued this NEB at about $15 per household.

- ESA Impact: The 2019 study stated that the installation of a subset of ESA measures reduced the amount of water used by participants. They estimated a $29.70 average annual benefit per participant in 2020 and adjusted that for inflation in the following years.

  The list of applicable measures was developed from various national reports. The 2019 study stated that the expected savings were below those found in other studies because fewer of these measures were installed. If this NEB was low, it may have been because California has unique water demands due to lengthy draughts. If participants already had efficient fixtures to reduce their water expenses, it might explain why they were included in ESA measures at a lower rate.

- Data: The following data were used as inputs in the research.

Table II-10A
Reduced Water and Wastewater Bills Data Inputs

	Input	Source	Value	Notes
A	Water Savings (Gallons per Household per Year)	Utilities	2,373	
B	Conversion from Gallons to CCF	Conversion Metric	1/748	CCF = Hundred Cubic Feet
C	Avoided Water Rate per CCF	Utilities	$5.54	
D	Inflation Factor	Bureau of Labor Statistics	1.02-1.13	
E	Avoided Sewer Rate per CCF	Utilities	$3.60	
F	Weighted Measure Life (Years)	Utilities	1	Sum (Measure Lifetime * # of Measure)/Total # of Measures
G	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
H	Adjustment Factor Number of Measures	Utilities	1	Reduced to less than one if average # of causal measures per household was less than one.

  - Water Savings: Average water savings were calculated by multiplying the average water savings of each applicable group of ESA measures by the number of those measures per household. Table II-10B displays the figures used in the calculation for each of the applicable measures. See the discussion in Appendix-B4: Water/Wastewater Infrastructure for the full details regarding the calculations of water savings from each measure.

Table II-10B
Reduced Water and Wastewater Infrastructure Impact Calculation

Measure Group Name	Savings Source	# of Measures	# of Measures per Household	Gallons Saved per Measure	Water Savings (Gallons per HH/Year)
Showerheads	EPA 2019[28]	4,500	0.19	2,900	554.89
DHW Bundles*	EPA 2019	20,256	0.86	1,800	1,550.34
Tub Diverters	EPA 2017[29]	2,500	0.11	1,500	159.45
Clothes Washers	A4WE 2017[30]	426	0.02	6,000	108.68
Total		27,682	1.18		2373.36

*The 2019 report and spreadsheet tool did not state what was included in DHW bundles, but the 2015-2017 ESA Impact Assessment stated that "Other Hot Water" bundles included faucet aerators, low flow showerheads, thermostatic shower valves, and tub diverter/water spouts.

- Avoided Residential Water Rate per CCF: The avoided water rate per hundred cubic feet (CCF) was included in the 2019 spreadsheet tool as $5.54 based on utility inputs. An accompanying input requiring the source year for this data was set to 2019.

- Avoided Residential Sewer Rates per CCF: The avoided sewer rate per CCF was included in the 2019 spreadsheet tool as $3.60 based on utility inputs. An accompanying input requiring the source year for this data was set to 2019.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for participant NEBs (18%) was less than one.

  Factor = minimum of 1 or
  pmt(discount rate, yr horizon, PV(discount rate, measure life, 1))

  - Discount Rate = 18% (utility data)
  - Year Horizon = 10 years (utility data)
  - Weighted Measure Life = $\frac{\sum(Measure\ Lifetime * \#\ of\ Measures)}{Total\ \#\ of\ Measures}$ = 10

    The spreadsheet tool specified an override value of 1 for the weighted measure life but still used the 10-year weighted measure life.

[28] USEPA, WaterSense, www.epa.gov/watersense/showerheads, 2019.
[29] USEPA, WaterSense, "Bath and Shower Diverter NOI Public Meeting Presentation", www.epa.gov/watersense/bath-and-shower-diverter-update, 2017.
[30] Alliance for Water Efficiency, www.allianceforwaterefficiency.org/Residential_Clothes_Washer_Introduction.apx, 2019. This link no longer works.

- pmt(discount rate, yr horizon, PV(discount rate, measure life, 1)) = 1.00
  If the weighted measure life was less than the program horizon, this function would determine the amount by which the NEB should have been reduced.

Appendix Table A-7D displays the measures included in the calculation of weighted measure life for the societal NEB for water and wastewater reduction. This NEB included those same measures.

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one. This is the same calculation as in Appendix-B4 for Water/Wastewater Infrastructure. No adjustment was made.

- Assumptions: Key assumptions that were made.
  - Water savings equal those from national studies by the EPA, the Alliance for Water Efficiency, and EnergyStar.
  - Water savings of DHW Bundles equal 50 percent of the savings from low flow showerheads and faucet aerators.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	(C	+	D)	*	E	*	G	*	H	=	
Year	Water Savings (Gallons)		Conversion to CCF		Water Rate		Sewer Rate		Inflation		Adjust Prog. Horizon		Adjust # Measures		Annual Participant Impact
2020	2,373		1/748		$5.54		$3.60		1.024		1		1		$29.70
2021	2,373		1/748		$5.54		$3.60		1.059		1		1		$30.41
2022	2,373		1/748		$5.54		$3.60		1.074		1		1		$31.14
2023	2,373		1/748		$5.54		$3.60		1.100		1		1		$31.89
2024	2,373		1/748		$5.54		$3.60		1.136		1		1		$32.65

- Limitations
  - Use of national reports to estimate ESA measure impact.

- Applicability
  - Household water savings impacts from national reports may not be applicable to California.

- Duplication: This NEB did not duplicate another benefit calculated in this NEB analysis or other benefits that are already accounted for in the ESA cost-benefit analysis.

4. Thermal Comfort

Heating system replacements and shell improvements can improve home comfort. The 2019 report noted that there were dozens of studies from the early 2000s to the mid-2010s that valued this NEB at about $100 per household.

- ESA Impact: The 2019 study stated that the installation of ESA measures increased comfort of household occupants. The perception of this benefit was often greater than the financial benefit of reduced utility bills and was calculated based on survey findings. They estimated a $2.54 average annual benefit per participant every year from 2020 to 2024.

- Data: The following data were used as inputs in the research.

Table II-11A
Thermal Comfort Data Inputs

	Input	Source	Value	Notes
A	Average Bill Savings	Utilities	$30.42	
B	Inflation Factor	CPI	1.00	Assumed current
C	NEB Value Multiplier	Skumatz 2010 Xcel Study[31]	0.087	
D	Weighted Measure Life (Years)	Utilities	12	Sum (Measure Lifetime * # of Measure)/Total # of Measures
E	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
F	Adjustment Factor Number of Measures	Utilities	0.96	Reduced to less than one if average # of causal measures per household was less than one.

  - Average Bill Savings: Program attributable savings was calculated as $30.42 per participant per year using utility data.

    Program Attributable Savings per year per household = $\frac{Total\ Dollar\ Savings}{Total\ Participants}$ = $30.42

    - Total Dollar Savings = $715,332

      Total dollar savings was calculated by adding the value of all measures.

      Total dollar savings = $\sum(Measure\ kWh\ Savings * \#\ of\ Measures * kWh\ Rate * (1 - kWh\ CARE\ Discount)) +$
      $\sum(Measure\ Therm\ Savings * \#\ of\ Measures * Therm\ Rate * (1 - Therm\ CARE\ Discount))$ = $715,332

      - Residential kWh Rate = $0.12
      - kWh CARE discount = 35%
      - Residential Therm Rate = $1.26
      - Therm CARE discount = 20%

[31] Skumatz, L., "NEBs Analysis for Xcel Energy's Low Income Energy Efficiency Programs", Prepared for Xcel Energy, Denver CO, May 2010.

Table II-11B displays the kWh and therm savings for each measure included in this calculation. Because the NEB value multiplier was applied to total bill savings, all measures were included in this calculation instead of the relevant subset that was used to calculate weighted measure life for this NEB. This same value was used as in the other participant NEBs.

- Total Number of Participants = 23,518

Table II-11B
Measures Included in (Thermal) Comfort
Program Attributable Savings Calculation

Measure Name	# of Measures	Annual kWh Savings	Annual Therm Savings
High Efficiency Clothes Washer (with electric water heating)	21	208	0
High Efficiency Clothes Washer (with gas water heating)	405	0	16
Refrigerator	1,002	463	0
Low-flow showerhead & thermostatic valve (with electric water heating)	135	64.98	0
Low-flow showerhead & thermostatic valve (with gas water heating)	4,365	0	9.77
Domestic Hot Water Bundle (with electric water heating)	4,054	102	0
Domestic Hot Water Bundle (with gas water heating)	16,202	0	4
Heat pump water heater	25	2799	0
Tub diverter (with electric water heating)	75	52.56	0
Tub diverter (with gas water heating)	2,425	0	2
Water Heater Repair/Replace	1,154	0	6
Enclosure bundle (with electric space heating and A/c)	2,258	137	0
Enclosure bundle (with gas space heating and A/c)	3,161	137	5
Enclosure bundle (with gas space heating and no A/c)	5,870	0	5
Blower motor retrofit	0	121	-2
Central AC Replacement	0	343	0
Central AC tune-up	3	25	0
Duct Testing & Sealing (with electric space heating and A/c)	1	101	0
Duct Testing & Sealing (with gas space heating and A/c)	136	101	5
Duct Testing & Sealing (with gas space heating and no A/c)	251	0	5
Evaporative cooler new install	0	457	0
Evaporative cooler replacement	0	73	0
Fan control	25	111	0
Gas Furnace Clean and Tune	3,634	0	-1
Gas furnace pilot light conversion	18	0	15.1
Gas Furnace Repair/Replace	4,933	0	-7

Measure Name	# of Measures	Annual kWh Savings	Annual Therm Savings
Heat pump replacement	0	1372	0
High efficiency gas furnace	0	0	35
PCT (with CAC and gas heat)	875	150	12
PCT (with gas heat and no CAC)	1,625	0	12
Room AC Replacement	203	-102	0
Exterior Hard wired LED fixtures	2,734	77.61	0
Interior Hard wired LED fixtures	8,419	68.17	-0.0248
LED A-lamps	0	31	-0.7
LED BR lamps	0	33	-0.77
LED diffuse bulb	148,722	14	-0.26
LED reflector bulb	8,045	26.88	-0.45
LED Torchiere	14,817	68.17	-1.69
Vacancy sensor	0	108	0
Pool motor replacement	0	1136	0
Smart Power Strip	9,456	64	0
Smart strip Tier 2	7,501	133.9	-2.09
Variable speed pool pump	500	1154	0
Total	253,050	9360	116
Total kWh Dollar Savings = $632,988			
Total Therm Dollar Savings = $82,344			

- Multiplier for Value of NEB: The thermal comfort multiplier value per dollar saved was calculated as 0.087 based on the findings in the Skumatz 2010 Xcel Study.
  - Skumatz 2010 Xcel Study: This study surveyed participants in Xcel Energy's Low-Income Single-Family Weatherization Program in the Colorado service area. The program offers natural gas and electric efficiency measures that vary depending on the need of each participant. The study did not include the specific measures that were offered through the program but did state that the average savings were $238.30 per home per year.

    The study sent notifications of the survey to all 1,950 participating households and received online responses from 149 for a completed interview rate of 7.6 percent. The survey asked participants if they experienced a change (positive or negative) in the following categories of benefits.
    - Comfort
    - Water
    - Light
    - Noise
    - Safety

- Health
- Maintenance
- Resale (Property Value)
- Bill Control
- Environmental Contribution
- Bill Knowledge
- Collections

If participants responded with a positive or negative change in the attribute, they were asked to compare that change to the dollar savings on their bill. The survey estimated a total NEB value multiplier of 1.171 for electric participants, 1.148 for gas participants, and 1.156 overall. The study did not provide the specific calculation of these total NEB value multipliers but included the individual benefits of the above NEBs.

The study also provided the percentage of the total NEB value multiplier assigned to each category but did not state how these percentages were calculated. The results for the single-family weatherization program are shown in Table II-11C.

Table II-11C
2010 Xcel Thermal Comfort Multiplier Results

	Single-Family Weatherization Program		
	All	**Electric**	**Gas**
Total Participants	1,950		
Respondents	149	125	106
Total NEB Value Multiplier	1.156	1.171	1.148
Bill Savings	$238.30	$67.56	$170.74
Comfort	7.50%	7.50%	7.40%
Water	7.40%	7.50%	7.30%
Light	7.30%	7.20%	7.20%
Noise	8.10%	8.10%	8.10%
Safety	8.20%	8.20%	8.20%
Health	7.80%	7.70%	8.00%
Maintenance	7.20%	7.20%	7.20%
Resale	7.80%	7.70%	7.90%
Bill Control	8.20%	8.20%	8.30%
Environmental Contribution	7.90%	7.90%	7.80%
Bill Knowledge	7.40%	7.40%	7.40%
Collections	7.20%	7.20%	6.90%
Other	8.20%	8.10%	8.30%

	Single-Family Weatherization Program		
	All	**Electric**	**Gas**
Total	**100%**	**100%**	**100%**

The study stated that the percent of the total NEBs represented in the thermal comfort category was 7.5 percent. The 2019 spreadsheet tool multiplied the total NEB value by the comfort percentage to calculate the NEB multiplier for thermal comfort as 0.087. The calculation is displayed in Table II-11D.

Table II-11D
2010 Xcel Thermal Comfort Multiplier Results

	Number of Respondents	Multiplier
Total NEB Value Multiplier	149	1.156
Percent of NEB Value Multiplier attributed to Comfort	149	0.075
2019 Spreadsheet Tool Multiplier for Thermal Comfort		0.087

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for participant NEBs (18%) was less than one.

  Factor = minimum of 1 or
  pmt(discount rate, yr horizon, PV(discount rate, measure life, 1))

  - Discount Rate = 18% (utility data)
  - Year Horizon = 10 years (utility data)
  - Weighted Measure Life = $\frac{\sum(Measure\ Lifetime * \#\ of\ Measures)}{Total\ \#\ of\ Measures}$ = 12.0
  - pmt(discount rate, yr horizon, PV(discount rate, measure life, 1)) = 1.07
    If the weighted measure life was less than the program horizon, this function would determine the amount by which the NEB should have been reduced.

  Table II-11E displays the measures included in the calculation of weighted measure life.

Table II-11E
Measures Included in Thermal Comfort Calculation

Measure Name	Measure Lifetime	# of Measures	Lifetime * # Measures
Enclosure bundle (with electric space heating and A/c)	11	2,258	24,838
Enclosure bundle (with gas space heating and A/c)	11	3,161	34,771
Enclosure bundle (with gas space heating and no A/c)	11	5,870	64,570
Central AC tune-up	10	3	30
Gas Furnace Clean and Tune	5	3,634	18,170
Gas furnace pilot light conversion	13	18	234
Gas Furnace Repair/Replace	20	4,933	98,660
PCT (with CAC and gas heat)	11	875	9,625
PCT (with gas heat and no CAC)	11	1,625	17,875
Room AC Replacement	9	203	1,827
Total	112	22,580	270,600
Average Measure Life = 12.0 Years			

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household is less than one.

  Factor = minimum of 1 or average number of causal measures

  - Total Number of Measures = 22,580
  - Total Number of Participants = 23,518
  - Average Number of Causal Measures = $\frac{\sum(\#\ of\ Measures)}{Total\ \#\ of\ Participants}$ = 0.96

  This adjustment factor can be turned on or off by utilities in the sensitivity options.

- Assumptions
  - Value multiplier of 0.087, equal to the finding from the Skumatz 2010 Xcel Study.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	E	*	F	=	Annual
Year	Bill Savings		Inflation		Value Multiplier		Adjust Prog. Horizon		Adjust # Measures		Participant Impact
2020	$30.42		1.00		0.087		1		0.96		$2.54
2021	$30.42		1.00		0.087		1		0.96		$2.54
2022	$30.42		1.00		0.087		1		0.96		$2.54
2023	$30.42		1.00		0.087		1		0.96		$2.54
2024	$30.42		1.00		0.087		1		0.96		$2.54

- Limitations
  - Low response rate for survey that was used to develop the thermal comfort multiplier.
  - Use of 0.087 as NEB value multiplier.

- Applicability
  - Thermal comfort multiplier may not apply to the ESA program given that the 2010 Xcel participants saved $238 on average compared to the $30 program attributable bill savings for the ESA program.

- Duplication: This NEB did not duplicate another benefit calculated in this NEB analysis or other benefits that were already accounted for in the ESA cost-benefit analysis.

5. Household Safety

ESA measures can contribute to household safety. The 2019 report noted that there were only a few studies that addressed this NEB and no reliable impact estimates.

- ESA Impact: The 2019 study stated that the installation of ESA measures would increase household safety. They estimated a $0.00 average annual benefit per participant and stated that the NEB is a placeholder until better studies are conducted.

  The 2019 report stated that the value of NEBs like household safety were difficult to calculate directly and instead applied a multiplier to participant energy savings. This multiplier was estimated from survey findings.

- Data: The following data were used as inputs in the research.

Table II-12A
Household Safety Data Inputs

	Input	Source	Value	Notes
A	Average Bill Savings	Utilities	$30.42	
B	Inflation Factor	CPI	1.00	Assumed current.
C	Multiplier for Value of NEB	-	0	0 after removing CO monitors and other safety measures accounted for elsewhere.
D	Weighted Measure Life (Years)	Utilities	13	Sum (Measure Lifetime * # of Measure)/Total # of Measures
E	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
F	Adjustment Factor Number of Measures	Utilities	0.47	Reduced to less than one if average # of causal measures per household was less than one.

- Average Bill Savings: Program attributable savings was calculated as $30.42 per participant per year using utility data (as shown in the Thermal Comfort section).

  Table II-11B displays the kWh and therm savings for each measure included in this calculation. Because the NEB value multiplier was applied to total bill savings, all measures were included in this calculation instead of the relevant subset that was used to calculate weighted measure life later in this section.

- Multiplier for Value of NEB: This value is included as 0 because measures that contribute to household safety, such as CO monitors and those that reduce fires, are included in other NEBs.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for participant NEBs (18%) was less than one. This is the same calculation as in Appendix-C3 for Fewer Fires. No adjustment was made.

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one. This is the same calculation as in Appendix-A2 for Utility Health & Safety - Insurance. No adjustment was made.

- Assumptions: Key assumptions that were made.
  - Value multiplier of 0% because no measures were applicable.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	E	*	F	=	Annual
Year	Bill Savings		Inflation		Value Multiplier		Adjust Prog. Horizon		Adjust # Measures		Participant Impact
2020	$30.42		1.00		0		1		0.47		$0.00
2021	$30.42		1.00		0		1		0.47		$0.00
2022	$30.42		1.00		0		1		0.47		$0.00
2023	$30.42		1.00		0		1		0.47		$0.00
2024	$30.42		1.00		0		1		0.47		$0.00

- Limitations
  - Use of zero as the NEB value multiplier.

- Applicability
  - No studies applied to the ESA program.

- Duplication: This NEB did not duplicate another benefit calculated in this NEB analysis or other benefits that are already accounted for in the ESA cost-benefit analysis. However, it was included as 0 because all potential benefits were already included in other NEBs.

6. Outside Noise Reduction

Shell/enclosure measures can reduce outside noise and improve the household's environment. The 2019 report noted that this was a highly valued benefit and there were dozens of studies from the early 2000s to 2018 that valued this NEB at about $20.

- ESA Impact: The 2019 study stated that the installation of ESA measures reduced external noise. They estimated a $1.46 average annual benefit per participant from 2020 to 2024.

  The 2019 report stated that the value of NEBs like noise reduction were difficult to calculate directly and instead applied a multiplier to participant energy savings. This multiplier was estimated from survey findings.

- Data: The following data were used as inputs in the research.

Table II-13A
Outside Noise Reduction Data Inputs

	Input	Source	Value	Notes
A	Average Bill Savings	Utilities	$30.42	
B	Inflation Factor	CPI	1.00	Assumed current
C	NEB Value Multiplier	Skumatz Xcel 2010, ACEEE Russell 2015[32]	0.10	
D	Weighted Measure Life (Years)	Utilities	11	Sum (Measure Lifetime * # of Measure)/Total # of Measures
E	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
F	Adjustment Factor Number of Measures	Utilities	0.48	Reduced to less than one if average # of causal measures per household was less than one.

  - Average Bill Savings: Program attributable savings was calculated as $30.42 per participant per year using utility data (as shown in the Thermal Comfort section).

    Table II-11B displays the kWh and therm savings for each measure included in this calculation. Because the NEB value multiplier was applied to total bill savings, all measures were included in this calculation instead of the relevant subset that was used to calculate weighted measure life later in this section.

  - NEB Value Multiplier: The noise reduction multiplier value per dollar saved was calculated as 0.10 based on the midpoint between the findings from the ACEEE

[32] Xcel Citation: Skumatz, L., "NEBs Analysis for Xcel Energy's Low Income Energy Efficiency Programs", Prepared for Xcel Energy, Denver CO, May 2010, http://kms.energyefficiencycentre.org/sites/default/files/ie1502.pdf. ACEEE Russell study could not be located.

Russell 2015 study and the Skumatz 2010 Xcel study. The 2019 spreadsheet tool did not clearly state which estimates were used from each study.

- ACEEE Russell 2015 Study: This study could not be located.

- Skumatz 2010 Xcel Study: See the discussion the Thermal Comfort review for full details regarding this study. The study stated that the percentage of the total NEB multiplier value in the Xcel Single Family Weatherization program that were noise related was 8.1 percent. This value is displayed in Table II-11C and was the same for electric and gas participants. The 2019 spreadsheet tool did not clearly state how the final multiplier value for noise reduction was calculated. If it followed the calculation from the Thermal Comfort NEB, the result would be a multiplier of 0.094 after multiplying by the total NEB multiplier of 1.15 from this study. Table II-13B displays the calculation of this value and the final midpoint between the two studies of 0.10 used in the 2019 spreadsheet tool.

Table II-13B
2010 Xcel Outside Noise Reduction Multiplier Results

	# of Respondents	Multiplier
Total Multiplier for Noise Reduction (ACEEE Russell)	Unknown	0.05-0.15
Percent of NEB Attributed to Noise (2010 Xcel)	149	0.081
Total NEB Value Multiplier (2010 Xcel)	149	1.15
Total Multiplier for Noise Reduction (2010 Xcel)	149	0.094
2019 Spreadsheet Tool Multiplier for Noise Reduction (midpoint between above studies)		0.10

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for participant NEBs (18%) was less than one. This is the same calculation as in Appendix-C10 for Scalding. No adjustment was made.

Table II-13C displays the measures included in the calculation of weighted measure life.

Table II-13C
Measures Included in Outside Noise Reduction

Measure Name	Measure Lifetime	# of Measures	Lifetime * # Measures
Enclosure bundle (with electric space heating and AC)	11	2,258	24,838
Enclosure bundle (with gas space heating and AC)	11	3,161	34,771
Enclosure bundle (with gas space heating and no AC)	11	5,870	64,570

Measure Name	Measure Lifetime	# of Measures	Lifetime * # Measures
Total	33	11,289	124,179
Average Measure Life = 11.0 Years			

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one.

  Factor = minimum of 1 or average number of causal measures

  - Total Number of Measures = 11,289
  - Total Number of Participants = 23,518
  - Average Number of Causal Measures = $\frac{\sum(\#\ of\ Measures)}{Total\ \#\ of\ Participants}$ = 0.48

  This adjustment factor can be turned on or off by utilities in the sensitivity options.

- Assumptions: Key assumptions that were made.
  - Value multiplier of 10%, equal to midpoint of findings from 2010 Xcel and 2015 ACEEE Russell studies.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	E	*	F	=	
Year	Bill Savings		Inflation		Value Multiplier		Adjust Prog. Horizon		Adjust # Measures		Annual Participant Impact
2020	$30.42		1.00		0.10		1		0.48		$1.46
2021	$30.42		1.00		0.10		1		0.48		$1.46
2022	$30.42		1.00		0.10		1		0.48		$1.46
2023	$30.42		1.00		0.10		1		0.48		$1.46
2024	$30.42		1.00		0.10		1		0.48		$1.46

- Limitations
  - Use of 0.10 as NEB value multiplier.

- Applicability
  - Outdoor noise multiplier may not apply to the ESA program given that the 2010 Xcel participants saved $238 on average compared to the $30 program attributable bill savings for the ESA program.

- Duplication: This NEB did not duplicate another benefit calculated in this NEB analysis or other benefits that were already accounted for in the ESA cost-benefit analysis.

7. Inside Noise Reduction (Appliances)

New appliances can reduce indoor noise and improve the household's environment. The 2019 report noted that this was a highly valued benefit and there were about a dozen studies from the early 2000s to 2018 that valued this NEB at about $20.

- ESA Impact: The 2019 study stated that the installation of ESA measures reduced internal noise from appliances. They estimated a $0.17 average annual benefit per participant from 2020 to 2024.

  The 2019 report stated that the value of NEBs like noise reduction are difficult to calculate directly and instead applied a multiplier to participant energy savings. This multiplier was estimated from survey findings.

- Data: The following data were used as inputs in the research.

Table II-14A
Indoor Noise Reduction Data Inputs

	Input	Source	Value	Notes
A	Average Bill Savings	Utilities	$30.42	
B	Inflation Factor	CPI	1.00	Assumed current.
C	NEB Value Multiplier	Skumatz Xcel 2010[33]	0.08	No normalization
D	Weighted Measure Life (Years)	Utilities	12.6	Sum (Measure Lifetime * # of Measure)/Total # of Measures
E	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
F	Adjustment Factor Number of Measures	Utilities	0.069	Reduced to less than one if average # of causal measures per household was less than one.

  - Average Bill Savings: Program attributable savings was calculated as $30.42 per participant per year using utility data (as shown in the Thermal Comfort section).

    Table II-11B displays the kWh and therm savings for each measure included in this calculation. Because the NEB value multiplier was applied to total bill savings, all measures were included in this calculation instead of the relevant subset that was used to calculate weighted measure life later in this section.

  - NEB Value Multiplier: The indoor noise reduction multiplier value per dollar saved was calculated as 0.08 based on the finding of 0.085 from the Skumatz 2010 Xcel study.
    - Skumatz 2010 Xcel Study: See the discussion in the Thermal Comfort review for full details regarding this study. The study stated that the percentage of the total NEBs in the Xcel Single Family Weatherization program that were noise

[33] http://kms.energyefficiencycentre.org/sites/default/files/ie1502.pdf (pg. 3); Xcel Citation: Skumatz, L., "NEBs Analysis for Xcel Energy's Low Income Energy Efficiency Programs", Prepared for Xcel Energy, Denver CO, May 2010;

related was 8.1 percent. The 2019 spreadsheet instead used 7.3 percent, which was the percentage for lighting benefits. This value immediately precedes the 8.1 percent for noise in the study's results table, so it is possible 7.3 percent was used in error. The results from this study are displayed in Table II-11C.

Table II-14B displays the calculation using the value of 7.3 percent.

Table II-14B
2010 Xcel Indoor Noise Reduction Multiplier Results

	Number of Respondents	Multiplier
Total NEB Value Multiplier	149	1.150
Percent of NEB Attributed to Lighting*	149	0.073
2019 Spreadsheet Tool Multiplier for Noise Reduction		0.080

*Value not equal to finding from Xcel study of 8.1 percent for noise.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for participant NEBs (18%) was less than one.

  Factor = minimum of 1 or
  pmt(discount rate, yr horizon, PV(discount rate, measure life, 1))

  - Discount Rate = 18% (utility data)
  - Year Horizon = 10 years (utility data)
  - Weighted Measure Life = $\frac{\sum(Measure\ Lifetime * \#\ of\ Measures)}{Total\ \#\ of\ Measures}$ = 12.6
  - pmt(discount rate, yr horizon, PV(discount rate, measure life, 1)) = 1.08
    If the weighted measure life was less than the program horizon, this function would determine the amount by which the NEB should have been reduced.

  Table II-14C displays the measures included in the calculation of weighted measure life.

Table II-14C
Measures Included in Inside Noise Reduction

Measure Name	Measure Lifetime	# of Measures	Lifetime * # Measures
High Efficiency Clothes Washer (with electric water heating)	11	21	231
High Efficiency Clothes Washer (with gas water heating)	11	405	4,455
Refrigerator	14	1,002	14,028
Room AC Replacement	9	203	1,827
Total	45	1,631	20,541
Average Measure Life = 12.6 Years			

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one.

  Factor = minimum of 1 or average number of causal measures

  - Total Number of Measures = 1,631
  - Total Number of Participants = 23,518
  - Average Number of Causal Measures = $\frac{\sum(\#\ of\ Measures)}{Total\ \#\ of\ Participants}$ = 0.069

  This adjustment factor can be turned on or off by utilities in the sensitivity options.

- Assumptions: Key assumptions that were made.
  - Value multiplier of 0.08, equal to the finding from the Skumatz Xcel 2010 study.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	E	*	F	=	Annual
Year	Energy Savings		Inflation		Value Multiplier		Adjust Prog. Horizon		Adjust # Measures		Participant Impact
2020	$30.42		1.00		0.08		1		0.069		$0.17
2021	$30.42		1.00		0.08		1		0.069		$0.17
2022	$30.42		1.00		0.08		1		0.069		$0.17
2023	$30.42		1.00		0.08		1		0.069		$0.17
2024	$30.42		1.00		0.08		1		0.069		$0.17

- Limitations
  - Use of 0.08 as NEB value multiplier.

- Applicability
  - Indoor noise multiplier may not apply to the ESA program given that the 2010 Xcel participants saved $238 on average compared to the $30 program attributable bill savings for the ESA program.

- Duplication: This NEB did not duplicate another benefit calculated in this NEB analysis or other benefits that were already accounted for in the ESA cost-benefit analysis

8. Operations & Maintenance Cost Changes

Appliances require regular maintenance and repair, and program appliance replacement can reduce this ongoing cost. The 2019 report noted that this was a highly valued benefit and there were dozens of studies from the early 2000s that valued this NEB at about $40.

- ESA Impact: The 2019 study stated that the installation of ESA measures reduced the need for appliance maintenance. They estimated a $0.38 average annual benefit per participant in 2020 and adjusted it for inflation every year until 2024.

- Data: The following data were used as inputs in the research. The 2019 spreadsheet tool noted that only commercial estimates could be found for most inputs and that further research would be needed to find more reliable values.

Table II-15A
Operations & Maintenance Cost Changes Data Inputs

	Input	Source	Value	Notes
A	Average # ESA Appliance Measures	Utilities	0.061	
B	Appliance Repair Rate	Yaleappliance.com	0.045	Spreadsheet notes that this is a conservative estimate.
C	Reduction in Repairs	Consumer Reports[34]	75%	
D	Appliance Repair Cost	Home Advisor[35]	$176	
E	Inflation Factor	Bureau of Labor Statistics	1.05-1.15	
F	Weighted Measure Life (Years)	Utilities	10.1	Sum (Measure Lifetime * # of Measure)/Total # of Measures
G	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
H	Adjustment Factor Number of Measures	Utilities	1	Reduced to less than one if average # of causal measures per household was less than one.

- Average Number of Appliances Replaced by the ESA Program: The average number of appliances was calculated as 0.061 per participant using utility data.

$$\text{Average Appliances} = \frac{Total\ Appliances}{Total\ Participants} = 0.061$$

  - Total Appliances = 1,428
  - Total Number of Participants = 23,518

[34] www.consumerreports.org/cro/news2014/04/home-appliance-repair-frequency-of-use-vs-years=of=service/index.htm.

[35] www.homeadvisor.com/cost/kitchen/repair-an-appliance.com

Table II-15B displays the total number of appliances included in this calculation.

Table II-15B
Appliances Included in Operations & Maintenance Cost Changes

Measure Name	# of Measures
High Efficiency Clothes Washer (with electric water heating)	21
High Efficiency Clothes Washer (with gas water heating)	405
Refrigerator	1,002
Total	1,428

- Appliance Repair rate: The appliance repair rate was 0.045 based on the estimate on yaleappliance.com. The 2019 report spreadsheet tool notes that this was a conservative estimate.
  - Yaleappliance.com: The 2019 spreadsheet tool did not give a specific hyperlink and this exact estimate could not be found on the website.

- Reduction in Repairs: The reduction in the need for repairs was 75 percent based on Consumer Reports for appliances under four years old.
  - Consumerreports.com: The hyperlink provided in the 2019 spreadsheet tool was no longer functional.

- Cost of Appliance Repair: The cost per appliance repair was $176 based on homeadvisor.com's average value for California.
  - Homeadvisor.com: The hyperlink provided in the 2019 spreadsheet tool was no longer functional. The spreadsheet tool stated that this value was calculated according to a California zip code but did not state which zip code.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for participant NEBs (18%) was less than one.

  Factor = minimum of 1 or
  pmt(discount rate, yr horizon, PV(discount rate, measure life, 1))

  - Discount Rate = 18% (utility data)
  - Year Horizon = 10 years (utility data)
  - Weighted Measure Life = $\frac{\sum(Measure\ Lifetime * \#\ of\ Measures)}{Total\ \#\ of\ Measures}$ = 10.1

- pmt(discount rate, yr horizon, PV(discount rate, measure life, 1)) = 1.01
  If the weighted measure life was less than the program horizon, this function would determine the amount by which the NEB should have been reduced.

Table II-15C displays the measures included in the calculation of weighted measure life. The 2019 spreadsheet did not state why this differed from the measures included in the calculation of the average number of appliances.

Table II-15C
Measures Included in Operations & Maintenance Cost Changes

Measure Name	Measure Lifetime	# of Measures	Lifetime * # Measures
High Efficiency Clothes Washer (with electric water heating)	11	21	231
High Efficiency Clothes Washer (with gas water heating)	11	405	4,455
Refrigerator	14	1,002	14,028
Low-flow showerhead & thermostatic valve (with electric water heating)	10	135	1,350
Low-flow showerhead & thermostatic valve (with gas water heating)	10	4,365	43,650
Domestic Hot Water Bundle (with electric water heating)	10	4,054	40,540
Domestic Hot Water Bundle (with gas water heating)	10	16,202	162,020
Heat pump water heater	13	25	325
Tub diverter (with electric water heating)	10	75	750
Tub diverter (with gas water heating)	10	2,425	24,250
Water Heater Repair/Replace	11	1,154	12,694
Central AC tune-up	10	3	30
Duct Testing & Sealing (with electric space heating and A/c)	18	1	18
Duct Testing & Sealing (with gas space heating and A/c)	18	136	2,448
Duct Testing & Sealing (with gas space heating and no A/c)	18	251	4,518
Fan control	11	25	275
Gas Furnace Clean and Tune	5	3,634	18,170
Gas furnace pilot light conversion	13	18	234
Gas Furnace Repair/Replace	20	4,933	98,660
PCT (with CAC and gas heat)	11	875	9,625
PCT (with gas heat and no CAC)	11	1,625	17,875
Room AC Replacement	9	203	1,827
Smart Power Strip	8	9,456	75,648
Smart strip Tier 2	8	7,501	60,008
Variable speed pool pump	10	500	5,000
Total	290	59,024	598,629
Average Measure Life = 10.1 Years			

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one.

  Factor = minimum of 1 or average number of causal measures

  - Total Number of Measures = 59,629
  - Total Number of Participants = 23,518
  - Average Number of Causal Measures = $\frac{\sum(\#\ of\ Measures)}{Total\ \#\ of\ Participants}$ = 2.510

  This adjustment factor can be turned on or off by utilities in the sensitivity options.

- Assumptions: Key assumptions that were made.
  - Appliance repair rate of 4.5%, equal to the value reported by yaleappliance.com.
  - Reduction of repairs of 75%, equal to the value reported by cosumerreports.org.
  - Appliance repair cost of $176, equal to the value reported on homeadvisor.com.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	D	*	E	*	G	*	H	=	
Year	Appliances Replaced by ESA		Repair Rate		ESA Impact		Repair Cost		Inflation		Adjust Prog. Horizon		Adjust # Measures		Annual Participant Impact
2020	0.060719		4.5%		75%		$176		1.05		1		1		$0.38
2021	0.060719		4.5%		75%		$176		1.07		1		1		$0.39
2022	0.060719		4.5%		75%		$176		1.10		1		1		$0.40
2023	0.060719		4.5%		75%		$176		1.13		1		1		$0.41
2024	0.060719		4.5%		75%		$176		1.15		1		1		$0.42

- Limitations
  - Use of 4.5% as appliance repair rate.
  - Use of 75% as reduction in repairs.
  - Use of $176 as cost of appliance repair.

- Applicability
  - Repair rate may not apply to ESA participants in 2020.
  - Reduction in repairs may not apply to ESA participants.
  - Cost of appliance repair may not apply to appliances in ESA participant homes.

- Duplication: This NEB did not duplicate another benefit calculated in this NEB analysis or other benefits that were already accounted for in the ESA cost-benefit analysis.

E. Summary

This section provided a detailed review of the 14 NEBs included in the 2019 ESA NEB Study. This section provides a summary of the calculated value of each NEB from the 2019 Study, whether the NEB was included in the 2019 study, and plans for inclusion or exclusion in the current study.

Table II-16A displays the Utility NEBs. The following Utility NEBs are proposed for inclusion in the current study.

- Arrearage Carrying Cost
- Bad Debt Write-Off
- Shutoffs
- Collections Notices
- Collections Calls

Table II-16A
Summary of Utility NEBs

Benefit	Category	2019 Value[#]	NEB Included		Exclusion Reason
			2019	New	
Arrearage Carrying Cost	Payment-Related	$5.58	Yes	Yes	
Bad Debt Write-Off	Payment-Related	$3.34	No	Yes	
Shutoffs	Payment-Related	$0.12	Yes	Yes	
Reconnects	Payment-Related	$0.04	Yes	No	Included in Shutoff NEB.
Collections Notices	Payment-Related	$0.94	Yes	Yes	
Collections Calls	Payment-Related	$0.93	No	Yes	
Utility H&S Insurance	Other Cost	$0.00	No	No	No expected benefit.
CARE Subsidy	Other Cost	$12.76	No	No	CARE subsidy savings are not realized.
Total of Included 2019 NEBs[*]		**$6.68**			

[*]Total only sums 2019 included benefits.
[#]The 2019 NEB value is the SDG&E value.

Table II-16B displays the Societal NEBs. The following Societal NEB is proposed for inclusion in the current study.

- Economic Output

Table II-16B
Summary of Societal NEBs

Benefit	Category	2019 Value[#]	NEB Included		Exclusion Reason
			2019	New	
Economic Output	Economic	$24.99	No	Yes	
Job Creation	Economic	$11.24	No	No	Duplicates Economic Output NEB.
Economic Tax Impacts	Economic	$6.25	No	No	Duplicates Economic Output NEB.
Emissions on Illnesses & Deaths	Health, Safety, & Comfort	$43.06	No	No	Duplicates emissions in cost-benefit analysis.
Water / Wastewater Infrastructure	Other Cost	$16.65	Yes	No	No defensible estimation method.
Work Sick Days	Health, Safety, & Comfort	$0.78	No	No	No clear ESA impact.
CO Poisonings	Health, Safety, & Comfort	$0.00	No	No	Included in new Health NEB.
Asthma Incidents	Health, Safety, & Comfort	$0.69	No	No	Only children with asthma. Not program overall.
Prescription Medication Adherence	Health, Safety, & Comfort	$0.00	No	No	Research has not shown significant relationship.
Low Birthweight Babies	Health, Safety, & Comfort	$0.00	No	No	Research has not shown significant relationship.
Total of Included 2019 NEBs[*]		**$16.65**			

[*]Total only sums 2019 included benefits.
[#]The 2019 NEB value is the SDG&E value.

Table II-16C displays the Participant NEBs. The following Participant NEBs are proposed for inclusion in the current study.

- Shutoffs
- Collections Calls
- Water / Wastewater Bills
- Comfort
- Noise Reduction
- Operations & Maintenance

Table II-16C
Summary of Participant NEBs

Benefit	Category	2019 Value[#]	NEB Included		Exclusion Reason
			2019	New	
Shutoffs	Payment-Related	$0.18	No	Yes	
Reconnects	Payment-Related	$0.02	No	No	Included in Shutoff NEB.
Collections Calls	Payment-Related	$0.53	Yes	Yes	
Arrearages	Payment-Related	$4.84	No	No	Bill savings already valued.
Water / Wastewater Bills	Other Cost	$29.70	Yes	Yes	
Comfort	Health, Safety, & Comfort	$2.54	Yes	Yes	
Fires	Health, Safety, & Comfort	$0.02	Yes	No	Research has not shown significant relationship.
Work Sick Days	Health, Safety, & Comfort	$0.88	No	No	Research has not shown significant relationship.
School Sick Days	Health, Safety, & Comfort	$0.25	No	No	Research has not shown significant relationship.
CO Poisonings	Health, Safety, & Comfort	$0.00	Yes	No	Included in new Health NEB.
Asthma Incidence	Health, Safety, & Comfort	$0.95	Yes	No	Only children with asthma. Not overall.
Allergies	Health, Safety, & Comfort	$3.73	Yes	No	Included in new Health NEB.
Cold Symptoms	Health, Safety, & Comfort	$0.00	No	No	Research has not shown significant relationship.
Scaldings	Health, Safety, & Comfort	$0.00	Yes	No	No literature to support this NEB.
Household Safety	Health, Safety, & Comfort	$0.00	No	No	Included in new Safety NEB.
Property Value	Home Op. & Value	$0.00	No	No	Duplicates other NEBs.
Outside Noise Reduction	Health, Safety, & Comfort	$1.46	Yes	Yes	
Inside Noise Reduction	Health, Safety, & Comfort	$0.17	Yes		
Lighting	Health, Safety, & Comfort	$3.04	No	No	No literature to support this NEB.
Operations & Maintenance	Home Op. & Value	$0.38	Yes	Yes	
Deferred Purchase	Home Op. & Value	$26.20	No	No	No literature to support this NEB.
Detergent Usage	Home Op. & Value	$0.97	Yes	No	No recent literature to support this NEB.
Improved Equipment	Home Op. & Value	$2.25	No	No	Basic models primarily improve efficiency.
Home Appearance	Home Op. & Value	$2.68	Yes	No	No applicable measures.
Hardship Benefits	Payment-Related	$0.00	No	No	No literature to support this NEB.
Moves	Payment-Related	$2.09	No	No	No literature to support this NEB.
Energy Bill Control	Payment-Related	$2.70	No	No	No literature to support this NEB.

Benefit	Category	2019 Value[#]	NEB Included		Exclusion Reason
			2019	New	
Environmental Good	Home Op. & Value	$0.82	No	No	No literature to support this NEB.
Total of Included 2019 NEBs[*]		**$43.13**			

[*]Total only sums 2019 included benefits.
[#]The 2019 NEB value is the SDG&E value.

III. Non-Energy Benefit Calculations

This section provides an overview of the NEBs that are proposed for inclusion and exclusion, and a detailed review of the proposed calculations.

A. NEB Calculation Overview

As part of this research, we created a new primary categorization for the NEBs that is related to the type of impact rather than to the beneficiary. Each NEB refers to the specific beneficiary, whether it is the utility, society, or the participant.

The NEBs are categorized into the following impact areas.

- Payment-Related
- Other Cost Reduction
- Economic
- Home Operation and Value
- Health, Safety, and Comfort

One important input in the Payment-Related NEBs; the Economic NEB; and the Health, Safety, and Comfort NEBs is the energy bill savings that result from the ESA program. This is equal to the kWh or therm savings multiplied by the retail rate paid by CARE participants.

The 2019 model used measure-level energy savings multiplied by the average number of measures installed per participant. The advantage of this method is that it utilizes the average number of measures installed in the most recent year, which best represents the current average installation package. The measure-level energy savings are developed by running a regression of energy savings (developed through a billing analysis) on each installed measure. However, it is not possible to develop a good estimate of the savings achieved by each individual measure because the sample is not large enough, the variation in measures installed is not large enough, and the savings achieved for some measures is too small to develop a statistically significant estimate. For those measures where good regression estimates were not developed, the previous model used projected savings for individual measures. As a result, the sum of the measure-level savings greatly overstates the energy savings achieved by the program as compared to the energy savings estimated in the billing analysis. Therefore, the energy bill savings is well overstated and results in overstated NEBs. If the reported savings are used as an input in the NEB analysis, they should first be adjusted by the realization rate.[36]

The model proposed in this study uses the total electric and natural gas savings estimated in the most recent billing analysis to overcome this problem of overstated savings. The advantage of this method is that it provides a much more accurate estimate of energy savings. The disadvantage of this model is that it can only provide savings from the most recent evaluation, and the measure mix may have changed between the most recent evaluation and the current NEB study. For example, the current model uses energy savings from the 2017 ESA impact

[36] In some cases, utilities used disaggregated measure savings that sum to the whole house evaluated savings. The use of measure-level savings is another option in these cases.

evaluation. (Note that SDG&E uses 2016 evaluation results for electric savings because they believe that the 2016 results are more representative of their annual savings and that the 2017 results were an outlier).

Payment-Related NEBs

Table III-1A provides a review of the payment-related benefits that we propose to include in the revised NEB model. The 2019 Model provides the SDG&E value, and the updated value is the average across the four utilities. The calculation section and the summary display the NEBs for each utility individually. The updated calculation of these benefits shows a small value for most of the NEBs, and an average total of only $2.51 across all of the NEBs. Only the bad debt write-off has a value over one dollar, driven by a high rate of write-offs for PG&E.

Table III-1A
Included Payment-Related Benefits
First Year Benefit per ESA Participant

Benefits	NEB Type	2019 Model		Updated Value[##]	Calculation
		Included	Value[#]		
Arrearage Carrying Cost	Utility	Yes	$5.58	$0.56	ESA Bill Impact * Arrearage Reduction as % of Bill Reduction * Interest Rate
Bad Debt Write-Off	Utility	No	$3.34	$1.55	ESA Bill Impact * Arrearage Reduction as % of Bill Reduction * % of Arrears Written Off
Shutoffs	Utility	Yes	$0.12	$0.01	ESA Bill Impact * Shutoff Reduction relative to Bill Reduction * Shutoffs per CARE Participant * (Shutoff Cost + Reconnect Cost)
Reconnects	Utility	Yes	$0.04		
Shutoffs	Participant	No	$0.18	$0.00	ESA Bill Impact * Shutoff Reduction relative to Bill Reduction * Shutoffs per CARE Participant * Participant Reconnect Fee
Reconnects	Participant	No	$0.02		
Collections Notices	Utility	Yes	$0.94	$0.06	ESA Bill Impact * Collections Notice Reduction relative to Bill Reduction * Collections Notice Cost
Collections Calls	Utility	No	$0.93	$0.29	ESA Bill Impact * Collections Calls Reduction relative to Bill Reduction * Collections Calls Cost
Collections Calls	Participant	Yes	$0.53	$0.04	ESA Bill Impact * Collections Calls Reduction relative to Bill Reduction * Call Length * Minimum Wage
TOTAL[*]			**$7.21**	**$2.51**	

[*]Total only sums 2019 included benefits.
Note: CARE provides discounts on energy bills for income-qualified customers.
[#]The 2019 NEB value is the SDG&E value.
[##]The 2020 NEB value is the average of the four IOUs. Updated inputs are used where available.

Table III-1B lists the payment-related benefits from the 2019 ESA NEB Study that we propose to exclude from the revised NEB model. These were excluded because the bill savings were already valued, or the benefit was not supported by the literature.

Table III-1B
Excluded Payment-Related Benefits
First Year Benefit per ESA Participant

Benefits	NEB Type	2019 Model		Reason for Exclusion
		Included	Value[#]	
Arrearages	Participant	No	$4.84	Duplication of energy benefits.
Hardship Benefits	Participant	No	$0.00	Not supported by literature.
Moves	Participant	No	$2.09	Not supported by literature.
Energy Bill Control	Participant	No	$2.81	Not supported by literature.
TOTAL[*]			**$0.00**	

[*]Total only sums 2019 included benefits.
[#]The 2019 NEB value is the SDG&E value.

Other Cost Reduction NEBs

Table III-2A provides a review of the other cost reduction benefits that we propose to include in the revised NEB model. The water and wastewater value is almost $10.

Table III-2A
Included Other Cost Reduction Benefits
First Year Benefit per ESA Participant

Benefits	NEB Type	2019 Model		Updated Value[##]	Calculation
		Included	Value[#]		
Water & Wastewater Bills	Participant	Yes	$29.70	$9.94	Average Water Savings * (Water + Sewage Rates) * % ESA Jobs in Owned Homes
TOTAL			**$29.70**	**$9.94**	

[#]The 2019 NEB value is the SDG&E value.
[##]The 2020 NEB value is the average of the four IOUs. Updated inputs are used where available.

Table III-2B lists the other cost reduction benefits from the 2019 ESA NEB Study that we propose to exclude from the revised NEB model. These were excluded because there was no significant expected benefit or there was no defensible estimation method available.

Table III-2B
Excluded Other Cost Reduction Benefits
First Year Benefit per ESA Participant

Benefits	NEB Type	2019 Model		Reason for Exclusion
		Included	Value[#]	
CARE Subsidy	Utility	No	$12.76	CARE subsidy savings are not realized.
Utility H&S - Insurance	Utility	No	$0.00	No significant expected benefit.
Water & Wastewater Infrastructure	Societal	Yes	$16.65	No defensible estimation method available.
TOTAL[*]			**$16.65**	

[*]Total only sums 2019 included benefits.
[#]The 2019 NEB value is the SDG&E value.

Economic NEBs

Table III-3A provides a review of the economic benefit that we propose to include in the revised NEB model. This NEB was not one of the NEBs that was included from the 2019 model. The updated economic output value is $35.27. The high value reflects the large annual ESA spending, totaling over $369 million across the four utilities.

Table III-3A
Included Economic Benefit
First Year Benefit per ESA Participant

Benefits	NEB Type	2019 Model		Updated Value[##]	Calculation
		Included	Value[#]		
Economic Output	Societal	No	$24.99	$35.27	($ Spent in CA * Output Multiplier Change – $ Spent outside CA * Output Multiplier) / (# of Jobs) + ESA Bill Reduction * Output Multiplier Change
TOTAL[*]			**$0.00**	**$35.27**	

[*]Total only sums 2019 included benefits.
[#]The 2019 NEB value is the SDG&E value.
[##]The 2020 NEB value is the average of the four IOUs. Updated inputs are used where available.

Table III-3B lists the economic benefits from the 2019 ESA NEB Study that we propose to exclude from the revised NEB model. These were excluded because they were included in the economic output NEB.

Table III-3B
Excluded Economic Benefits
First Year Benefit per ESA Participant

Benefits	NEB Type	2019 Model		Reason for Exclusion
		Included	Value[#]	
Job Creation	Societal	No	$11.24	Duplicate of output impact.
Economic Tax Impacts	Societal	No	$6.25	Duplicate of output impact.
TOTAL[*]			**$0.00**	

[*]Total only sums 2019 included benefits.
[#]The 2019 NEB value is the SDG&E value.

Home Operation and Value NEB

Table III-4A provides a review of the home operation and value benefit that we propose to include in the revised NEB model. The updated value for this NEB is $1.38.

Table III-4A
Included Home Operation and Value Benefit
First Year Benefit per ESA Participant

Benefits	NEB Type	2019 Model		Updated Value[##]	Calculation
		Included	Value[#]		
Operations & Maintenance	Participant	Yes	$0.38	$1.38	ESA Appliance Measure Rate * Appliance Repair Rate * Repair Cost * % ESA Jobs in Owned Homes
TOTAL			**$0.38**	**$1.38**	

[#]The 2019 NEB value is the SDG&E value.
[##]The 2020 NEB value is the average of the four IOUs. Updated inputs are used where available.

Table III-4B lists the home operation and value benefits from the 2019 ESA NEB Study that we propose to exclude from the revised NEB model. These were excluded because they duplicated other NEBs, they were not supported by the literature, or the measures mainly provide increased efficiency rather than the other attributes.

Table III-4B
Excluded Home Operation and Value Benefits
First Year Benefit per ESA Participant

Benefits	NEB Type	2019 Model		Reason for Exclusion
		Included	Value[#]	
Property Value Benefits	Participant	No	$0.00	Duplicates other benefits.
Measure Lifetime / Deferred Purchase	Participant	No	$26.20	Not supported by literature.

Benefits	NEB Type	2019 Model		Reason for Exclusion
		Included	Value[#]	
Reduced Detergent Usage	Participant	Yes	$0.97	Not supported by recent literature.
Improved Equipment Features / Performance	Participant	No	$2.25	Measures mainly improve efficiency.
Aesthetics / Appearance of Home	Participant	Yes	$2.68	Measures mainly improve efficiency.
Environmental Good	Participant	No	$0.00	Not supported by literature.
TOTAL[*]			**$3.65**	

[*]Total only sums 2019 included benefits.
[#]The 2019 NEB value is the SDG&E value.

Health, Safety, and Comfort NEBs

Table III-5A provides a review of the health, safety, and comfort benefits that we propose to include in the revised NEB model. These NEBs have a total value of $6.86.

Table III-5A
Included Health, Safety, and Comfort Benefits
First Year Benefit per ESA Participant

Benefits	NEB Type	2019 Model		Updated Value[##]	Calculation
		Included	Value[#]		
Health	Participant	Yes	$4.68	$1.69	ESA Bill Savings * Benefit Multiplier
Safety	Participant	Yes	$0.02	$1.78	ESA Bill Savings * Benefit Multiplier
Comfort	Participant	Yes	$2.54	$1.63	ESA Bill Savings * Benefit Multiplier
Outside Noise	Participant	Yes	$1.46	$1.76	ESA Bill Savings * Benefit Multiplier
Inside Noise	Participant	Yes	$0.17		
TOTAL			**$8.87**	**$6.86**	

*Health includes CO Poisonings, Asthma Incidents, Reduction in Allergies from 2019 model.
**Safety includes Fires and Scalding from 2019 model.
#The 2019 NEB value is the SDG&E value.
##The 2020 NEB value is the average of the four IOUs. Updated inputs are used where available.

Table III-5B lists the health, safety, and comfort benefits from the 2019 ESA NEB Study that we propose to exclude from the revised NEB model. These were excluded because they duplicated other NEBs, they were not supported by the literature, there was no rationale for ESA causation, or they were included in general health and general safety NEBs.

Table III-5B
Excluded Health, Safety, and Comfort Benefits
First Year Benefit per ESA Participant

Benefits	NEB Type	2019 Model		Reason for Exclusion
		Included	Value[#]	
Emissions on Illness & Deaths	Societal	No	$43.06	Duplicate of emissions benefit in cost-benefit calc.
Sick Days from Work	Societal	No	$0.78	No clear impact of ESA on sick days. Not clear what percent of days would be taken off as PTO.
Sick Days from Work	Participant	No	$0.88	Not supported by the literature.
Sick Days from School	Participant	No	$0.25	Not supported by the literature.
CO Poisonings	Societal	No	$0.00	Included in general safety benefit.
CO Poisonings	Participant	Yes	$0.00	Included in general safety benefit.
Asthma Incidents	Societal	No	$0.69	Included in general health benefit.
Asthma Incidents	Participant	Yes	$0.95	Included in general health benefit
Reduction in Allergies	Participant	Yes	$3.73	Included in general health benefit.
Reduction in Cold Symptoms	Participant	No	$0.00	Included in general health benefit.
Prescription Adherence	Societal	No	$0.00	Included in general health benefit.
Low Birthweight Babies Costs	Societal	No	$0.00	Included in general health benefit.
Fires	Participant	Yes	$0.02	Included in general safety benefit.
Scalding	Participant	Yes	$0.00	Included in general safety benefit.
Household Safety	Participant	No	$0.00	Included in general safety benefit.
Quality / Quantity of Lighting	Participant	No	$3.04	Not supported by the literature.
TOTAL[*]			**$4.70**	

[*]Total only sums 2019 included benefits.
[#]The 2019 NEB value is the SDG&E value.

B. Detailed Calculation Review

This section describes the calculations for the NEBs recommended for inclusion, within the following categories. All calculations show the first year benefit per ESA participant.

- Payment-Related
- Other Cost Reduction
- Economic
- Home Operation and Value
- Health, Safety, and Comfort

1. Payment-Related Benefits

Benefits included in this category are as follows.

- Arrearage Carrying Cost (Utility)
- Bad Debt Write-Off (Utility)
- Shutoffs (Utility)

- Shutoffs (Participant)
- Collections Notices (Utility)
- Collections Calls (Utility)
- Collections Calls (Participant)

Arrearage Carrying Cost (Utility NEB)

The ESA program reduces energy bills, energy costs, and potentially reduces participant arrearages. This results in a lower arrearage carrying cost for utilities.

- Benefit Type: Utility

- Data: Table III-6A displays the data that were used as inputs.

Table III-6A
Arrearage Carrying Cost Data Inputs

	Input	Source	Input Type	Value			
				PG&E	SDG&E	SCG	SCE
A	Average kWh Savings	ESA Evaluation (2017), SDG&E (2016)	Utility	131	67	--	187
B	kWh CARE Rate	PG&E (2019), SDG&E (2020)*, SCE (2020)*	Utility	$0.14	$0.18	--	$0.13
C	Average Therm Savings	ESA Evaluation (2017)	Utility	9	3	7	--
D	Therm CARE Rate	PG&E (2019), SDG&E (2020)*, SCG (2020)	Utility	$1.28	$1.14	$0.82	--
E	ESA Arrearage Impact	Lit Review	Literature	37%			
F	Interest Rate	PGE (2019), SDG&E (2020), SCG (2020), SCE (2020)	Utility	7.88%	7.63%	7.68%	8.75%

*The SDG&E and SCE CARE rates were calculated using their average residential rates and CARE discounts.

- Average kWh and Therm Savings: The average energy savings were from the 2019 ESA Impact Evaluation for program year 2017.[37] Table III-6B displays the savings for 2017. The SDG&E electric savings value is from 2016.

Table III-6B
2017 ESA Energy Savings

Utility	Average 2017 Electric Savings (kWh)	Average 2017 Gas Savings (Therms)
PG&E	131	9
SDG&E	67*	3
SCG	--	7
SCE	187	--

* The SDG&E electric savings value is from 2016.

[37] DNV-GL, Energy Savings Assistance Program Impact Evaluation Program Years 2015-2017, Southern California Gas Company, April 2019, pg. 39, 48.

- Arrearage Impact: The ESA program impact on arrearages was estimated as 37 percent of the bill reduction, based on a review of the literature. This estimate was calculated as the mean impact of bill reductions on arrearages from previous APPRISE research. A literature review did not find other research that included data on arrearage reduction that resulted from energy efficiency or bill payment assistance bill reduction.

  The referenced APPRISE studies were not publicly available, so the programs are not identified, but key information on the studies is presented in Table III-6C. The arrearage was reduced on average by 37 percent of the bill reduction. This estimate excluded two programs with the highest and two programs with the lowest arrearage impact estimates (the mean would have been 39 percent without these removals).

  Other key information about the research is summarized below.
  - Evaluations were from program years 2010 to 2018.
  - The bill assistance evaluations used one or more comparison groups described in the table; later program participants, earlier program participants, or LIHEAP nonparticipants.
  - Most of the results were statistically significant.

Table III-6C
APPRISE Research on Arrearage Reduction

Study	Program Type	Program Year	Treatment Group Obs.	Comparison Group	Bill Reduction	Arrearage Reduction	
						$ Reduced	% Of Bill Reduction
EE1	LI Efficiency	2018	4,427	Not Used	$66***	$36***	55%
BA1	Bill Assistance Elec Non-Heat	2017-2018	3,148	Later Participants, LIHEAP Nonparts	$851	$454***	53%
BA2	Bill Assistance Elec Heat	2017-2018	2,035	Later Participants, LIHEAP Nonparts	$1,146	$642***	56%
BA5	Bill Assistance Gas	2017	2,588	Later Participants, Earlier Participants	$688***	$539***	78%
BA6	Bill Assistance Gas	2015	3,516	Later Participants, LIHEAP Nonparts	$323***	$15	5%
BA7	Bill Assistance Elec Non-Heat	2013	964	LIHEAP Nonparts	$272***	$37*	14%
BA8	Bill Assistance Elec Heat	2013	98	LIHEAP Nonparts	$235***	$14	6%
BA9	Bill Assistance Elec & Gas	2012	633	Later Participants	$705***	$188***	27%
BA10	Bill Assistance Elec	2012	566	Later Participants	$343	$71***	21%
BA11	Bill Assistance Elec & Gas	2010	1,231	LIHEAP Nonparts	$410***	$330***	80%

Study	Program Type	Program Year	Treatment Group Obs.	Comparison Group	Bill Reduction	Arrearage Reduction	
						$ Reduced	% Of Bill Reduction
Mean		**2014**	**1,920**		**$504**	**$233**	**39%**
Mean Outliers Excluded		**2015**	**1,962**		**$564**	**$238**	**37%**

*** Denotes significance at the 99 percent level. * Denotes significance at the 90 percent level.

- Assumptions
  - Average energy savings equal to the findings of the 2019 ESA Impact Evaluation for program year 2017.
  - Arrearage reduction of 37% of bill reduction, equal to the mean of findings from previous research.

- Calculation: The following calculation was used to compute the annual arrearage carrying cost benefit per ESA participant.

	{(A	*	B)	+	(C	*	D)}	*	E	*	F		
	BILL REDUCTION								Arrearage Reduction		Interest Rate	=	Annual Impact
Utility	kWh Savings		kWh Rate		Therm Savings		Therm Rate						
PG&E	131		$0.14		9		$1.28		37%		7.88%		$0.88
SDG&E	67		$0.18		3		$1.14		37%		7.63%		$0.43
SCG	--		--		7		$0.82		37%		7.68%		$0.16
SCE	187		$0.13		--		--		37%		8.75%		$0.77

- Limitations
  - Used relationship between bill reduction and arrearage reduction from other studies because the impact of the ESA program on arrearage reduction was not available.

- Applicability
  - The mean impact of the bill reduction on the arrearage reduction that was found in other program evaluations may not be applicable to the ESA program.

- Additional Research Recommended
  - ESA Usage Impact Evaluation: Continue to update energy savings estimates based on billing analysis.
  - ESA Payment Impact Evaluation: Analyze the impact of ESA energy savings on bills and arrearages for ESA participants. This should be done through an analysis of transactions and arrearage data before and after ESA participation, and a comparison group should be used.

Bad Debt Write-Off (Utility NEB)

The ESA program reduces energy bills, energy costs, and potentially reduces bad debt write-off, resulting in reduced utility costs.

- Benefit Type: Utility

- Data: Table III-7A displays the data that were used as inputs.

Table III-7A
Bad Debt Cost Data Inputs

	Input	Source	Input Type	Value			
				PG&E	SDG&E	SCG	SCE
A	Average kWh Savings	ESA Evaluation (2017), SDG&E (2016)	Utility	131	67	--	187
B	kWh CARE Rate	PG&E (2019), SDG&E (2020)*, SCE (2020)*	Utility	$0.14	$0.18	--	$0.13
C	Average Therm Savings	ESA Evaluation (2017)	Utility	9	3	7	--
D	Therm CARE Rate	PG&E (2019), SDG&E (2020)*, SCG (2020)	Utility	$1.28	$1.14	$0.82	--
E	ESA Arrearage Impact	Literature Review	Literature	37%			
F	% of Arrearages Written Off	PG&E (2019), SDG&E (2020), SCG (2019), SCE (2019)	Utility	32%	21%	21%	11%

*The SDG&E and SCE CARE rates were calculated using their average residential rates and CARE discounts.

  - Average kWh and Therm Savings: The average energy savings were from the 2019 ESA Impact Evaluation for program year 2017.[38] Table III-6B in Section B1-Arrearage Carrying Costs displays the savings for 2017.

  - Arrearage Impact: The ESA impact on arrearages was estimated as 37 percent of the bill reduction, based on a review of the literature. See description in Section B1-Arrearage Carrying Costs.

  - Percentage of Arrearages Written Off: Utilities reported the percentage of arrearages written off as bad debt.

- Assumptions
  - Average energy savings equal to the findings of the 2019 ESA Impact Evaluation for program year 2017.
  - Arrearage reduction of 37% of bill reduction, equal to the mean of findings from previous research.

[38] DNV-GL, Energy Savings Assistance Program Impact Evaluation Program Years 2015-2017, Southern California Gas Company, April 2019, pg. 39, 48.

- Calculation: The following calculation was used to compute the annual bad debt write-off benefit per ESA participant.

	{(A	*	B)	+	(C	*	D)}	*	E	*	F		
	BILL REDUCTION												
Utility	kWh Savings		kWh Rate		Therm Savings		Therm Rate		Arrearage Reduction		% of Arrears Written Off	=	Annual Impact
PG&E	131		$0.14		9		$1.28		37%		32%		$3.59
SDG&E	67		$0.18		3		$1.14		37%		21%		$1.19
SCG	--		--		7		$0.82		37%		21%		$0.44
SCE	187		$0.13		--		--		37%		11%		$0.96

- Limitations
  - Used relationship between bill reduction and arrearage reduction from other studies because the impact of the ESA program on arrearage reduction was not available.

- Applicability
  - The mean impact of the bill reduction on the arrearage reduction that was found in other program evaluations may not be applicable to the ESA program.

- Additional Research Recommended
  - ESA Usage Impact Evaluation
  - ESA Payment Impact Evaluation

Shutoffs (Utility NEB)

The ESA program reduces energy bills, energy costs, and potentially reduces shutoffs and reconnects, resulting in reduced utility costs.

- Benefit Type: Utility

- Data: Table III-8A displays the data that were used as inputs.

Table III-8A
Utility Shutoff and Reconnect Cost Data Inputs

	Input	Source	Input Type	Value			
				PG&E	SDG&E	SCG	SCE
A	Average kWh Savings	ESA Evaluation (2017), SDG&E (2016)	Utility	131	67	--	187
B	kWh CARE Rate	PG&E (2019), SDG&E (2020)*, SCE (2020)*	Utility	$0.14	$0.18	--	$0.13
C	Average Therm Savings	ESA Evaluation (2017)	Utility	9	3	7	--
D	Therm CARE Rate	PG&E (2019), SDG&E (2020)*, SCG (2020)	Utility	$1.28	$1.14	$0.82	--
E	Bill Reduction in Shutoff Studies	Lit Review	Lit	$452			
F	Literature Shutoff Impact	Lit Review	Lit	12.6%			

	Input	Source	Input Type	Value			
				PG&E	SDG&E	SCG	SCE
G	Shutoffs per CARE Household	PG&E (2019), SDG&E (2019), SCG (2020), SCE (2019)	Utility	0.0692	0.0241	0.0327	0.0630
H	Utility Shutoff Cost	Skumatz (2002), SDG&E (2020), SCG (2020)	Utility	$20.87[39]	$25.73	$25.73	$20.87
I	Net Utility Reconnect Cost	Skumatz (2002), SDG&E (2020), SCG (2020), SCE (2020)	Utility	$6.11	$0.00	$44.05	$0.35

*The SDG&E and SCE CARE rates were calculated using their average residential rates and CARE discounts.

- Average kWh and Therm Savings: The average energy savings were from the 2019 ESA Impact Evaluation for program year 2017.[40] Table III-6B in Section B1-Arrearage Carrying Costs displays the savings for 2017.

- Shutoff Impact: The mean impact on shutoffs from previous APPRISE studies was estimated as 12.6 percent. A literature review did not find other research that included data on shutoff reduction that resulted from energy efficiency or bill payment assistance programs.

  The mean bill reduction in those studies was $452, significantly higher than the ESA savings, so the ESA shutoff impact was scaled down based on the lower bill reduction. The APPRISE studies were not publicly available, so the programs are not identified, but key information on the studies is presented in Table III-8B.

  Other key information about the research is summarized below.
  - Evaluations were from program years 2011 to 2013.
  - Each evaluation used a comparison group as described in the table.
  - Most of the results were statistically significant.

Table III-8B
APPRISE Research on Shutoff Reduction

Study	Program Type	Program Year	Treatment Group Obs.	Comparison Group	Bill Reduction	Shutoff Reduction
BA8	Bill Assistance, Elec Heat	2013	98	LIHEAP Nonparts	$235***	-12%***
BA9	Bill Assistance, Elec & Gas	2011	593	Later Participants	$672***	-18%***
BA9	Bill Assistance, Elec & Gas	2012	633	Later Participants	$705***	-17%***
BA10	Bill Assistance, Electric	2011	616	Later Participants	$304**	-10%***
BA10	Bill Assistance, Electric	2012	566	Later Participants	$343	-6%***
Mean		**2012**	**501**		**$452**	**12.6%**

*** Denotes significance at the 99 percent level. ** Denotes significance at the 95 percent level.

[39]Skumatz, Lisa and Nordeen, Trevor. "Connecticut WRAP Program Non-Energy Benefits", March 2002.
[40]DNV-GL, Energy Savings Assistance Program Impact Evaluation Program Years 2015-2017, Southern California Gas Company, April 2019, pg. 39, 48.

- Shutoffs per CARE Household: The number of shutoffs per CARE household was reported by the utilities.

- Utility Shutoff and Reconnect Costs: The costs per shutoff and reconnect were reported by the utilities.

- Assumptions
  - Average energy savings equal to the findings of the 2019 ESA Impact Evaluation for program year 2017.
  - Shutoff reduction equal to the mean of findings from previous research on shutoffs, reduced by relative bill reduction.

- Calculation: The following steps were used to compute the annual shutoff and reconnect cost benefit per ESA participant.
  - Utility Bill Reduction
  - Number of Avoided Shutoffs
  - Annual Shutoff Impact per ESA Participant

	{(A	*	B)	+	(C	*	D)}	=	Utility Bill Reduction
	BILL REDUCTION								
Utility	kWh Savings		kWh Rate		Therm Savings		Therm Rate		
PG&E	131		$0.14		9		$1.28		$30.30
SDG&E	67		$0.18		3		$1.14		$15.17
SCG	--		--		7		$0.82		$5.77
SCE	187		$0.13		--		--		$23.68

	(	/	E)	*	F	*	G	=	
	SHUTOFF REDUCTION								
Utility	Utility Bill Reduction		Mean Lit. Bill Reduction		Mean Lit Shutoff Reduction		Shutoffs per CARE Household		# Avoided Shutoffs
PG&E	$30.30		$452		12.6%		0.0692		0.00058
SDG&E	$15.17		$452		12.6%		0.0241		0.00001
SCG	$5.77		$452		12.6%		0.0327		0.00003
SCE	$23.68		$452		12.6%		0.0630		0.00042

		*	(H	+	I)	=	Annual Impact
Utility	# Avoided Shutoffs		Utility Shutoff Cost		Net Utility Reconnect Cost		
PG&E	0.00058		$20.87		$6.11		$0.016
SDG&E	0.00001		$25.73		$0.00		$0.003
SCG	0.00003		$25.73		$44.05		$0.004
SCE	0.00042		$20.87		$0.35		$0.009

- Limitations
  - Used reduction in shutoffs from other studies, reduced by relative bill reduction, because the impact of the ESA program on shutoffs and reconnections was not available.

- Applicability
  - The mean impact on shutoffs that was found in other program evaluations may not be applicable to the ESA program.

- Additional Research Recommended
  - ESA Usage Impact Evaluation
  - ESA Collections Impact Evaluation: Analyze the impact of ESA energy savings on collections actions and costs for ESA participants. This should be done through an analysis of collections actions and costs before and after ESA participation, and a comparison group should be used.

Shutoffs (Participant NEB)

The ESA program reduces energy bills, energy costs, and potentially reduces shutoffs and reconnects, resulting in reduced costs for ESA participants.

- Benefit Type: Participant

- Data: Table III-9A displays the data that were used as inputs.

Table III-9A
Participant Shutoff and Reconnect Cost Data Inputs

	Input	Source	Input Type	Value			
				PG&E	SDG&E	SCG	SCE
A	Average kWh Savings	ESA Evaluation (2017), SDG&E (2016)	Utility	131	67	--	187
B	kWh CARE Rate	PG&E (2019), SDG&E (2020)*, SCE (2020)*	Utility	$0.14	$0.18	--	$0.13
C	Average Therm Savings	ESA Evaluation (2017)	Utility	9	3	7	--
D	Therm CARE Rate	PG&E (2019), SDG&E (2020)*, SCG (2020)	Utility	$1.28	$1.14	$0.82	--
E	Bill Reduction in Shutoff Studies	Lit Review	Lit	$452			
F	Literature Shutoff Impact	Lit Review	Lit	12.6%			
G	Shutoffs per CARE Household	PG&E (2019), SDG&E (2019), SCG (2020), SCE (2019)	Utility	0.0692	0.0241	0.0327	0.0630
H	Participant Reconnect Cost	PG&E (2019), SDG&E (2020), SCG (2020), SCE (2019)	Utility	$11.25	$6.00	$16.00	$5.00

*The SDG&E and SCE CARE rates were calculated using their average residential rates and CARE discounts.

  - Average kWh and Therm Savings: The average energy savings were from the 2019 ESA Impact Evaluation for program year 2017.[41] Table III-6B in Section B1-Arrearage Carrying Costs displays the savings for 2017.

[41] DNV-GL, Energy Savings Assistance Program Impact Evaluation Program Years 2015-2017, Southern California Gas Company, April 2019, pg. 39, 48.

- Shutoff Impact: The mean impact on shutoffs from previous APPRISE studies was estimated as 12.6 percent. The mean bill reduction in those studies was $452, significantly higher than the ESA savings, so the ESA shutoff impact was scaled down based on the lower bill reduction. Key information on those studies is included in Table III-8B in Section B1 – Shutoffs.

- Shutoffs per CARE Household: The number of shutoffs per CARE household for each utility was based on utility inputs.

- Reconnect Fee: The fee charged to the participant to reconnect was based on utility inputs.

- Assumptions
  - Average energy savings equal to the findings of the 2019 ESA Impact Evaluation for program year 2017.
  - Shutoff reduction equal to the mean of findings from previous research on shutoffs reduced by relative bill reduction.

- Calculation: The following steps were used to compute the annual shutoff and reconnect cost benefit per ESA participant.
  - Utility Bill Reduction
  - Number of Avoided Shutoffs
  - Annual Shutoff Impact per ESA Participant

	{(A	*	B)	+	(C	*	D)}	=	Utility Bill Reduction
	BILL REDUCTION								
Utility	kWh Savings		kWh Rate		Therm Savings		Therm Rate		
PG&E	131		$0.14		9		$1.28		$30.30
SDG&E	67		$0.18		3		$1.14		$15.17
SCG	--		--		7		$0.82		$5.77
SCE	187		$0.13		--		--		$23.68

	(	/	E)	*	F	*	G	=	# Avoided Shutoffs
Utility	SHUTOFF REDUCTION								
	Utility Bill Reduction		Mean Lit. Bill Reduction		Mean Lit Shutoff Reduction		Shutoffs per CARE Household		
PG&E	$30.30		$452		12.6%		0.0692		0.00058
SDG&E	$15.17		$452		12.6%		0.0241		0.00001
SCG	$5.77		$452		12.6%		0.0327		0.00003
SCE	$23.68		$452		12.6%		0.0630		0.00042

		*	H	=	Annual Impact
Utility	# Avoided Shutoffs		Participant Reconnect Cost		
PG&E	0.00058		$11.25		$0.0066
SDG&E	0.00001		$6.00		$0.0006
SCG	0.00003		$16.00		$0.0008
SCE	0.00042		$5.00		$0.0021

- Limitations
  - Used reduction in shutoffs from other studies, reduced by relative bill reduction, because the impact of the ESA program on shutoffs was not available.

- Applicability
  - The mean impact on shutoffs that was found in other program evaluations may not be applicable to the ESA program.

- Additional Research Recommended
  - ESA Usage Impact Evaluation
  - ESA Collections Impact Evaluation

Collections Notices (Utility NEB)

The ESA program reduces energy bills, energy costs, and potentially reduces the number of notices that need to be sent to participants, resulting in reduced utility costs.

- Benefit Type: Utility

- Data: Table III-10A displays the data that were used as inputs.

Table III-10A
Collections Notice Cost Data Inputs

	Input	Source	Input Type	Value			
				PG&E	SDG&E	SCG	SCE
A	Average kWh Savings	ESA Evaluation (2017), SDG&E (2016)	Utility	131	67	--	187
B	kWh CARE Rate	PG&E (2019), SDG&E (2020)*, SCE (2020)*	Utility	$0.14	$0.18	--	$0.13
C	Average Therm Savings	ESA Evaluation (2017)	Utility	9	3	7	--
D	Therm CARE Rate	PG&E (2019), SDG&E (2020)*, SCG (2020)	Utility	$1.28	$1.14	$0.82	--
E	Bill Reduction in Collections Studies	Lit Review	Literature	$636			
F	Literature Collections Notice Impact	Lit Review	Literature	1.2			
G	Collections Notice Cost	PG&E (2020), SDG&E (2020), SGG (2020), SCE (2020)	Utility	$0.30	$3.63	$10.10	$0.48

*The SDG&E and SCE CARE rates were calculated using their average residential rates and CARE discounts.

  - Average kWh and Therm Savings: The average energy savings were from the 2019 ESA Impact Evaluation for program year 2017.[42] Table III-6B in Section B1-Arrearage Carrying Costs displays the savings for 2017.

[42] DNV-GL, Energy Savings Assistance Program Impact Evaluation Program Years 2015-2017, Southern California Gas Company, April 2019, pg. 39, 48.

- Collections Notice Impact: The impact on collections notices was estimated as 1.2 notices per household, based on a review of the literature. This estimate was calculated as the mean impact on collections notices from previous research. The mean bill reduction in those studies was $636, significantly higher than the ESA savings, so the ESA collections notice impact was scaled down based on the lower bill reduction. The APPRISE studies were not publicly available, so the programs are not identified, but key information on the studies is presented in Table III-10B.

  Other key information about the research is summarized below.
  - Evaluations were from program years 2010 to 2018.
  - The bill assistance evaluations used one or more comparison groups described in the table.
  - Most of the results were statistically significant.
  - The studies considered various types of notices, letters, and mail actions as shown in the table.

Table III-10B
APPRISE Research on Collections Notice Reductions

Study	Program Type	Program Year	Treatment Group Obs.	Comparison Group	Bill Reduction	Notice Type	Collections Notice Reduction
BA1	Bill Assistance Elec Non-Heat	2017-2018	3,148	Later Participants, LIHEAP Nonparts	$851	Letter	1.0***
BA1	Bill Assistance Elec Heat	2017-2018	3,148	Later Participants	$1,146		
BA2	Bill Assistance Elec Non-Heat	2017-2018	2,035	LIHEAP Nonparts	$851	Notice	-2.2***
BA2	Bill Assistance Elec Heat	2017-2018	2,035	Later Participants	$1,146		
BA3	Bill Assistance Elec	2017	3,297	LIHEAP Nonparts	$613	Notice	-2.7
BA4	Bill Assistance Elec & Gas	2017	655	LIHEAP Nonparts	$618	Notice	-2.6
BA5	Bill Assistance Gas	2017	2,588	Later Participants, Earlier Participants	$688***	10-Day Notice	-0.9***
BA6	Bill Assistance Gas	2015	3,516	Later Participants, LIHEAP Nonparts	$323***	Post Term Notice	0.0
BA8	Bill Assistance Gas	2013	98	LIHEAP Nonparts	$235***	Letter	<0.1
BA9	Bill Assistance Elec & Gas	2011	633	Later Participants	$672**	Disconnect Notice	-2.6***
BA9	Bill Assistance Elec & Gas	2012	633	Later Participants	$705***	Disconnect Notice	-3.5***
BA10	Bill Assistance Elec	2011	566	Later Participants	$304***	Disconnect Notice	-0.4**
BA10	Bill Assistance Elec	2012	566	Later Participants	$343	Disconnect Notice	-0.5***
BA11	Bill Assistance Elec & Gas	2010	1,231	LIHEAP Nonparts	$410***	Mail Action	-0.2***

Study	Program Type	Program Year	Treatment Group Obs.	Comparison Group	Bill Reduction	Notice Type	Collections Notice Reduction
Mean			**1,725**		**$636**		**-1.2**

*** Denotes significance at the 99 percent level. ** Denotes significance at the 95 percent level.

- Collections Notice Cost: The cost per collections notice was included from utility inputs.

- Assumptions
  - Average energy savings equal to the findings of the 2019 ESA Impact Evaluation for program year 2017.
  - Collections notice reduction equal to the mean of findings from previous research on collections actions, reduced by relative bill reduction.

- Calculation: The following steps were used to compute the annual collections notice cost benefit per ESA participant.
  - Utility Bill Reduction
  - Annual Collections Notice Impact per ESA Participant

	{(A	*	B)	+	(C	*	D)}	=	Utility Bill Reduction
	BILL REDUCTION								
Utility	kWh Savings		kWh Rate		Therm Savings		Therm Rate		
PG&E	131		$0.14		9		$1.28		$30.30
SDG&E	67		$0.18		3		$1.14		$15.17
SCG	--		--		7		$0.82		$5.77
SCE	187		$0.13		--		--		$23.68

	(	/	E)	*	F	*	G	=	Annual Impact
	COLLECTIONS NOTICE REDUCTION								
Utility	Utility Bill Reduction		Mean Lit. Bill Reduction		Mean Lit Collections Notice Reduction		Collections Notice Cost		
PG&E	$30.30		$636		1.2		$0.30		$0.02
SDG&E	$15.17		$636		1.2		$3.63		$0.10
SCG	$5.77		$636		1.2		$10.10		$0.11
SCE	$23.68		$636		1.2		$0.48		$0.02

- Limitations
  - Used reduction in collections notices from other studies, reduced by relative bill reduction, because the impact of the ESA program on collections notices was not available.

- Applicability
  - The mean impact on collections notices that was found in other program evaluations may not be applicable to the ESA program.

- Additional Research Recommended
  - ESA Usage Impact Evaluation
  - ESA Collections Impact Evaluation

Collections Calls (Utility NEB)

The ESA program reduces energy bills, energy costs, and potentially reduces the number of collections calls made to participants, resulting in reduced utility costs.

- Benefit Type: Utility

- Data: Table III-11A displays the data that were used as inputs.

Table III-11A
Collections Call Cost Data Inputs

	Input	Source	Input Type	Value			
				PG&E	SDG&E	SCG	SCE
A	Average kWh Savings	ESA Evaluation (2017), SDG&E (2016)	Utility	131	67	--	187
B	kWh CARE Rate	PG&E (2019), SDG&E (2020)*, SCE (2020)*	Utility	$0.14	$0.18	--	$0.13
C	Average Therm Savings	ESA Evaluation (2017)	Utility	9	3	7	--
D	Therm CARE Rate	PG&E (2019), SDG&E (2020)*, SCG (2020)	Utility	$1.28	$1.14	$0.82	--
E	Bill Reduction in Collections Studies	Lit Review	Lit	$611			
F	Literature Collections Call Impact	Lit Review	Lit	1.4			
G	Collections Call Cost	PG&E (2020), SDG&E (2020), SCG (2020), SCE (2020)	Utility	$11.25	$6.94	$9.55	$0.03

*The SDG&E and SCE CARE rates were calculated using their average residential rates and CARE discounts.

- Average kWh and Therm Savings: The average energy savings were from the 2019 ESA Impact Evaluation for program year 2017.[43] Table III-6B in Section B1-Arrearage Carrying Costs displays the savings for 2017.

- Collections Calls Impact: The impact on collections calls was estimated as 1.4 calls per household, based on a review of the literature. This estimate was calculated as the mean impact on collections calls from previous research. The mean bill reduction in those studies was $611, significantly higher than the ESA savings, so the ESA collections calls impact was scaled down based on the lower bill reduction. The APPRISE studies were not publicly available, so the programs are not identified, but key information is presented in Table III-11B.

  Other key information about the research is summarized below.
  - Evaluations were from program years 2010 to 2018.

[43] DNV-GL, Energy Savings Assistance Program Impact Evaluation Program Years 2015-2017, Southern California Gas Company, April 2019, pg. 39, 48.

- The bill assistance evaluations used one or more comparison groups described in the table.
- Most of the results were statistically significant.

Table III-11B
APPRISE Research on Collections Call Reductions

Study	Program Type	Program Year	Treatment Group Obs.	Comparison Group	Bill Reduction	Collections Call Reduction
BA1	Bill Assistance Elec Non-Heat	2017-2018	3,148	Later Participants, LIHEAP Nonparts	$851	-1.7***
BA2	Bill Assistance Elec Heat	2017-2018	2,035	Later Participants, LIHEAP Nonparts	$1,146	
BA3	Bill Assistance Elec	2017	3,297	LIHEAP Nonparts	$613	-2.7
BA4	Bill Assistance Elec & Gas	2017	655	LIHEAP Nonparts	$618	-2.1
BA5	Bill Assistance Gas	2017	2,588	Later Participants, Earlier Participants	$688***	-1.6***
BA6	Bill Assistance Gas	2015	3,516	Later Participants, LIHEAP Nonparts	$323***	0.03**
BA8	Bill Assistance Elec Heat	2013	98	LIHEAP Nonparts	$235***	-1.9***
BA11	Bill Assistance Elec & Gas	2010	1,231	LIHEAP Nonparts	$410***	<0.1
Mean			**2,071**		**$611**	**-1.4**

*** Denotes significance at the 99 percent level. **Denotes significance at the 95 percent level.

- Collections Call Cost: The cost per collections call was included from utility inputs.

- Assumptions
  - Average energy savings equal to the findings of the 2019 ESA Impact Evaluation for program year 2017.
  - Collections calls reduction equal to the mean of findings from previous research on collections actions, reduced by relative bill reduction.

- Calculation: The following steps were used to compute the annual collections call cost benefit per ESA participant.
  - Utility Bill Reduction
  - Annual Collections Call Impact per ESA Participant

	{(A	*	B)	+	(C	*	D)}	=	Utility Bill Reduction
	BILL REDUCTION								
Utility	kWh Savings		kWh Rate		Therm Savings		Therm Rate		
PG&E	131		$0.14		9		$1.28		$30.30
SDG&E	67		$0.18		3		$1.14		$15.17
SCG	--		--		7		$0.82		$5.77
SCE	187		$0.13		--		--		$23.68

	(	/	E)	*	F	*	G	=	Annual Impact
	COLLECTIONS CALLS REDUCTION								
Utility	Utility Bill Reduction		Mean Lit. Bill Reduction		Mean Lit Collections Calls Reduction		Collections Calls Cost		
PG&E	$30.30		$611		1.4		$11.25		$0.78
SDG&E	$15.17		$611		1.4		$6.94		$0.24
SCG	$5.77		$611		1.4		$9.55		$0.13
SCE	$23.68		$611		1.4		$0.03		$0.00

- Limitations
  - Used reduction in collections calls from other studies, reduced by relative bill reduction, because the impact of the ESA program on collections calls was not available.

- Applicability
  - The mean impact on collections calls that was found in other program evaluations may not be applicable to the ESA program.

- Additional Research Recommended
  - ESA Usage Impact Evaluation.
  - ESA Collections Impact Evaluation

Collections Calls (Participant NEB)

The ESA program reduces energy bills, energy costs, and potentially reduces the time that participants spend on utility collections calls.

- Benefit Type: Participant

- Data: Table III-12A displays the data that were used as inputs.

Table III-12A
Collections Calls Cost Data Inputs

	Input	Source	Input Type	Value			
				PG&E	SDG&E	SCG	SCE
A	Average kWh Savings	ESA Evaluation (2017), SDG&E (2016)	Utility	131	67	--	187
B	kWh CARE Rate	PG&E (2019), SDG&E (2020)*, SCE (2020)*	Utility	$0.14	$0.18	--	$0.13
C	Average Therm Savings	ESA Evaluation (2017)	Utility	9	3	7	--
D	Therm CARE Rate	PG&E (2019), SDG&E (2020)*, SCG (2020)	Utility	$1.28	$1.14	$0.82	--
E	Bill Reduction in Collections Studies	Lit Review	Literature	$611			
F	Literature Collections Calls Impact	Lit Review	Literature	1.4			
G	Collections Calls Length	PG&E (2019), SDG&E (2020), SCG (2020), Skumatz (2002)	Utilities	7.60	0.50	7.00	4.67[44]
H	Minimum Wage per Hour	State of California[45] (2020)	Literature	$12.00			

*The SDG&E and SCE CARE rates were calculated using their average residential rates and CARE discounts.

- Average kWh and Therm Savings: The average energy savings were from the 2019 ESA Impact Evaluation for program year 2017.[46] Table III-6B in Section B1-Arrearage Carrying Costs displays the savings for 2017.

- Collections Calls Impact: The impact on collections calls was estimated as 1.4 calls per household, based on a review of the literature. This estimate was calculated as the mean impact on collections calls from previous research. The mean bill reduction in those studies was $611, significantly higher than the ESA savings, so the ESA collections calls impact was scaled down based on the lower bill reduction. The APPRISE studies were not publicly available, so the programs are not identified, but key information on the studies is presented in Table III-11B in Section B1 – Collections Calls.

[44] The value of 4.67 minutes is from the inputs to the 2019 spreadsheet tool, which originally came from Skumatz, Lisa and Nordeen, Trevor. "Connecticut WRAP Program Non-Energy Benefits, March 2002.
[45] State of California, Department of Industrial Relations, "Minimum Wage", https://www.dir.ca.gov/dlse/FAQ_MinimumWage.htm
[46] DNV-GL, Energy Savings Assistance Program Impact Evaluation Program Years 2015-2017, Southern California Gas Company, April 2019, pg. 39, 48.

- Collections Call Length: The length of the average collections call was included from utility inputs.

- Minimum Wage per Hour: The minimum wage per hour was included from the State of California Department of Industrial Relation's website as $12.00 for 2020.

- Assumptions
  - Average energy savings equal to the findings of the 2019 ESA Impact Evaluation for program year 2017.
  - Collections calls reduction equal to the mean of findings from previous research on collections actions, reduced by relative bill reduction.

- Calculation: The following steps were used to compute the annual collections calls benefit per ESA participant.
  - Utility Bill Reduction
  - Annual Collections Calls Impact per ESA Participant

	{(A	*	B)	+	(C	*	D)}	=	Utility Bill Reduction
	BILL REDUCTION								
Utility	kWh Savings		kWh Rate		Therm Savings		Therm Rate		
PG&E	131		$0.14		9		$1.28		$30.30
SDG&E	67		$0.18		3		$1.14		$15.17
SCG	--		--		7		$0.82		$5.77
SCE	187		$0.13		--		--		$23.68

	(	/	E)	*	F	*	G	*	(H	/	)	=	Annual Impact
	COLLECTIONS CALLS REDUCTION						Call Length-Minutes						
Utility	Utility Bill Reduction		Mean Lit. Bill Reduction		Mean Lit Collections Calls Reduction				Min Wage		Minutes per Hour		
PG&E	$30.30		$611		1.4		7.60		$12		60		$0.11
SDG&E	$15.17		$611		1.4		0.50		$12		60		$0.00
SCG	$5.77		$611		1.4		7.00		$12		60		$0.02
SCE	$23.68		$611		1.4		4.67		$12		60		$0.05

- Limitations
  - Used reduction in collections calls from other studies, reduced by relative bill reduction, because the impact of the ESA program on collections calls was not available.

- Applicability
  - The mean impact on collections calls that was found in other program evaluations may not be applicable to the ESA program.

- Additional Research Recommended
  - ESA Usage Impact Evaluation
  - ESA Collections Impact Evaluation

2. Other Cost Reduction Benefit

Benefits included in this category are as follows.

- Water and Wastewater Bills (Participant)

Water and Wastewater Bills (Participant NEB)

Some ESA measures reduce water usage, resulting in lower water and wastewater bills for participants.

- Benefit Type: Participant

- Data: Table III-13A displays the data that were used as inputs.

Table III-13A
Water and Wastewater Cost Data Inputs

	Input	Source	Input Type	Value			
				PG&E	SDG&E	SCG	SCE
A	**Water Savings per Household (Gallons)**						
	Showerheads	EPA (2020)[47]	Literature	2,700			
	Faucet Aerators	EPA (2020)[48]		700			
	Other Hot Water Bundle	Showerheads and Aerators		3,400[49]			
	Tub Diverter	EPA (2017)[50]		1,500			
	Clothes Washer	NRDC (2014)[51]		3,385			
B	**Number of Households with ESA Measures**						
	Other Hot Water Bundle	Utilities (2019)	Utility	79,760	10,889	116,534	441
	Tub Diverter			353	31	2,998	0
	Clothes Washer			3,367	294	3,961	0
C	Gallons per CCF	Conversion Factor	-	748			
D	ESA Participants	Utilities (2019)	Utility	106,673	16,271	122,037	95,397
E	Water Rate	PG&E (2020), SDG&E (2019), SCG (2019)	Utility	$4.30	$5.25	$4.68	$5.25
F	Wastewater Rate	PG&E (2020), SDG&E (2019), SCG (2019)	Utility	$4.80	$3.60	$4.31	$3.60

[47] "WaterSense: Showerheads", EPA, 2020, https://www.epa.gov/watersense/showerheads, see "Water Savings" section.
[48] "WaterSense: Bathroom Faucets", EPA, 2020, https://www.epa.gov/watersense/bathroom-faucets, see "Water Savings" section.
[49] This value should be changed depending on what percentage of bundles include showerheads and aerators. The 2019 spreadsheet tool assumed 50%, but data from SCG said 100% included showerheads and 86% included aerators.
[50] Tanner, Stephanie, "WaterSense Public Meeting: Notice of Intent (NOI) for Bath and Shower Diverters", EPA, February 8, 2017, https://www.epa.gov/sites/production/files/2017-05/documents/ws-proudcts-bath-and-shower-diverter-public-meeting-presentation-508.pdf.
[51] "Saving Water and Energy through Clothes Washer Replacement", NRDC, March 13, 2014, https://www.nrdc.org/resources/saving-water-and-energy-through-clothes-washer-replacement.

	Input	Source	Input Type	Value			
				PG&E	SDG&E	SCG	SCE
G	Percent of ESA Jobs in Owned Homes	PG&E (2019), SDG&E (2019), SCG (2019), SCE (2019)	Utility	54%	17%	43%	46%

- Water Savings per Household: The water savings per household for each relevant measure were included from the Environmental Protection Agency's (EPA) WaterSense program and the National Resources Defense Council (NRDC).
  - Low-Flow Showerheads: The EPA WaterSense website stated that WaterSense labelled showerheads could save up to 2,700 gallons of water per household per year. WaterSense showerheads must have a maximum flow rate value of 2.0 gallons per minute, while standard showerheads use 2.5 gallons per minute.

  - Faucet Aerators: The EPA WaterSense website stated that WaterSense labelled faucet aerators in bathrooms could save up to 700 gallons of water per household per year. WaterSense aerators must have a maximum flow rate value of 1.5 gallons per minute, while standard aerators use 2.2 gallons per minute.

  - Showerheads and Aerators: Utilities reported the combined number of aerators and showerheads bundle (except SCE reported aerators and showerheads separately). Water savings per household was 3,400 gallons per year, the sum of savings for showerheads and faucet aerators.

  - Tub Diverter: The EPA's WaterSense program does not currently certify tub diverters but issued a Notice of Intent in 2016 to develop the certification. In a 2017 presentation, the EPA estimated that the average household could save 1,500 gallons per year by replacing all old, leaky diverters with new models. This was estimated using an average leak rate of 0.3 gallons per minute (gpm).

    This presentation was based on two field studies.
    - The 2011 Taitem Engineering, PC, LLC[52] study for the New York State Housing and Community Renewal Weatherization Assistance Program found that 34 percent of the 120 apartments and houses surveyed had tub diverters that leaked more than 0.1 gpm. Of the leaking diverters, the average one leaked 0.8 gpm.

    - The 2015 field study conducted in Fort Carson, Colorado by Johnson Controls, Inc.[53] estimated an average leak of 0.7 gpm, but only looked at diverters more than ten years old.

[52] Taitem Engineering, "Taitem TechTip: Leaking Shower Diverters", http://www.taitem.com/wp-content/uploads/Diverter-Valve-Tech-Tip-2011.7.20.pdf, 2011.
[53] Johnson Controls, Inc., 2015.

- Clothes Washer: The 2014 NRDC research stated that an ENERGY STAR washing machine used 35 percent less water than a standard, non-ENERGY STAR model. The article calculated an annual savings of 3,385 gallons of water per year. It also stated that replacing an older model washing machine with a new ENERGY STAR model could reduce water usage by over 70 percent.

- Number of Households with Each Measure: The number of households per utility that received each type of measure is displayed in Table III-13B based on 2019 utility inputs.

Table III-13B
2019 ESA Households with Each Water-Related Measure

Utility	Other Hot Water Bundle	Tub Diverter	Clothes Washer
PG&E	79,760	353	3,367
SDG&E	10,889	31	294
SCG	116,534	2,998	3,961
SCE	441	0	0

- Number of Participants: The 2019 number of ESA participants per utility is displayed in Table III-13C based on utility inputs.

Table III-13C
2019 ESA Participants

Utility	Number of ESA Participants
PG&E	106,673
SDG&E	16,271
SCG	122,037
SCE	95,397

- Water and Wastewater Rates: The water and wastewater rates were provided by the IOUs.

- Percent of ESA Jobs in Owned Homes: The percent of jobs in owned homes was provided by the utilities.

- Assumptions
  - Average showerhead and faucet aerator water savings equal to the findings of the EPA's WaterSense program.
  - Average tub diverter water savings equal to the studies used in the EPA's WaterSense program Notice of Intent.

- Average clothes washer water savings equal to the finding of the NRDC's review article.

- Calculation: The following component benefits were used to compute the annual water and wastewater cost benefit per ESA participant.
  - Showerheads and Faucet Aerators
  - Tub Diverters
  - Clothes Washers
  - Annual Water and Wastewater Impact per ESA Participant

	{(A	*	B	*	C)	/	D}	*	(E	+	F)		
Utility	Showerheads and Aerators Water Savings		ESA Showerheads and Aerators Replaced		CCF to Gallons		ESA Participants		Water Rate		Wastewater Rate	=	Annual Showerheads and Aerators Impact
PG&E	3,400		79,760		(1/748)		106,673		$4.30		$4.80		$30.93
SDG&E	3,400		10,889		(1/748)		16,271		$5.25		$3.60		$26.92
SCG	3,400		116,534		(1/748)		122,037		$4.68		$4.31		$39.02
SCE	3,400		441		(1/748)		95,397		$5.25		$3.60		$0.19

	{(A	*	B	*	C)	/	D}	*	(E	+	F)		
Utility	Tub Div. Water Savings		ESA Tub Diverters Replaced		CCF to Gallons		ESA Participants		Water Rate		Wastewater Rate	=	Annual Tub Diverter Impact
PG&E	1,500		353		(1/748)		106,673		$4.30		$4.80		$0.06
SDG&E	1,500		31		(1/748)		16,271		$5.25		$3.60		$0.03
SCG	1,500		2,998		(1/748)		122,037		$4.68		$4.31		$0.44
SCE	1,500		0		(1/748)		95,397		$5.25		$3.60		$0.00

	{(A	*	B	*	C)	/	D}	*	(E	+	F)		
Utility	Washer Water Savings		ESA Washers Replaced		CCF to Gallons		ESA Participants		Water Rate		Wastewater Rate	=	Annual Clothes Washer Impact
PG&E	3,385		3,367		(1/748)		106,673		$4.30		$4.80		$1.30
SDG&E	3,385		294		(1/748)		16,271		$5.25		$3.60		$0.72
SCG	3,385		3,961		(1/748)		122,037		$4.68		$4.31		$1.32
SCE	3,385		0		(1/748)		95,397		$5.25		$3.60		$0.00

Utility	(	Annual Showerhead and Aerator Impact	+	Annual Tub Diverter Impact	+	Annual Washer Impact	)	*	% of Jobs in Owned Homes	=	Annual Impact
PG&E		$30.93		$0.06		$1.30			54%		$17.44
SDG&E		$26.92		$0.03		$0.72			17%		$4.71
SCG		$39.02		$0.44		$1.32			43%		$17.54
SCE		$0.19		$0.00		$0.00			46%		$0.09

- Limitations
  - Used EPA estimates of water savings per household for showerheads, aerators, and tub diverters.
  - Used NRDC estimate of water savings per clothes washer.

- Applicability
  - The average water savings per household for each measure may not be applicable to the ESA measures and participants.

- Additional Research Recommended
  - ESA Water Impact Evaluation: Analyze the impact of ESA water savings on water and wastewater bills for ESA participants. This should be done through an analysis of water and wastewater bills before and after ESA participation, and a comparison group should be used.

3. Economic Benefit

The benefit included in this category is as follows.

- Economic Output (Societal)

Economic Output (Societal NEB)

ESA expenditures increase economic activity in California because they are more labor intensive than the expenditures that they replace.

- Benefit Type: Societal

- Data: Table III-14A displays the data that were used as inputs.

Table III-14A
Economic Output Data Inputs

	Input	Source	Input Type	Value			
				PG&E	SDG&E	SCG	SCE
A	**ESA Expenditures**						
	Materials & Labor	Utilities (2019)	Utility	$148,873,855	$15,134,001	$102,967,321	$67,466,599
	Marketing			$1,614,844	$1,062,027	$1,203,578	$1,175,862
	Inspections & Quality Control			$3,317,102	$141,308	$1,751,136	$1,294,222
	Research & Evaluation			$81,308	$91,392	$157,722	$356,243
	Administrative			$6,017,223	$3,575,346	$6,907,405	$4,702,455
	Other ESA			$920,640	$7,250	$730,450	$158,243
	% ESA Expenditures Spent in California						
	Materials & Labor	Utilities (2019)	Utility	98%	98%	98%	98%
	Marketing			95%	95%	95%	95%
	Inspections & Quality Control			100%	100%	100%	100%
	Research & Evaluation			20%	20%	20%	20%
	Administrative			100%	100%	100%	100%
	Other ESA			100%	100%	100%	100%

	Input		Source	Input Type	Value			
					PG&E	SDG&E	SCG	SCE
B	**RIMS-II Economic Output Multiplier with Program**							
	Materials & Labor	Other Retail/ Construction	Bureau of Economic Analysis (BEA, 2018)	Lit	2.0956			
	Marketing	Admin & Support			2.1894			
	QC	Prof, Scien, Tech			2.1586			
	Eval	Prof, Scien, Tech			2.1586			
	Admin	Admin & Support			2.1894			
	Other	Prof, Scien, Tech			2.1586			
	Retail	Other Retail			2.0388			
C	**RIMS-II Economic Output Multiplier without Program**							
	Retail	Other Retail	BEA (2018)	Lit	2.0388			
	Elec&Gas	Utilities			1.6409			
D	Average kWh Savings		ESA Eval (2017), SDG&E (2016)	Utility	131	67	--	187
E	kWh CARE Rate		PG&E (2019), SDG&E (2020)*, SCE (2020)*	Utility	$0.14	$0.18	--	$0.13
F	Average Therm Savings		ESA Eval (2017)	Utility	9	3	7	--
G	Therm CARE Rate		PG&E (2019), SDG&E (2020)*, SCG (2020)	Utility	$1.28	$1.14	$0.82	--

*The SDG&E and SCE CARE rates were calculated using their average residential rates and CARE discounts.

- ESA Expenditures: ESA expenditures were reported by the utilities.

  Table III-14B displays the expenditures for each category, the percentage spent in California, and the amount spent in and outside of California.

Table III-14B
ESA Expenditures

Expend Category	PG&E				SDG&E			
	$ Spent	% CA	$ in CA	$ out CA	$ Spent	% CA	$ in CA	$ out CA
Materials & Labor	$148,873,855	98%	$145,896,378	$2,977,477	$15,134,001	98%	$14,831,321	$302,680
Marketing	$1,614,844	95%	$1,534,102	$80,742	$1,062,027	95%	$1,008,926	$53,101
QC	$3,317,102	100%	$3,317,102	$0	$141,308	100%	$141,308	$0
Evaluation	$81,308	20%	$16,262	$65,046	$91,392	20%	$18,278	$73,114
Admin	$6,017,223	100%	$6,017,223	$0	$3,575,346	100%	$3,575,346	$0
Other	$920,640	100%	$920,640	$0	$7,250	100%	$7,250	$0

Expend Category	PG&E				SDG&E			
	$ Spent	% CA	$ in CA	$ out CA	$ Spent	% CA	$ in CA	$ out CA
Total	**$160,824,972**	**98%**	**$157,701,706**	**$3,123,266**	**$20,011,324**	**98%**	**$19,582,429**	**$428,895**

Expend Category	SCG				SCE			
	$ Spent	% CA	$ in CA	$ Out CA	$ Spent	% CA	$ in CA	$ Out CA
Materials & Labor	$102,967,321	98%	$100,907,975	$2,059,346	$67,466,599	98%	$66,117,267	$1,349,332
Marketing	$1,203,578	95%	$1,143,399	$60,179	$1,175,862	95%	$1,117,069	$58,793
QC	$1,751,136	100%	$1,751,136	$0	$1,294,222	100%	$1,294,222	$0
Evaluation	$157,722	20%	$31,544	$126,178	$356,243	20%	$71,249	$284,994
Admin	$6,907,405	100%	$6,907,405	$0	$4,702,455	100%	$4,702,455	$0
Other	$730,450	100%	$730,450	$0	$158,243	100%	$158,243	$0
Total	**$113,717,612**	**98%**	**$111,471,909**	**$2,245,703**	**$75,153,624**	**97%**	**$73,460,505**	**$1,693,119**

- RIMS-II Economic Output Multipliers: Each category of ESA expenses was matched with the appropriate industry multipliers from the Regional Input-Output Modeling System II (RIMS-II) produced by the Bureau of Economic Analysis (BEA).[54] These multipliers capture the additional impact of ESA charges and expenditures on the CA economy.

  The macroeconomic effects of any economic activity are divided into three categories.

  - Direct effects: The direct effects are outputs created from the initial investment in the program. For the ESA program, examples include the salaries of program administrators and the salaries of workers hired to install ESA measures.

  - Indirect effects: The indirect effects are outputs created in industries that supply goods and services to the program. For the ESA program, an example would be the jobs created by the contractors' expenditures on ESA measures.

  - Induced effects: The induced effects are outputs created when the individuals who are directly and indirectly affected by the program spend their earnings.

  A multiplier shows the change in output that results from a change in final demand in any given industry and is defined as follows.

$$Multiplier = \frac{direct\ effect + indirect\ effect + induced\ effect}{direct\ effect}$$

[54] RIMS-II, Bureau of Economic Analysis (BEA), https://www.bea.gov/regional/rims/rimsii/.

The ESA program results in an economic benefit because it shifts expenditures from industries with lower multipliers in the economy to industries with higher multipliers. The total economic benefit from the ESA program is the sum of two key expenditure shifts that occur because of the program.

- Program expenditures replace general retail expenditures: Funding for the ESA program is derived from additional charges for each unit of energy consumed. We assume that these customer expenditures replace retail purchases that otherwise would have been made in the absence of these charges. This results in an economic benefit because expenditures on the ESA program create more economic activity than expenditures on retail goods. However, since a portion of ESA expenditures are spent outside of the State of California and we assume that most retail expenditures would have been spent inside the state, the calculation is adjusted for the amount of ESA expenditures outside of CA. The economic benefit is calculated using the following equation.

  {$ Spent in CA *
  (Output Multiplier with Program – Output Multiplier without Program)} –
  ($ Spent Outside of CA * Output Multiplier without Program)

- Retail expenditures replace energy expenditures: The ESA program results in reduced electric and gas usage and costs for program participants. We assume that participants increase spending on retail goods with their energy bill savings. This results in an economic benefit because expenditures on retail goods create more economic activity than expenditures on energy. The economic benefit of this shift is calculated using the following equation.

  $ ESA Bill Savings * (Output Multiplier with Program – Output Multiplier without Program)

To calculate the RIMS-II multipliers, the BEA uses a set of national input-output accounts that record the goods and services used by each industry. National values are then modified using location quotients that show the ratio between an industry's share of local wages and salaries and that industry's national share of wages and salaries. Location quotients for the State of California were used in this analysis. The BEA's national tables were last updated in 2012 and the location quotients were updated in 2018.

The most important assumptions underlying the multipliers are as follows (BEA Assumptions).

- Backward Linkages: The calculation assumes backward linkages, meaning that an increase in demand for outputs results in an increase in the demand for inputs (as opposed to a forward linkage model in which an increased supply of inputs results in an increased supply of output).

- No Time Dimension: Because it is assumed that there is no time dimension, multipliers hold no predictions about how long it will take for the calculated economic benefits to be realized.

- Fixed Purchase Patterns: Industries are assumed to use the same mix of inputs and produce the same outputs and that doubling outputs requires doubling inputs.

- Industry Homogeneity: It is assumed that industries are homogenous, meaning that all businesses in a single industry use the same inputs to make the same outputs in the same way.

- No Regional Feedback: It is assumed that once output leaves the region, it does not come back in any way. In other words, if a business purchases an input from another state, it is assumed that the second business does not purchase any inputs from a third business in California.

Table III-14C displays the RIMS-II output multipliers with and without the ESA program for the State of California. The output multipliers represent the dollars of output created per one-dollar change in final demand. The table also displays the change in the multiplier as the difference between the multipliers with and without the ESA program.

Table III-14C
RIMS-II Economic Output Multipliers

Expenditure Category	Output Multiplier with Program		Output Multiplier Without Program		Output Multiplier Change
	Sector	Output Multiplier	Sector	Output Multiplier	
Materials & Labor	Other Retail/ Construction	2.0956	Other Retail	2.0388	0.0568
Marketing	Admin & Support Svc	2.1894	Other Retail	2.0388	0.1506
QC	Prof, Scientific, Tech	2.1586	Other Retail	2.0388	0.1198
Evaluation	Prof, Scientific, Tech	2.1586	Other Retail	2.0388	0.1198
Admin	Admin & Support Svc	2.1894	Other Retail	2.0388	0.1506
Other	Prof, Scientific, Tech	2.1586	Other Retail	2.0388	0.1198
Retail	Other Retail	2.0388	Utilities	1.6409	0.3979

- Average kWh and Therm Savings: The average energy savings were from the 2019 ESA Impact Evaluation for program year 2017.[55] Table III-6B in Section B1-Arrearage Carrying Costs displays the savings for 2017.

[55]DNV-GL, Energy Savings Assistance Program Impact Evaluation Program Years 2015-2017, Southern California Gas Company, April 2019, pg. 39, 48.

- Assumptions
  - Public Purpose charges for the ESA program would otherwise have been spent on retail goods in California.
  - ESA participants spend bill savings on retail expenses in California.

- Calculation: The following steps were used to calculate the total economic benefit of the ESA program.
  - Annual Impact of ESA Expenditures Replacing Retail Expenditures
  - Annual Impact of Retail Expenditures Replacing Energy Expenditures

Benefit from ESA Expenditures Replacing Retail Expenditures										
Utility	Expenditure Category	{A	*	(B – C)}	-	(A	*	C)	=	Annual ESA Expenditures Replacing Retail Impact
		$ Spent in CA		Output Multiplier Change		$ Spent Out of CA		Multiplier without Program		
PG&E	Materials & Labor	$145,896,378		0.0568		$2,977,477		2.0388		$2,216,434
	Marketing	$1,534,102		0.1506		$80,742		2.0388		$66,419
	QC	$3,317,102		0.1198		$0		2.0388		$397,389
	Research & Evaluation	$16,262		0.1198		$65,046		2.0388		-$130,668
	Administrative	$6,017,223		0.1506		$0		2.0388		$906,194
	Other	$920,640		0.1198		$0		2.0388		$110,293
	Total	**$157,701,706**				**$3,123,266**				**$3,566,059**
	Total Per Job (106,673 jobs)									**$33.43**
SDG&E	Materials & Labor	$14,831,321		0.0568		$302,680		2.0388		$225,315
	Marketing	$1,008,926		0.1506		$53,101		2.0388		$43,681
	QC	$141,308		0.1198		$0		2.0388		$16,929
	Research & Evaluation	$18,278		0.1198		$73,114		2.0388		-$146,874
	Administrative	$3,575,346		0.1506		$0		2.0388		$538,447
	Other	$7,250		0.1198		$0		2.0388		$869
	Total	**$19,582,429**				**$428,895**				**$678,366**
	Total Per Job (16,271 jobs)									**$41.69**
SCG	Materials & Labor	$100,907,975		0.0568		$2,059,346		2.0388		$1,532,977
	Marketing	$1,143,399		0.1506		$60,179		2.0388		$49,503
	QC	$1,751,136		0.1198		$0		2.0388		$209,786
	Research & Evaluation	$31,544		0.1198		$126,178		2.0388		-$253,472
	Administrative	$6,907,405		0.1506		$0		2.0388		$1,040,255
	Other	$730,450		0.1198		$0		2.0388		$87,508
	Total	**$111,471,909**				**$2,245,703**				**$2,666,558**
	Total Per Job (122,037 jobs)									**$21.85**
SCE	Materials & Labor	$66,117,267		0.0568		$1,349,332		2.0388		$1,004,443
	Marketing	$1,117,069		0.1506		$58,793		2.0388		$48,363
	QC	$1,294,222		0.1198		$0		2.0388		$155,048
	Research & Evaluation	$71,249		0.1198		$284,994		2.0388		-$572,511
	Administrative	$4,702,455		0.1506		$0		2.0388		$708,190
	Other	$158,243		0.1198		$0		2.0388		$18,958
	Total	**$73,460,505**				**$1,693,119**				**$1,362,490**
	Total Per Job (95,397 jobs)									**$14.28**

Benefit from Retail Expenditures Replacing Energy Expenditures													
Utility	Expenditure Category	{(D	*	E)	+	(F	*	G)}	*	(B – C)	=	Annual Retail Replacing Energy Expenditure Impact
		BILL REDUCTION								Output Multiplier Change		
		kWh Savings		kWh Rate		Therm Savings		Therm Rate				
PG&E	Retail	131		$0.14		9		$1.28		0.3979		$12.06
SDG&E	Retail	67		$0.18		3		$1.14		0.3979		$6.03
SCG	Retail	--		--		7		$0.82		0.3979		$2.30
SCE	Retail	187		$0.13		--		--		0.3979		$9.42

Utility	Annual ESA Expenditures Replacing Retail Impact	+	Annual Retail Replacing Energy Expenditure Impact	=	Annual Economic Impact
PG&E	$33.43		$12.06		$45.49
SDG&E	$41.69		$6.03		$47.73
SCG	$21.85		$2.30		$24.15
SCE	$14.28		$9.42		$23.71

- Limitations
  - In the absence of the ESA program, costs are assumed to be spent on retail.
  - Percent spent in CA is an estimate.

4. Home Operation and Value Benefit

The benefit included in this category is as follows.

- Operations and Maintenance Cost (Participant)

Operations and Maintenance Cost (Participant NEB)

The ESA program provides new appliances and potentially reduces the need for future appliance repairs.

- Benefit Type: Participant

- Data: Table III-15A displays the data that were used as inputs.

Table III-15A
Operations and Maintenance Cost Data Inputs[56]

	Input	Source	Input Type	Value			
				PG&E	SDG&E	SCG	SCE
A	**ESA Appliance Replacement Rates**						
	Clothes Washer	Utilities (2019)	Utility	0.032	0.018	0.032	0.000
	Furnace			0.017	0.126	0.066	0.000
	Microwave			0.075	0.036	0.000	0.000
	Refrigerator/Freezer			0.092	0.060	0.000	0.146
	Room A/C			0.014	0.024	0.000	0.007

[56] Central air conditioning and evaporative cooling could be added in the future.

	Input	Source	Input Type	Value			
				PG&E	SDG&E	SCG	SCE
	Water Heater			0.015	0.063	0.127	0.000
B	Appliance Repair Rate	Yale Appliances[57] (2019)	Literature	5%			
C	**Appliance Repair Cost**						
	Clothes Washer	Puls Appliance Repair[58]	Literature	$221			
	Furnace	Home Advisor[59]	Literature	$297			
	Microwave	Puls Appliance Repair	Literature	$195			
	Refrigerator/Freezer	Puls Appliance Repair	Literature	$242			
	Room A/C	Home Advisor[60]	Literature	$227			
	Water Heater	Home Advisor[61]	Literature	$572			
D	Percent of ESA Jobs in Owned Homes	PG&E (2019), SDG&E (2019), SCG (2019), SCE (2019)	Utility	54%	17%	43%	46%

- Appliance Replacement Rate: The appliance replacement rate was calculated as the number of each type of appliance provided by each utility divided by that utility's total number of participants. Measures, participants, and replacement rates are displayed in Table III-15B.

Table III-15B
2019 ESA Appliance Measures, Participants, and Replacement Rates

Appliance	ESA Number of Measures				ESA Replacement Rate			
	PG&E	SDG&E	SCG	SCE	PG&E	SDG&E	SCG	SCE
ESA Participants	106,673	16,271	122,037	95,398				
Clothes Washer	3,367	294	3,961	0	0.032	0.018	0.032	0.000
Furnace	1,800	2,052	8,100	0	0.017	0.126	0.066	0.000
Microwave	8,022	592	0	0	0.075	0.036	0.000	0.000
Refrigerator/Freezer	9,786	972	0	13,926	0.092	0.060	0.000	0.146
Room A/C	1,451	384	0	666	0.014	0.024	0.000	0.007
Water Heater	1,560	1,017	15,487	0	0.015	0.063	0.127	0.000
Total	**25,986**	**5,311**	**27,548**	**14,592**	**0.24**	**0.33**	**0.23**	**0.15**

[57] Yale Appliances, "Most Reliable/Least Serviced Appliance Brands for 2020", https://blog.yaleappliance.com/bid/86332/the-least-serviced-most-reliable-appliance-brands
[58] Puls Appliance Repair, "U.S. Appliance Repair Affordability, Reliability & Seasonality 2019", https://cdn2.hubspot.net/hubfs/4039866/National%20Appliance%20Repair%20Report%20FINAL_EDITS.pdf
[59] Home Advisor, "How Much Does Furnace Clearing or Repair Cost?", https://www.homeadvisor.com/cost/heating-and-cooling/repair-a-furnace
[60] Home Advisor, "How Much Do Window Air Conditioner Repairs Cost?" https://www.homeadvisor.com/cost/heating-and-cooling/repair-a-window-air-conditioner/
[61] Home Advisor, "How Much Does It Cost to Repair a Water Heater?" https://www.homeadvisor.com/cost/plumbing/repair-a-water-heater/

- Appliance Repair Rate: The appliance repair rate was included as five percent based on the reliability of top brands reported by Yale Appliances using service data for 2019. Table III-15C displays the repair rates of the top ten brands.

Table III-15C
2019 Yale Appliance Repair Rate

Brand	Repair Rate
Whirlpool	4.04%
GE	5.70%
LG	5.98%
Gaggenau	9.03%
Samsung	10.04%
Bosch	11.61%
Miele	16.60%
Fisher & Paykel	18.37%
Thermador	19.79%
KitchenAid	20.54%
Repair Rate Used	**5.00%**

- Repair Cost: The average repair cost for each appliance was obtained from Puls Appliance Repairs' "U.S. Appliance Repair Affordability, Reliability & Seasonality 2019" report or HomeAdvisor.com. Table III-15D displays these repair costs.

Table III-15D
Appliance Repair Cost

Appliance	Source	Repair Cost
Clothes Washer	Puls Appliance Repair	$221
Furnace	Home Advisor	$297
Microwave	Puls Appliance Repair	$195
Refrigerator/Freezer	Puls Appliance Repair	$242
Room A/C	Home Advisor	$227
Water Heater	Home Advisor	$572

- Percent of ESA Jobs in Owned Homes: The percent of jobs in owned homes was provided by the utilities.

- Assumptions
  - Appliance repair rate of five percent was estimated based on the findings of Yale Appliance Repair's 2019 data.
  - Appliance repair costs equal to the reported values from Puls Appliance Repair and HomeAdvisor.com

- Calculation: The following calculation was used to compute the annual maintenance benefit per ESA participant. The replacement rate was multiplied by the repair rate and the repair cost for each measure. The impacts from the measures were summed to compute the annual operations and maintenance cost impact.[62]

Utility	Appliance	A	*	B	*	C	=	Annual
		ESA Replace Rate		Repair Rate		Repair Cost		Maintenance Impact
PG&E	Washers	0.032		5%		$221.00		$0.35
	Furnace	0.017				$297.00		$0.25
	Microwave	0.075				$195.00		$0.73
	Refrigerator	0.092				$242.00		$1.11
	Room A/C	0.014				$227.00		$0.15
	Water Heater	0.015				$572.00		$0.42
	Total							**$3.02**
SDG&E	Washers	0.018		5%		$221.00		$0.20
	Furnace	0.126				$297.00		$1.87
	Microwave	0.036				$195.00		$0.35
	Refrigerator	0.060				$242.00		$0.72
	Room A/C	0.024				$227.00		$0.27
	Water Heater	0.063				$572.00		$1.79
	Total							**$5.21**
SCG	Washers	0.032		5%		$221.00		$0.36
	Furnace	0.066				$297.00		$0.99
	Microwave	0.000				$195.00		$0.00
	Refrigerator	0.000				$242.00		$0.00
	Room A/C	0.000				$227.00		$0.00
	Water Heater	0.127				$572.00		$3.63
	Total							**$4.97**
SCE	Washers	0.000		5%		$221.00		$0.00
	Furnace	0.000				$297.00		$0.00
	Microwave	0.000				$195.00		$0.00
	Refrigerator	0.146				$242.00		$1.77
	Room A/C	0.007				$227.00		$0.07
	Water Heater	0.000				$572.00		$0.00
	Total							**$1.85**

Utility	Annual Maintenance Impact	*	% of Jobs in Owned Homes	=	Annual Impact
PG&E	$3.02		54%		$1.63
SG&E	$5.21		17%		$0.88
SGG	$4.97		43%		$2.14

[62] Central air conditioning and evaporative cooling could be added in the future.

SCE	$1.85		46%		$0.85

- Limitations
  - Used repair rate from Yale Appliance Repair report.
  - Used repair costs from Puls Appliance Repair report and HomeAdvisor.com.

- Applicability
  - The appliance repair rate may not be applicable to the ESA participants.
  - The appliance repair costs may not be applicable to the ESA participants.

5. Health, Safety, and Comfort Benefits

The benefits included in this category are as follows.

- Health (Participant)
- Safety (Participant)
- Comfort (Participant)
- Noise (Participant)

Health (Participant NEB)

The ESA program potentially improves participant health through HVAC equipment repair and replacement, other equipment repair and replacement, and home repairs.

- Benefit Type: Participant

- Data: Table III-16A displays the data that were used as inputs.

Table III-16A
Increased Health Benefit Data Inputs

	Input	Source	Input Type	Value			
				PG&E	SDG&E	SCG	SCE
A	Average kWh Savings	ESA Evaluation (2017), SDG&E (2016)	Utility	131	67	--	187
B	kWh CARE Rate	PG&E (2019), SDG&E (2020)*, SCE (2020)*	Utility	$0.14	$0.18	--	$0.13
C	Average Therm Savings	ESA Evaluation (2017)	Utility	9	3	7	--
D	Therm CARE Rate	PG&E (2019), SDG&E (2020)*, SCG (2020)	Utility	$1.28	$1.14	$0.82	--
E	Health Multiplier	Skumatz 2010 Xcel Study[63]	Literature	9.0%			

*The SDG&E and SCE CARE rates were calculated using their average residential rates and CARE discounts.

[63] Skumatz, L., "NEBs Analysis for Xcel Energy's Low Income Energy Efficiency Programs", Prepared for Xcel Energy, Denver CO, May 2010.

- Average kWh and Therm Savings: The average energy savings were from the 2019 ESA Impact Evaluation for program year 2017.[64] Table III-6B in Section B1-Arrearage Carrying Costs displays the savings for 2017.

- Health Multiplier: The health multiplier was included as 9.0 percent based on survey results from the Skumatz 2010 evaluation of the Xcel Energy Single-Family Weatherization Program in Colorado. The program offers natural gas and electric efficiency measures. The study did not include the specific measures that were offered through the program but did state that the average savings were $238 per home per year.

  The study sent notifications of the survey to all 1,950 participating households and received online responses from 149 for a completed interview rate of 7.6 percent. The survey asked participants if they experienced a change (positive or negative) in the categories of benefits shown in Table III-16B.

  If participants responded with a positive or negative change in the attribute, they were asked to compare that change to the dollar savings on their bill. The survey estimated a total NEB value multiplier for electric and gas customers of 1.156. The study did not provide the specific calculation, but the value included the individual benefits of each NEB.

  The study also provided the percentage of the total NEB value multiplier assigned to each benefit category but did not state how these percentages were calculated. The results for the single-family weatherization program are shown in Table III-16B.

Table III-16B
Skumatz 2010 Xcel Survey Share of Multiplier Results

	Value
Total Participants	1,950
Respondents	149
Total NEB Value Multiplier	1.156
Bill Savings	$238
% of Value Multiplier Attributable to Each NEB Category	
Comfort	7.50%
Water	7.40%
Light	7.30%

[64] DNV-GL, Energy Savings Assistance Program Impact Evaluation Program Years 2015-2017, Southern California Gas Company, April 2019, pg. 39, 48.

	Value
Noise	8.10%
Safety	8.20%
Health	7.80%
Maintenance	7.20%
Resale	7.80%
Bill Control	8.20%
Environmental Contribution	7.90%
Bill Knowledge	7.40%
Collections	7.20%
Other	8.20%
Percentage Total	100%

The total NEB value of 1.156 was multiplied by the 7.8 percent attributed to health to develop the health multiplier for use in the impact estimate. The calculation is displayed in Table III-16C.

Table III-16C
Skumatz 2010 Xcel Health Multiplier Results

	Number of Respondents	Multiplier
Total NEB Value Multiplier	149	1.156
Percent of NEB Value Multiplier Attributed to Health	149	7.8%
Increased Health Multiplier		9.0%

- The 2010 Skumatz study was used to estimate the health impact because it provides a monetization for the NEB. A more recent National WAP Evaluation found a significant reduction in the number of participants who reported poor physical health but did not provide a monetization. Because this is a more recent study with statistically significant impact findings, the relevant results are summarized below, as additional evidence for the NEB.

  WAP provides weatherization measures through grantees and subgrantees to households with income at or below 150 percent of the federal poverty level or 60 percent of state median income. The program provides the following measures.
  - Air Sealing
  - Insulation
  - Baseloads
  - Water-Heating System
  - Space-Heating System
  - HVAC Accessories
  - Windows

- Doors
- Ventilation
- Air-Conditioning Systems

The National WAP Evaluation included a national occupant survey with a sample of the WAP participants and a comparison group of earlier WAP participants.[65]

- Treatment Group: The pre-treatment survey was conducted with this group just prior to completion of the home energy audit in Program Year 2011 or 2012. The post-treatment survey was conducted approximately two years later, at the same time of the year.

- Comparison Group: This was a group of earlier WAP participants who received WAP services in Program Year 2010. The quasi pre-treatment survey was conducted with this group one year later. The quasi post-treatment survey was conducted approximately 18 months following the initial survey.

The Baseline interviews were completed with 1,094 Treatment Group clients and 803 Comparison Group clients, for a total of 1,897. Of those 1,897 households, 139 households' treatment status could not be verified and were deemed ineligible and 15 households had moved. The remaining 1,743 respondents were contacted by phone. The Follow-up Survey was able to determine that 66 treatment households had not completed weatherization and only 454 of the treatment group clients received WAP services, continued to live in the weatherized housing unit, and could be contacted for follow-up interviews.

Similarly, 430 of the Comparison Group households who continued to live in their weatherized homes could be contacted. That group of 454 Treatment Group households and 430 Comparison Group households served as the analysis population for the analysis. Table III-16D displays the attrition results of this study.

Table III-16D
WAP Evaluation Survey Attrition

Population	Treatment Group		Comparison Group	
	#	%	#	%
Baseline Survey	1,094	100%	803	100%
Treatment Status Determined	955	87%	803	100%
Complete	454	48%	430	54%
Incomplete	501	40%	373	46%

[65]National Weatherization Assistance Program Evaluation. Analysis Report. Non-Energy Benefits of WAP Estimated with the Client Longitudinal Survey Final Report. January 2018. http://www.appriseinc.org/wp-content/uploads/2018/02/WAP-Non-Energy-Benefits-Analysis-Report.pdf

Population	Treatment Group		Comparison Group	
	#	%	#	%
Final Follow-Up Sample	454		430	

The health impact of the National WAP program is displayed in Table III-16E. While there was no clear impact on mental health, there was a significant reduction of eight percent in poor physical health in the previous thirty days.

Table III-16E
2018 WAP Evaluation Results
Respondent Days of Poor Physical or Mental Health

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Physical							
1-15 days	25%	28%	4%	24%	26%	3%	1%
16-29 days	7%	4%	-3%**	6%	6%	0%	-3%
All 30 days	23%	18%	-5%**	19%	22%	4%	-8%**
Mental							
1-15 days	25%	24%	-1%	24%	21%	-2%	2%
16-29 days	4%	4%	0%	4%	5%	1%	-1%
All 30 days	13%	12%	-2%	14%	11%	-3%*	2%

** Denotes significance at the 95 percent level. * Denotes significance at the 90 percent level.

- Assumptions
  - Average energy savings equal to the findings of the 2019 ESA Impact Evaluation for program year 2017.
  - Savings multiplier for health of 9.0%, equal to the finding of the Skumatz 2010 Xcel study.

- Calculation: The following calculation was used to compute the annual health benefit per ESA participant.

	{(A	*	B)	+	(C	*	D)}	*	E		
	BILL REDUCTION										
Utility	kWh Savings		kWh Rate		Therm Savings		Therm Rate		Health Multiplier	=	Annual Health Impact
PG&E	131		$0.14		9		$1.28		9.0%		$2.73
SDG&E	67		$0.18		3		$1.14		9.0%		$1.36
SCG	--		--		7		$0.82		9.0%		$0.52
SCE	187		$0.13		--		--		9.0%		$2.13

- Limitations
  - Used savings multiplier for health from the Skumatz 2010 study.

- Applicability
  - The savings multiplier for health may not be applicable to the 2020 ESA participants.

- Additional Research Recommended
  - ESA Usage Impact Evaluation
  - ESA Benefit Perception Survey: Conduct a survey with ESA program participants. Ask participant to value NEBs relative to ESA energy savings.

Safety (Participant NEB)

The ESA program potentially improves home safety by testing equipment and providing a safer indoor temperature; improving ventilation; and providing safety measures including smoke and CO alarms.

- Benefit Type: Participant

- Data: Table III-17A displays the data that were used as inputs.

Table III-17A
Increased Safety Benefit Data Inputs

	Input	Source	Input Type	Value			
				PG&E	SDG&E	SCG	SCE
A	Average kWh Savings	ESA Evaluation (2017), SDG&E (2016)	Utility	131	67	--	187
B	kWh CARE Rate	PG&E (2019), SDG&E (2020)*, SCE (2020)*	Utility	$0.14	$0.18	--	$0.13
C	Average Therm Savings	ESA Evaluation (2017)	Utility	9	3	7	--
D	Therm CARE Rate	PG&E (2019), SDG&E (2020)*, SCG (2020)	Utility	$1.28	$1.14	$0.82	--
E	Safety Multiplier	Skumatz 2010 Xcel Study[66]	Literature	9.5%			

*The SDG&E and SCE CARE rates were calculated using their average residential rates and CARE discounts.

  - Average kWh and Therm Savings: The average energy savings were from the 2019 ESA Impact Evaluation for program year 2017.[67] Table III-6B in Section B1-Arrearage Carrying Costs displays the savings for 2017.

  - Safety Multiplier: The safety multiplier was included as 9.5 percent based on the survey results of the Skumatz 2010 evaluation of the Xcel Energy Single-Family

[66]Skumatz, L., "NEBs Analysis for Xcel Energy's Low Income Energy Efficiency Programs", Prepared for Xcel Energy, Denver CO, May 2010.
[67] DNV-GL, Energy Savings Assistance Program Impact Evaluation Program Years 2015-2017, Southern California Gas Company, April 2019, pg. 39, 48.

Weatherization program in Colorado. For full details regarding this study, see the discussion in Section B5-Health.

The total NEB value of 1.156 was multiplied by the 8.2 percent attributed to safety. The calculation is displayed in Table III-17B.

Table III-17B
Skumatz 2010 Xcel Safety Multiplier Results

	Number of Respondents	Multiplier
Total NEB Value Multiplier	149	1.156
Percent of NEB Value Multiplier Attributed to Safety	149	8.2%
Increased Safety Multiplier		9.5%

- The 2010 Skumatz study was used to estimate the safety impact because it provides a monetization of the NEB. A more recent National WAP Evaluation found significant reductions in the number of participants who reported unsafe indoor temperatures, insect and rodent infestations, mildew, and standing water, but did not provide a monetization. Because this is a more recent study with statistically significant impact findings, the relevant results are summarized below as additional evidence for the NEB. For full details regarding this study, see the discussion in B5-Health.

  Safety impacts of the National WAP program are displayed in Table III-17C. There were significant reductions in the number of participants who reported that their home had an unsafe indoor temperature, insects, rodents, mildew, and standing water.

Table III-17C
APPRISE 2018 WAP Evaluation Results
Change in Household Safety

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Unsafe Indoor Temperature							
Almost every month	3%	1%	-2%**	1%	1%	0%	-2%
Some months	8%	3%	-4%***	3%	4%	1%	-6%***
1-2 months	7%	2%	-5%***	4%	4%	0%	-5%***
Never	81%	93%	12%***	91%	91%	0%	12%***
Infested with Cockroaches, Spiders, and Other Insects							
Extremely/very infested	5%	2%	-3%**	2%	2%	0%	-3%**
Somewhat infested	19%	12%	-7%***	13%	15%	3%	-10%***

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Infested with Rats or Mice							
Extremely/very infested	2%	0%	-2%***	0%	1%	0%	-2%***
Somewhat infested	8%	6%	-2%	6%	6%	0%	-2%
Mold, Mildew, or Standing Water							
Mold	24%	19%	-5%**	17%	17%	-1%	-4%
Mildew odor or musty smell	29%	21%	-8%***	15%	16%	1%	-10%***
Always or often observed standing water	5%	4%	-1%	3%	3%	0%	-1%
Sometimes observed standing water	15%	9%	-6%***	7%	7%	-1%	-5%**

*** Denotes significance at the 99 percent level. ** Denotes significance at the 95 percent level.

- Assumptions
  - Average energy savings equal to the findings of the 2019 ESA Impact Evaluation for program year 2017.
  - Savings multiplier for safety of 9.5%, equal to the finding of the Skumatz 2010 Xcel study.

- Calculation: The following calculation was used to compute the annual safety benefit per ESA participant.

	{(A	*	B)	+	(C	*	D)}	*	E		
	BILL REDUCTION										
Utility	kWh Savings		kWh Rate		Therm Savings		Therm Rate		Safety Multiplier	=	Annual Safety Impact
PG&E	131		$0.14		9		$1.28		9.5%		$2.88
SDG&E	67		$0.18		3		$1.14		9.5%		$1.44
SCG	--		--		7		$0.82		9.5%		$0.55
SCE	187		$0.13		--		--		9.5%		$2.25

- Limitations
  - Used savings multiplier for safety from the Skumatz 2010 study.

- Applicability
  - The savings multiplier for safety may not be applicable to the 2020 ESA participants.

- Additional Research Recommended
  - ESA Usage Impact Evaluation
  - ESA Benefit Perception Survey

Comfort (Participant NEB)

The ESA program potentially improves the comfort of the participant's household by replacing and repairing HVAC equipment and improving the home's shell with insulation and air sealing.

- Benefit Type: Participant

- Data: Table III-18A displays the data that were used as inputs.

Table III-18A
Increased Comfort Benefit Data Inputs

	Input	Source	Input Type	Value			
				PG&E	SDG&E	SCG	SCE
A	Average kWh Savings	ESA Evaluation (2017), SDG&E (2016)	Utility	131	67	--	187
B	kWh CARE Rate	PG&E (2019), SDG&E (2020)*, SCE (2020)*	Utility	$0.14	$0.18	--	$0.13
C	Average Therm Savings	ESA Evaluation (2017)	Utility	9	3	7	--
D	Therm CARE Rate	PG&E (2019), SDG&E (2020)*, SCG (2020)	Utility	$1.28	$1.14	$0.82	--
E	Comfort Multiplier	Skumatz 2010 Xcel Study[68]	Literature	8.7%			

*The SDG&E and SCE CARE rates were calculated using their average residential rates and CARE discounts.

- Average kWh and Therm Savings: The average energy savings were from the 2019 ESA Impact Evaluation for program year 2017.[69] Table III-6B in Section B1-Arrearage Carrying Costs displays the savings for 2017.

- Comfort Multiplier: The comfort multiplier was included as 8.7 percent based on the survey results of the Skumatz 2010 evaluation of the Xcel Energy Single-Family Weatherization program in Colorado. For full details regarding this study, see the discussion in B5-Health.

  The total NEB value of 1.156 was multiplied by the 7.5 percent attributed to comfort. The calculation is displayed in Table III-18B.

[68] Skumatz, L., "NEBs Analysis for Xcel Energy's Low Income Energy Efficiency Programs", Prepared for Xcel Energy, Denver CO, May 2010.
[69] DNV-GL, Energy Savings Assistance Program Impact Evaluation Program Years 2015-2017, Southern California Gas Company, April 2019, pg. 39, 48.

Table III-18B
Skumatz 2010 Xcel Comfort Multiplier Results

	Number of Respondents	Multiplier
Total NEB Value Multiplier	149	1.156
Percent of NEB Value Multiplier Attributed to Comfort	149	7.5%
Increased Comfort Multiplier		8.7%

- The 2010 Skumatz study was used to estimate the comfort impact because it provides a monetization of the NEB. A more recent WAP study found significant reductions in the number of participants who reported that their home was drafty, too hot, or too cold, but did not provide a monetization. Because this is a more recent study with statistically significant impact findings, the relevant results are summarized below as additional evidence for the NEB. For full details regarding this study, see the discussion in B5-Health.

  The comfort impact of the National WAP program is displayed in Table III-18C. There were significant reductions in the number of participants who reported that their home was drafty, too cold in the winter, and too hot in the summer.

Table III-18C
APPRISE 2018 WAP Evaluation Results
Change in Household Comfort

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Drafty all the time	12%	2%	-10%***	4%	3%	-1%	-9%***
Drafty most of the time	17%	4%	-12%***	4%	2%	-2%**	-10%***
Indoor Temperature in Winter							
Very Cold	6%	2%	-4%***	3%	1%	-2%**	-3%*
Cold	33%	14%	-19%***	15%	14%	-1%	-17%***
Comfortable	58%	82%	23%***	79%	83%	4%*	20%***
Indoor Temperature in Summer							
Comfortable	57%	71%	13%***	72%	74%	2%	12%***
Hot	27%	22%	-5%**	22%	18%	-4%*	-1%
Very hot	12%	4%	-8%***	4%	4%	1%	-8%***

*** Denotes significance at the 99 percent level. ** Denotes significance at the 95 percent level.
* Denotes significance at the 90 percent level.

- Assumptions
  - Average energy savings equal to the findings of the 2019 ESA Impact Evaluation for program year 2017.

- Savings multiplier for comfort of 8.7%, equal to the finding of the Skumatz 2010 Xcel study.

- Calculation: The following calculation was used to compute the annual comfort benefit per ESA participant.

	{(A	*	B)	+	(C	*	D)}	*	E		
	BILL REDUCTION								Comfort Multiplier	=	Annual Comfort Impact
Utility	kWh Savings		kWh Rate		Therm Savings		Therm Rate				
PG&E	131		$0.14		9		$1.28		8.7%		$2.64
SDG&E	67		$0.18		3		$1.14		8.7%		$1.32
SCG	--		--		7		$0.82		8.7%		$0.50
SCE	187		$0.13		--		--		8.7%		$2.06

- Limitations
  - Used savings multiplier for comfort from the Skumatz 2010 study.

- Applicability
  - The savings multiplier for comfort may not be applicable to the 2020 ESA participants.

- Additional Research Recommended
  - ESA Usage Impact Evaluation
  - ESA Benefit Perception Survey

Noise (Participant NEB)

The ESA program potentially reduces noise in the participants' home by installing energy efficient appliances that reduce indoor noise and insulation that reduces outdoor noise.

- Benefit Type: Participant

- Data: Table III-19A displays the data that were used as inputs.

Table III-19A
Noise Reduction Benefit Data Inputs

	Input	Source	Input Type	Value			
				PG&E	SDG&E	SCG	SCE
A	Average kWh Savings	ESA Evaluation (2017), SDG&E (2016)	Utility	131	67	--	187
B	kWh CARE Rate	PG&E (2019), SDG&E (2020)*, SCE (2020)*	Utility	$0.14	$0.18	--	$0.13
C	Average Therm Savings	ESA Evaluation (2017)	Utility	9	3	7	--
D	Therm CARE Rate	PG&E (2019), SDG&E (2020)*, SCG (2020)	Utility	$1.28	$1.14	$0.82	--

	Input	Source	Input Type	Value			
				PG&E	SDG&E	SCG	SCE
E	Noise Multiplier	Skumatz 2010 Xcel Study[70]	Literature	9.4%			

*The SDG&E and SCE CARE rates were calculated using their average residential rates and CARE discounts.

- Average kWh and Therm Savings: The average energy savings were from the 2019 ESA Impact Evaluation for program year 2017.[71] Table III-6B in Section B1-Arrearage Carrying Costs displays the savings for 2017.

- Noise Multiplier: The noise multiplier was included as 9.4 percent based on the survey results from the Skumatz 2010 evaluation of the Xcel Energy Single-Family Weatherization program in Colorado. For full details regarding this study, see the discussion in B5-Health.

  The total NEB value of 1.156 was multiplied by the 8.1 percent attributed to noise reduction. The calculation is displayed in Table III-19B.

Table III-19B
2010 Xcel Noise Reduction Multiplier Results

	Number of Respondents	Multiplier
Total NEB Value Multiplier	149	1.156
Percent of NEB Value Multiplier Attributed to Noise Reduction	149	8.1%
Noise Multiplier		9.4%

- The 2010 Skumatz study was used to estimate the noise impact because it provides a monetization of the NEB. A more recent WAP study found a significant reduction in the number of participants who reported outdoor noise but did not provide a monetization. Because this is a more recent study with statistically significant impact findings, the relevant results are summarized below as additional evidence for the NEB. For full details regarding this study, see the discussion in B5-Health.

  The noise impact of the National WAP program is displayed in Table III-19C. There was a significant reduction of 12 percentage points for participants who reported a great deal of outdoor noise.

[70] Skumatz, L., "NEBs Analysis for Xcel Energy's Low Income Energy Efficiency Programs", Prepared for Xcel Energy, Denver CO, May 2010.
[71] DNV-GL, Energy Savings Assistance Program Impact Evaluation Program Years 2015-2017, Southern California Gas Company, April 2019, pg. 39, 48.

Table III-19C
APPRISE 2018 WAP Evaluation Results
Level of Noise with Windows Shut

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
A great deal of noise	28%	17%	-12%***	12%	12%	0%	-12%***
Some noise	39%	37%	-1%	39%	41%	1%	-3%

*** Denotes significance at the 99 percent level.

- Assumptions
  - Average energy savings equal to the findings of the 2019 ESA Impact Evaluation for program year 2017.
  - Savings multiplier for noise of 9.4%, equal to the finding of the Skumatz 2010 Xcel study.

- Calculation: The following calculation was used to compute the annual noise benefit per ESA participant.

	{(A	*	B)	+	(C	*	D)}	*	E		
	BILL REDUCTION										
Utility	kWh Savings		kWh Rate		Therm Savings		Therm Rate		Noise Multiplier	=	Annual Noise Impact
PG&E	131		$0.14		9		$1.28		9.4%		$2.85
SDG&E	67		$0.18		3		$1.14		9.4%		$1.43
SCG	--		--		7		$0.82		9.4%		$0.54
SCE	187		$0.13		--		--		9.4%		$2.23

- Limitations
  - Used savings multiplier for noise from the Skumatz 2010 Xcel study.

- Applicability
  - The savings multiplier for noise may not be applicable to ESA participants.

- Additional Research Recommended
  - ESA Usage Impact Evaluation
  - ESA Benefit Perception Survey

C. Summary

This section provided recommendations for a revised ESA NEB model and related calculations. NEBs categorized as payment-related; other cost reduction; economic; home operation and value; and health, safety, and comfort were calculated. The table below summarizes the calculated annual values for the proposed NEBs.

Table III-20
Proposed NEB Values
First Year Benefit per ESA Participant

Payment-Related	**PG&E**	**SDG&E**	**SoCalGas**	**SCE**
Arrearage Carrying Cost (Utility)	$0.88	$0.43	$0.16	$0.77
Bad Debt Write-Off (Utility)	$3.59	$1.19	$0.44	$0.96
Shutoffs (Utility)	$0.02	$0.00	$0.00	$0.01
Shutoffs (Participant)	$0.01	$0.00	$0.00	$0.00
Collections Notices (Utility)	$0.02	$0.10	$0.11	$0.02
Collections Calls (Utility)	$0.78	$0.24	$0.13	$0.00
Collections Calls (Participant)	$0.11	$0.00	$0.02	$0.05
Other Cost Reduction	**PG&E**	**SDG&E**	**SoCalGas**	**SCE**
Water and Wastewater Bills (Participant)	$17.44	$4.71	$17.54	$0.09
Economic Impact	**PG&E**	**SDG&E**	**SoCalGas**	**SCE**
Economic Output (Societal)	$45.49	$47.73	$24.15	$23.71
Home Operation and Value	**PG&E**	**SDG&E**	**SoCalGas**	**SCE**
Operations and Maintenance Cost Changes (Participant)	$1.63	$0.88	$2.14	$0.85
Health, Safety, and Comfort Benefits	**PG&E**	**SDG&E**	**SoCalGas**	**SCE**
Health (Participant)	$2.73	$1.36	$0.52	$2.13
Safety (Participant)	$2.88	$1.44	$0.55	$2.25
Comfort (Participant)	$2.64	$1.32	$0.50	$2.06
Noise Reduction (Participant)	$2.85	$1.43	$0.54	$2.23
Total NEB	**$81.04**	**$60.84**	**$46.80**	**$35.12**

IV. Non-Energy Benefit Allocation

This section provides a proposed methodology to allocate NEBs to measures, and a justification for that methodology.

This study proposes a significant change in the method used to allocate NEB value to the contributing measures. The change was partially made to greatly simplify the calculation. Given the level of uncertainty even in the overall NEB values, and even more so in the responsibility of each measure, developing an overly complex model provides a false sense of precision in the results.

The 2019 Model developed a complicated system for allocating NEB value across the measures. The following values were used for the allocations.

- Measure contribution to savings, with negative and zero measure savings values included.
- Measure contribution to savings, with negative measure savings values set to zero.
- Measure share of spending.
- Measure share of water savings.

The full complexity is shown in the study's Excel Model.

The model proposed in this study, however, allocates the value for each NEB to measures in proportion to the percentage of costs that the measures represent out of all responsible measures for the particular NEB.

A. Allocation Step 1: Measures Responsible for Each NEB

The table below provides a list of measures to which each NEB will be allocated.

Non-Energy Benefit	Measure Category	Measures
Payment-Related		
Arrearage Carrying Cost (Utility)	• Lighting • Baseload • Appliances • HVAC • Shell • DHW • Other	• All Measures
Bad Debt Write-Off (Utility)		
Shutoffs (Utility)		
Shutoffs (Participant)		
Collections Notices (Utility)		
Collections Calls (Utility)		
Collections Calls (Participant)		
Other Cost Reduction		
Water & Wastewater (Participant)	• Appliances	• Clothes Washer
	• DHW	• Faucet Aerators • Low-Flow Showerhead • Thermostatic Shower Valve • Combined Showerhead/TSV • Tub Diverter/Tub Spout • Other Domestic Hot Water

Non-Energy Benefit	Measure Category	Measures
Economic Impact		
Economic Output (Societal)	• Lighting • Baseload • Appliances • HVAC • Shell • DHW • Other	• All Measures
Home Operation and Value		
Operations & Maintenance (Participant)	• Appliances	• Clothes Washer • Refrigerator • Freezer • Microwave
	• HVAC	• Central AC – Split • Central AC – Package • Room A/C Replacement • Evaporative Cooler • Central Heat Pump – Split System • Central Heat Pump – Package • Furnace Repair/Replacement • High Efficiency Forced Air Unit • High Efficiency Wall Furnace
	• DHW	• Water Heater Repair/Replace • Heat Pump Water Heater • Solar Water Heater
Health, Safety, and Comfort		
Health (Participant) Safety (Participant)	• Appliances	• Refrigerator • Freezer
	• HVAC	• Central AC – Split • Central AC – Package • Central AC – Tune Up • Room A/C Replacement • Evaporative Cooler • AC Time Delay • Central Heat Pump – Split System • Central Heat Pump – Package • Furnace Clean and Tune • Furnace Repair/Replacement • High Efficiency Forced Air Unit • High Efficiency Wall Furnace • Duct Test and Seal • Prescriptive Duct Sealing • Fan Control
	• Shell	• Air Sealing • Caulking • Attic Insulation
	• DHW	• Water Heater Repair /Replace • Heat Pump Water Heater

Non-Energy Benefit	Measure Category	Measures
		• Solar Water Heater
	• Other	• CO & Smoke Alarms • Home Health & Safety Checkup
Comfort (Participant)	• HVAC	• Central AC – Split • Central AC – Package • Central AC – Tune Up • Room A/C Replacement • Evaporative Cooler • AC Time Delay • Central Heat Pump – Split System • Central Heat Pump – Package • Furnace Clean and Tune • Furnace Repair/Replacement • High Efficiency Forced Air Unit • High Efficiency Wall Furnace • Duct Test and Seal • Prescriptive Duct Sealing • Fan Control • Smart Thermostat
	• Shell	• Air Sealing • Caulking • Attic Insulation
	• DHW	• Water Heater Repair /Replace • Heat Pump Water Heater • Solar Water Heater
Noise Reduction (Participant)	• Appliances	• Clothes Washer • Refrigerator • Freezer • Microwave
	• HVAC	• Central AC – Split • Central AC – Package • Central AC – Tune Up • Room A/C Replacement • Evaporative Cooler • Central Heat Pump – Split System • Central Heat Pump – Package • Furnace Clean and Tune • Furnace Repair/Replacement • High Efficiency Forced Air Unit • High Efficiency Wall Furnace • Fan Control
	• Shell	• Attic Insulation

B. Allocation Step 2: Percent of the NEB Allocated to Each Measure

We propose to allocate NEB value to measures in proportion to the percentage of costs that the measures represent out of all responsible measures for the particular NEB. The responsible measures for each NEB are shown in Step 1. An example for PG&E Noise Reduction is shown below. The table shows how the NEB is allocated to all of the measures.

Non-Energy Benefit	Measure Category	Measures	2019 PGE Measure Cost	% of Included Measure Costs	NEB Allocated Value
Noise Reduction (Participant)	Appliances	Clothes Washer	$2,945,889	10%	$2.34
		Refrigerator	$7,960,911	26%	$6.32
		Freezer	$0	0%	$0.00
		Microwave	$742,917	2%	$0.59
	HVAC	Central AC – Split	$0	0%	$0.00
		Central AC – Package	$0	0%	$0.00
		Central AC – Tune Up	$3,361,398	11%	$2.67
		Room A/C Replacement	$1,262,472	4%	$1.00
		Evaporative Cooler	$1,475,438	5%	$1.17
		Central Heat Pump – Split System	$0	0%	$0.00
		Central Heat Pump – Package	$0	0%	$0.00
		Furnace Clean and Tune	$0	0%	$0.00
		Furnace Repair/Replacement	$6,011,964	20%	$4.77
		High Efficiency Forced Air Unit	$0	0%	$0.00
		High Efficiency Wall Furnace	$0	0%	$0.00
		Fan Control	$1,756,649	6%	$1.39
	Shell	Attic Insulation	$4,775,963	16%	$3.79
	TOTAL COST/VALUE		**$30,293,601**	**100%**	**$24.05**

An example for clothes washers and air sealing is shown below. The table shows how all of PGE's NEBs are allocated to these two measures (all measures are shown in the Excel spreadsheet).

Measure	Payment-Related							Other Cost Reduction
	Arrearage Carrying Cost	Bad Debt Write-Off	Shutoffs		Collections Notices	Collections Calls		Water & Wastewater
	Utility	Utility	Utility	Participant	Utility	Utility	Participant	Participant
Clothes Washer	$0.19	$0.77	$0.00	$0.00	$0.00	$0.17	$0.02	$47.44
Air Sealing	$1.75	$7.12	$0.03	$0.01	$0.03	$1.55	$0.21	NA

Measure	Economic	Home Operation	Health, Safety, & Comfort				Total NEB Value for Measure	% of Total NEB Value for All Measures
	Economic Output	Operation & Maintenance	Health	Safety	Comfort	Noise		
	Societal	Participant	Participant					
Clothes Washer	$3.46	$1.71	NA	NA	NA	$2.34	$56.11	13%
Air Sealing	$31.78	NA	$8.96	$9.46	$9.76	NA	$70.67	16%

The rationale for this methodology is discussed below for each NEB category.

- Economic Output: The rationale for using the percent of measure costs to allocate the NEB value across responsible measures is the most straightforward for the economic output. The impact of the ESA program on economic activity is directly related to ESA expenditures. While the ESA measures may have variable rates of labor inputs (and therefore have different output multipliers), the exact labor percentages are unknown and the percent of the total measure cost is the most accurate way to assess the impact of each ESA measure on the economic output NEB.

- Payment-Related: These NEBs depend on the energy usage reduction and cost reduction that result from ESA measure installation. If good estimates of measure-level savings were available, the best allocation method would use the energy bill savings resulting from each measure. However, accurate measure-level savings are not available.

  One method that is used for measure-level savings is the projected savings. These savings over-predict the energy savings achieved in the program as a whole, as shown by the realization rate that ranged from 18 to 53 percent for electric and from 18 percent to 43 percent for natural gas savings. Another method to estimate savings is to use the regression estimates from the evaluation billing analysis. However, this analysis cannot provide high-precision estimates of each installed measure.

  Therefore, a more reliable way to allocate the NEBs is to assume that energy cost reductions are related to investments in ESA measures to achieve a similar Savings to Investment Ratio (SIR) for each measure. The investments in the responsible measures are thus the most reliable means of determining the measure-level NEBs.

- Other Cost Reduction – Water & Wastewater Costs: These NEBs depend on the water usage reduction and cost reduction that result from ESA measure installation. If good estimates of measure-level water savings were available, the best allocation method would use the water and wastewater bill savings resulting from each measure. The water savings used to generate the NEB estimate could be used for the allocation. However, this method would be more complicated than using the measure costs and would not provide increased accuracy. Therefore, a more straightforward approach to allocate the NEBs is to assume that water cost reductions are related to investments in ESA measures.

- Home Operation and Value: These NEBs result from the reduction in appliance repairs that are due to the appliance replacements. No good estimate of the relative impact of the

various appliance replacements on repair costs is available. The best proxy for this impact is the total amount spent on each appliance relative to all appliance replacement costs.

- Health, Safety, and Comfort: These NEBs are valued based on participants' reports of the relative value of the NEB compared to the energy savings. As with the other NEBs, since good estimates of measure-level savings are not available, the best proxy is the relative amount spent on each responsible measure.

V. Summary of Findings and Research Recommendations

This section provides a summary of findings provided in this report as well as recommendations for NEB research to improve the accuracy of the NEB estimates for the CA ESA program.

A. Summary of Findings

The 2019 NEB value was $66.46 (for SDG&E) compared to an average value of $55.95 across the four utilities with updated inputs in the model developed in this study. While utility and participant benefits are lower in this 2020 model, societal benefits are higher due to the large value of the economic benefit.

This study makes the following contributions toward improving the CA ESA NEB estimates.

- NEB Inclusion Improvements
  - Includes only those NEBs that are relevant to the CA ESA program measures.
  - Excludes NEBs that were double counted.
  - Excludes NEBs with data that cannot be justified.

- NEB Data Improvements
  - Data sources are clearly identified.
  - Data are updated with the most recently available information.

- NEB Calculation Improvements
  - Calculation methodology is transparent.
  - NEB data from other jurisdictions with different savings were adjusted for applicability to the CA ESA program.
  - Calculation errors were identified and removed.
  - NEB allocation was simplified.

- Overall Model Improvements
  - False precision is reduced in this model.
  - Increased transparency is provided with respect to data inputs and calculations.

There are many limitations and imperfections remaining in the model proposed in this study, including the following.

- Data Inputs: The inputs used in the NEB calculations are not ideal but are the best currently available.

- IOU Data: In some cases, the IOUs do not have consistent data reporting methods.

- Payment Literature: The payment-related benefit calculations refer to unpublished studies conducted by APPRISE. These studies cannot be provided due to client confidentiality. However, the information provided includes key data to assess reliability and applicability including program type, program year, sample size, and comparison groups used in the analysis. This provides greater transparency than in the 2019 study.

- Water Savings: These data should be re-assessed to determine applicability to CA and additional research should be conducted to develop water savings estimates for ESA participants.

- Health, Safety, and Comfort Multipliers: These multipliers are from dated studies with small sample sizes in jurisdictions that differ from CA. Additional research should be conducted to develop multipliers for ESA participants.

- Uncertainty: There remains considerable uncertainty in the NEB values used in this report due to both the data inputs and the calculations. The uncertainty is present at the NEB level, and even more so at the measure level. It is important to acknowledge the uncertainty that is present in these estimates and not place a false sense of precision on the results.

These limitations and imperfections were present to a greater extent in the previous model. They are reviewed, assessed, and documented in much greater detail in this report. Additional research is recommended to improve the NEB calculation.

B. NEB Research Recommendations

The following research is recommended to provide more robust NEB calculations and potentially assess additional NEBs.

The research below that discusses a comparison group uses a difference-in-differences estimation methodology. To control for changes that are exogenous to the program, we compare the change for the treatment group (those who we are studying) to the change for the comparison group (those who received services one year later). The change for the treatment group is the gross change, the difference between what the customer experienced in the year before service delivery and the year after service delivery. This change measures both the impact of the program and the impact of factors outside of the program. The same time period is examined for the comparison group, but since these customers received services one year later, the two years examined for the comparison group are two years prior to service delivery and one year prior to service delivery. The comparison group's change is an estimate of what the change for the treatment group would have been if they had not received services. By subtracting the comparison group's change from the treatment group's change, we obtain the net change, or the estimate of the impact of the program, excluding the influences that are external to the program. This information is illustrated in Table V-1.

Table V-1
Treatment and Comparison Groups

	Pre	Post	Change	Measured
Treatment Group	Year Before Services	Year After Services	After - Before	Program Impact and Other Factors
Comparison Group	2 Years Before	1 Year Before	1 Year Before – 2 Years Before	Other Factors
Treatment - Comparison				**Program Impact**

- ESA Usage Impact Evaluation: Continue to update energy savings estimates based on billing analysis. We recommend the use of weather-normalized energy usage data for close to a full year prior to treatment and close to a full year following treatment. A comparison group should be used to control for factors exogenous to the program that impact participants' usage including the economy and energy prices.

- ESA Payment Impact Evaluation: Analyze the impact of ESA energy savings on bills, payments, and arrearages for ESA participants. This should be done through an analysis of transactions and arrearage data before and after ESA participation, and a comparison group should be used. The analysis should estimate the change in energy bills, payments, and arrearages experienced by program participants for close to a full year prior to treatment to close to a full year following treatment.

- ESA Collections Impact Evaluation: Analyze the impact of ESA energy savings on collections actions and costs for ESA participants. This should be done through an analysis of collections actions and costs before and after ESA participation, and a comparison group should be used. The analysis should estimate the change in the number of collections calls, notices, and shutoffs from close to a full year prior to treatment to close to a full year following treatment. Data on average costs for calls, notices, shutoffs, and reconnections should be developed by utilities. These costs would be multiplied by the change in the number of actions to develop the estimate of the change in collections costs.

- ESA Water Impact Evaluation: Analyze the impact of ESA water savings on water and wastewater bills for ESA participants. This should be done through an analysis of water and wastewater bills before and after ESA participation, and a comparison group should be used. This would require obtaining water usage data and costs from a sample of water utilities.

- ESA Benefit Perception Survey: Conduct a survey with ESA program participants. Ask participants to value NEBs relative to the ESA energy bill savings. Data from the following types of questions could be used to develop updated health, safety, and comfort multipliers for the ESA program.
  - Have you noticed a change in your home comfort in the winter since the energy efficiency work? Is the home now much more comfortable, somewhat more comfortable, no change, somewhat less comfortable, or much less comfortable?
  - Think about the positive or negative value you experienced from this change in winter comfort — would you say it is of more value, less value, or the same value to you as any possible energy savings you may have received from the program?
  - What is the dollar value from the change in winter comfort?
  - How does the dollar value from the change in winter comfort compare to the energy savings — ten percent of energy savings, 20 percent, 30 percent, etc.?
  - On a scale of 0 to 5, with 0 meaning "not at all important", and 5 meaning "extremely important", how important to you is the positive or negative change in the winter comfort of your home?

- ESA Impact Survey: Conduct a pre- and post-treatment survey with ESA participants and a comparison group to estimate the impact of the ESA program on health, safety, comfort, and other indicators, as was done in the National WAP Evaluation Occupant Survey.[72] Questions would need to be asked of the treatment group prior to the audit and one year following the conclusion of service delivery. The comparison group here is recommended to be earlier program participants, as opposed to the later program participants used in the other comparison groups. The reason for using earlier program participants in this study is that it is very difficult to identify and survey participants two years prior and one year prior to service delivery. By using participants one year and two years following service delivery, we can measure their change in circumstances without a change in program experience, as they were post-treatment in both study periods.

  Data from the following types of questions, asked before and after service delivery, could be used to develop information on the impacts of the ESA program.
  - Do you have a CO (or carbon monoxide) monitor in your house?
  - Is your CO monitor currently working?
  - In the past 12 months, was your household unable to use any of the following equipment because it was broken? (main heating equipment, central air conditioner, room air conditioner)
  - Think about the indoor temperature of your home during the winter. Is it typically very cold, cold, comfortable, hot, or very hot?
  - In the past 12 months, has anyone in the household needed medical attention because your home was too cold?
  - How much outdoor noise do you hear indoors when the windows are closed?
  - How infested is your home with cockroaches or other insects or spiders?
  - Does your home frequently have a mildew odor or musty smell?
  - Have you seen mold in your home in the past 12 months?

- Excel Model: Continue to improve the Excel Model.

Table V-2
Recommended Research to Contribute to NEBs

Recommended Research	NEB Category	NEBs
ESA Usage Impact Evaluation	• Payment-Related Benefits	• Arrearage Carrying Cost (Utility) • Bad Debt Write-Off (Utility) • Shutoffs (Utility) • Shutoffs (Participant) • Collections Notices (Utility) • Collections Calls (Utility) • Collections Calls (Participant)

[72] National Weatherization Assistance Program Evaluation. Analysis Report. Non-Energy Benefits of WAP Estimated with the Client Longitudinal Survey Final Report. January 2018. http://www.appriseinc.org/wp-content/uploads/2018/02/WAP-Non-Energy-Benefits-Analysis-Report.pdf

Recommended Research	NEB Category	NEBs
	• Health, Safety, and Comfort Benefits	• Health (Participant) • Safety (Participant) • Comfort (Participant) • Noise (Participant)
ESA Payment Impact Evaluation	• Payment Related Benefits	• Arrearage Carrying Cost (Utility) • Bad Debt Write-Off (Utility)
ESA Collections Impact Evaluation	• Payment Related Benefits	• Shutoffs (Utility) • Shutoffs (Participant) • Collections Notices (Utility) • Collections Calls (Utility) • Collections Calls (Participant)
ESA Water Impact Evaluation	• Other Cost Reduction	• Water and Wastewater Bills (Participant)
ESA Benefit Perception Survey	• Health, Safety, and Comfort Benefits	• Health (Participant) • Safety (Participant) • Comfort (Participant) • Noise (Participant)
ESA Impact Survey	• Health, Safety, and Comfort Benefits	• Health (Participant) • Safety (Participant) • Comfort (Participant) • Noise (Participant)

Appendix: Excluded NEB Review

This section reviews the NEB calculations that were performed in the 2019 study that were not recommended for inclusion in this report. All data included in this section is for SDG&E.

A. Excluded Utility NEBs

This section reviews the utility NEBs that were not recommended for inclusion. The following benefits were excluded.

- Fewer Reconnects
- Utility Health & Safety – Insurance
- Utility Subsidy Avoided (CARE)

1. Fewer Reconnects

Reconnects following a shutoff due to nonpayment are an additional cost for the utility. The reconnect is offset by a fee charged to the customer, but the fee does not offset the full cost, so it is still a net loss for the utility. The 2019 report noted that there are more than a dozen studies from the late 1990s to 2018 that value this NEB, making it important to include, but they also noted that the expected benefit combined with that of reducing shutoffs is usually less than $1.00 per household in these studies and can be as low as $0.00 per household.

This NEB was not included as a separate value, but was instead combined with the shutoff NEB.

- ESA Impact: The 2019 study stated that the installation of ESA measures will improve payment behavior and thus reduce the number of reconnects that occur every year. They estimated a $0.04 average annual benefit per participant in 2020.

  ESA measures can reduce customer usage and bills and improve payment behavior, but it is unclear whether that reduction will have a significant impact on the number of reconnections a utility must carry out. The appropriate impact estimate is analyzed in the Calculation section of this report.

- Data: Table A-1A displays the data that were used as inputs in the 2019 study, as well as the sources of those data.

Table A-1A
Reduced Reconnect Data Inputs

	Input	Source	Value	Notes
A	Average Reconnects per CARE customer	Utilities	.0221	
B	ESA Reconnect Impact	Skumatz, CT WRAP, 2002[73]	16%	No normalization
C	Utility Reconnect Cost	Utilities	$17.36	
D	Utility Reconnect Fee	Utilities	$5.85	
E	Inflation Factor	Bureau of Labor Statistics	1.00	Assumed current
F	Weighted Measure Life (Years)	Utilities	14.4	Sum (Measure Lifetime * # of Measure)/Total # of Measures
G	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life is less than one.
H	Adjustment Factor # of Measures	Utilities	1	Reduced to less than one if average # of causal measures per household is less than one.

  - Average Number of Reconnects: The average number of reconnects per low-income customer per year, .0221, was based on 2018 utility CARE data. Data for CARE participants were used as an estimate for ESA participants because 83 percent of ESA participants received the CARE discount.

  - ESA Reconnect Impact: The ESA impact on reconnects was estimated to be a 16 percent reduction, based on the disconnect impact estimate in the Skumatz 2002 CT WRAP Study.
    - Skumatz 2002 CT Study: See the discussion in the Reduced Arrearage Carrying Cost NEB review for the full details regarding this study.

      The shutoff results from the study that were used for the reconnect results are displayed in Table A-1B. They estimated a 16 percent reduction in shutoffs, but the result was not statistically significant.

Table A-1B
CT WRAP Shutoff Impact Results
Used for Reconnect Estimate

	Pre	Post	Change		Significant (95% Confidence Level)
			$	%	
Participants	0.200%	0.017%	-0.003%	-16%	No

[73]Skumatz, Lisa and Nordeen, Trevor. "Connecticut WRAP Program Non-Energy Benefits, March 2002.

The 2019 report spreadsheet model noted that the reconnect impact should be reduced if program spending is less than the CT spending of $368.66 per household. The spreadsheet showed average spending of $548.85 per household so the percentage reduction in reconnects was not normalized.

- Utility Reconnect Cost: The fee charged to households to reconnect was included in the 2019 spreadsheet tool as $17.36 based on utility inputs. An accompanying input requiring the source year for this data was set to 2018.

- Utility Reconnect Fee: The fee charged to households to reconnect was included in the 2019 spreadsheet tool as $5.85 based on utility inputs. An accompanying input requiring the source year for this data was set to 2001. This date was used to update the fee for inflation.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for utility NEBs (8%) is less than one. This is the same calculation as in the Reduced Arrearage Carrying Cost NEB review. No adjustment was made.

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household is less than one. This is the same calculation as in the Reduced Arrearage Carrying Cost NEB review. No adjustment was made.

- Assumptions: Key assumptions that were made.
  - ESA reconnect impact of 16%, equal to the disconnection finding from the 2002 CT study.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	(C	-	D)	*	E	*	G	*	H		
Year	Reconnects		Reconnect Impact		Reconnect Cost		Reconnect Fee		Inflation		Adjust Prog. Horizon		Adjust # Measures	=	Annual Participant Impact
2020	.022		16%		$17.36		$5.85		1.00		1		1		$0.04
2021	.022		16%		$17.36		$5.85		1.00		1		1		$0.04
2022	.022		16%		$17.36		$5.85		1.00		1		1		$0.04
2023	.022		16%		$17.36		$5.85		1.00		1		1		$0.04
2024	.022		16%		$17.36		$5.85		1.00		1		1		$0.04

- Limitations
  - Use of 16% as an estimate for the reconnect reduction. This result was based on shutoffs, and was not statistically significant in the 2002 CT study.

- Applicability
  - The 16% reconnect reduction may not apply to the level of savings achieved by the ESA program.

- Duplication: This NEB does not duplicate another benefit calculated in this NEB analysis or other benefits that are already accounted for in the ESA cost-benefit analysis.

2. Utility Health & Safety – Insurance

Utilities carry insurance to cover the cost of gas leaks, fires, and other emergencies. Their premiums may be reduced if replacing faulty equipment in ESA participants' homes reduces these issues. The 2019 report noted that there are only a few studies from 2011 to 2017 that valued this NEB, and that no reliable impact data could be applied.

This NEB was excluded because the small change in emergencies that are expected to result from the ESA program would not have a measurable impact on insurance costs. This NEB also had no calculated value in the 2019 model and was not included in that model.

- ESA Impact: The 2019 study stated that the installation of ESA measures will reduce the self-insurance premiums for utilities. Since no reliable data or studies were available for this benefit, the impact was set to $0.

  ESA measures are aimed at replacing old, faulty, and inefficient equipment, which may impact the risk of accidents and damage in participants' homes. However, this impact is unlikely to affect insurance premiums.

- Data: Table A-2A displays the data that were used as inputs in the 2019 study, as well as the sources of those data.

Table A-2A
Reduced Utility Health & Safety Insurance Data Inputs

	Input	Source	Value	Notes
A	ESA Insurance Impact	NMR 2011/2014[74]	0.00	
B	Inflation Factor	Bureau of Labor Statistics	1.11-1.22	
C	Weighted Measure Life (Years)	Utilities	13	Sum (Measure Lifetime * # of Measure)/Total # of Measures
D	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life is less than one.
E	Adjustment Factor # of Measures	Utilities	.47	Reduced to less than one if average # of causal measures per household is less than one.

[74]NMR 2011/2014, eeac.org/wordpress/wp-content/uploads/Special-and-Cross-Sector-Studies-Area-Residential-and-Low-Income-Non-Energy-Impacts-Evaluation-Final-Report.pdf.

- ESA Insurance Impact: The ESA impact on insurance was estimated as 0 because there were no reliable studies for this NEB.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for utility NEBs (8%) is less than one.

  Factor = minimum of 1 or
  pmt(discount rate, yr horizon, PV(discount rate, measure life, 1))

  - Discount Rate = 8% (utility data)
  - Year Horizon = 10 years (utility data)
  - Average # Casual Measures per Household = 0.47
  - Weighted Measure Life = $\frac{\sum(Measure\ Lifetime * \#\ of\ Measures)}{Total\ \#\ of\ Measures}$=13
  - pmt(discount rate, yr horizon, PV(discount rate, measure life, 1)) = 1.18
    If the weighted measure life was less than the program horizon, this function would determine the amount by which the NEB should be reduced.

Table A-2B displays the measures included in the calculation of weighted measure life.

Table A-2B
Measures Included in Reduced Utility Health & Safety Insurance Calculation

Measure Name	Measure Lifetime	# of Measures	Lifetime * # Measures
Gas Furnace Clean and Tune	5	3,634	18,170
Gas furnace pilot light conversion	13	18	234
Gas Furnace Repair/Replace	20	4,933	98,660
Heat pump replacement	15	0	0
High efficiency gas furnace	20	0	0
PCT (with CAC and gas heat)	11	875	9,625
PCT (with gas heat and no CAC)	11	1,625	17,875
Total	95	11,085	144,564
Average Measure Life = 13 Years			

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household is less than one.

  Factor = minimum of 1 or average number of causal measures

  - Total Number of Measures = 11,085
  - Total Number of Participants = 23,518
  - Average Number of Causal Measures = $\frac{\sum(\#\ of\ Measures)}{Total\ \#\ of\ Participants}$=0.47

  This adjustment factor can be turned on or off by utilities in the sensitivity options.

- Assumptions: Key assumptions that were made.
  - ESA insurance impact of 0 due to unreliable estimates.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	D	*	E		
Year	Insurance Impact		Inflation		Adjust Prog. Horizon		Adjust # Measures	=	Annual Participant Impact
2020	0.00		1.11		1		47%		$0.00
2021	0.00		1.14		1		47%		$0.00
2022	0.00		1.16		1		47%		$0.00
2023	0.00		1.19		1		47%		$0.00
2024	0.00		1.22		1		47%		$0.00

- Limitations
  - No reliable data available to use in the estimate.

- Applicability
  - No results were applied to the ESA program.

- Duplication: This NEB does not duplicate another benefit calculated in this NEB analysis or other benefits that are already accounted for in the ESA cost-benefit analysis.

3. Utility Subsidy Avoided (CARE)

CARE participants receive a subsidy on their energy bills that is funded by higher rates for nonparticipants. The 2019 report noted that there are many studies from the late 1990s to 2018 that valued this NEB between $2.50 and $28 per household. However, utility review determined that CARE savings are not realized.

This NEB was excluded, as a CARE customer reducing usage only narrowly reduces the amount of utility revenue that needs to be collected from non-CARE customers via the Public Purpose Programs (PPP) charge, but is offset by increasing the revenue that needs to be collected from other cost categories. It was not included in the 2019 model.

- ESA Impact: The 2019 study stated that the installation of ESA measures will reduce energy usage for ESA participants, which will reduce the CARE subsidy. They estimated a $12.76 average annual benefit per participant from 2020 to 2024.

- Data: The following data were used as inputs in the research.

Table A-3A
Reduced Utility Subsidy Avoided (CARE) Data Inputs

	Input	Source	Value	Notes
A	Average kWh Saved	Utilities	345.1	
B	Average Therms Saved	Utilities	3.5	
C	Percent of ESA Participants on CARE	Utilities	83%	
D	Residential kWh Rate	Utilities	$0.12	
E	Residential Therm Rate	Utilities	$1.26	
F	Inflation Factor	Bureau of Labor Statistics	1.00	Assumed current
G	kWh Discount	Utilities	35%	
H	Therm Discount	Utilities	20%	
I	Weighted Measure Life (Years)	Utilities	14.4	Sum (Measure Lifetime * # of Measure)/Total # of Measures
J	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life is less than one.
K	Adjustment Factor # of Measures	Utilities	1	Reduced to less than one if average # of causal measures per household is less than one.

  - Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for utility NEBs (8%) is less than one. This is the same calculation as in the Reduced Arrearage Carrying Cost NEB review. No adjustment was made.

  - Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household is less than one. This is the same calculation as in the Reduced Arrearage Carrying Cost NEB review. No adjustment was made.

- Assumptions: None. All data were from CA utility inputs.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	C	*	D	*	F	*	G	*	J	*	K		
Year	kWh Saved		On CARE		kWh Rate		Inflation		kWh CARE Discount		Adjust Prog. Horizon		Adjust # Measures	=	Annual Participant Impact
2020	345.1		83%		$0.12		1.00		35%		1		1		$12.03
2021	345.1		83%		$0.12		1.00		35%		1		1		$12.03
2022	345.1		83%		$0.12		1.00		35%		1		1		$12.03
2023	345.1		83%		$0.12		1.00		35%		1		1		$12.03
2024	345.1		83%		$0.12		1.00		35%		1		1		$12.03

	B	*	C	*	E	*	F	*	H	*	J	*	K		
Year	Therms Saved		On CARE		Therm Rate		Inflation		Therm CARE Discount		Adjust Prog. Horizon		Adjust # Measures	=	Annual Participant Impact
2020	3.5		83%		$1.26		1.00		20%		1		1		$0.73
2021	3.5		83%		$1.26		1.00		20%		1		1		$0.73
2022	3.5		83%		$1.26		1.00		20%		1		1		$0.73
2023	3.5		83%		$1.26		1.00		20%		1		1		$0.73
2024	3.5		83%		$1.26		1.00		20%		1		1		$0.73

- Limitations
  - Use of ESA kWh savings per household that were considerably higher than those estimated for 2017 in the most recent ESA impact evaluation.

- Applicability
  - kWh savings may not apply to most utilities in 2020.

- Duplication: This NEB does not duplicate another benefit calculated in this NEB analysis or other benefits that are already accounted for in the ESA cost-benefit analysis.

B. Excluded Societal NEBs

This section reviews the societal NEBs that were not included in the Excel tool. The following benefits were excluded.

- Job Creation / Labor Income
- Economic Tax Impacts
- Emissions on Illnesses & Deaths
- Water / Wastewater Infrastructure
- Reduced Sick Days from Work
- Reduced CO Poisonings
- Reduced Asthma Incidents
- Health Care Prescription Adherence
- Low Birthweight Babies Costs

1. Job Creation/Labor Income

The manufacture and installation of ESA measures creates additional jobs in local, regional, and national economies. The 2019 report noted that dozens of studies from the early 2000s to 2016 valued this NEB, making it important to include.

This NEB was excluded, as it is accounted for in the economic output NEB. It was also not included in the 2019 model.

- ESA Impact: The 2019 study stated that the manufacture and installation of ESA measures will lead to increased jobs, both locally and in larger economies. They estimated an $11.24 average annual benefit per participant every year from 2020 to 2024.

- Data: The following data were used as inputs in the research.

Table A-4A
Reduced Job Creation/Labor Income Data Inputs

	Input	Source	Value	Notes
A	Average ESA Cost	Utilities	$548.85	
B	Inflation Factor	Bureau of Labor Statistics	1.00	Assumed current
C	Net Labor Multiplier	RIMS II Run, Skumatz unpub., 2016 CA Data	0.18	
D	Weighted Measure Life (Years)	Utilities	1	Sum (Measure Lifetime * # of Measure)/Total # of Measures = 14.4, overridden with 1.
E	Adjustment Factor Program Horizon	Utilities	.11	Reduced to less than one if discounted remaining weighted measure life is less than one.
F	Adjustment Factor # of Measures	Utilities	1	Reduced to less than one if average # of causal measures per household is less than one.

  - Average ESA Cost: The ESA expenditures per participant household were $548.85 as shown in the Economic Output NEB review.

  - Net Labor Multiplier: The net labor multiplier per dollar spent was calculated as 0.18 using a RIMS II model run by Skumatz (unpublished) with 2016 CA data. See the discussion in the Economic Output NEB review for information on the RIMS II model.

  - Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for societal NEBs (3%) is less than one. The weighted measure life was overridden with a value of one because the model estimated the labor benefits from a one-time ESA expenditure. The Program Horizon Adjustment Factor was calculated as 0.11.

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household is less than one. This is the same calculation as in the Reduced Arrearage Carrying Cost NEB review. No adjustment was made.

- Assumptions: Key assumptions that were made.
  - The ESA labor impact multiplier is equal to the previously calculated RIMS II multiplier that used 2016 CA data.
  - Use of all measure costs, as opposed to those that were incurred in CA.
  - Exclusion of other ESA costs including administration and evaluation.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	E	*	F		
Year	Expenditures		Inflation		Output Multiplier		Adjust Prog. Horizon		Adjust # Measures	=	Annual Participant Impact
2020	$548.85		1.00		.18		.11		1		$11.24
2021	$548.85		1.00		.18		.11		1		$11.24
2022	$548.85		1.00		.18		.11		1		$11.24
2023	$548.85		1.00		.18		.11		1		$11.24
2024	$548.85		1.00		.18		.11		1		$11.24

- Limitations
  - Use of a RIMS II multiplier calculated in a previous study.

- Applicability
  - We cannot assess whether the labor multiplier is applicable to the 2020 ESA impact because information on the model specification and the model output was not available.

- Duplication: This NEB may duplicate the impact of other NEBs.
  - The labor output multiplier may include duplication of benefits in the Economic Output and Tax Impact multipliers. Since neither the 2019 report nor the spreadsheet tool detailed the model specifications or output, this cannot be assessed.

2. Economic Tax Impacts

The manufacture and installation of ESA measures creates additional economic activity, which impacts the type and quantity of taxes collected. The 2019 report noted that a few studies from the mid-2000s valued this NEB, but that it is not typically included in NEB analysis.

This NEB was excluded, as it is accounted for in the economic output NEB. It was also not included in the 2019 model.

- ESA Impact: The 2019 study stated that the manufacture and installation of ESA measures will lead to increased tax revenue in local, regional, and national economies. They estimated a $6.25 average annual benefit per participant every year from 2020 to 2024.

- Data: The following data were used as inputs in the research.

Table A-5A
Reduced Economic Tax Impacts Data Inputs

	Input	Source	Value	Notes
A	Average ESA Cost	Utilities	$548.85	
B	Inflation Factor	Bureau of Labor Statistics	1.00	Assumed current
C	Net Tax Multiplier	RIMS II Run, Skumatz unpub., 2016 CA Data	0.10	
D	Weighted Measure Life (Years)	Utilities	1	Sum (Measure Lifetime * # of Measure)/Total # of Measures = 14.4, overwritten with 1.
E	Adjustment Factor Program Horizon	Utilities	0.11	Reduced to less than one if discounted remaining weighted measure life is less than one.
F	Adjustment Factor # of Measures	Utilities	1	Reduced to less than one if average # of causal measures per household is less than one.

  - Average ESA Cost: The ESA expenditures per participant household were $548.85 as shown in the Economic Output NEB review.

  - Net Tax Multiplier: The Net Tax Multiplier per dollar spent was calculated as 0.10 using a RIMS II model run by Skumatz (unpublished) with 2016 CA data. RIMS II does not calculate tax effects, so the economic impact multiplier of .40 was divided by four to calculate this impact. The 2019 spreadsheet stated that the ratio of ¼ was determined using IMPLAN model runs on 1999 California data, but did not explain how it was developed. The specifications and output for these models were not included in the 2019 report or spreadsheet tool.

    See the discussion in the Economic Output NEB review for the description of the RIMS II model.

  - Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for societal NEBs (3%) is less than one. The weighted measure life was overridden with a value of one because the model estimated the labor benefits from a one-time ESA expenditure. The Program Horizon Adjustment Factor was calculated as 0.11.

  - Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household is less than one. This is the same

calculation as in the Reduced Arrearage Carrying Cost NEB review. No adjustment was made.

- Assumptions: Key assumptions that were made.
  - The ESA Tax multiplier was set equal to one fourth of the ESA output multiplier that was previously calculated with the RIMS II model using 2016 CA data.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	E	*	F		Annual
Year	Expenditures		Inflation		Tax Multiplier		Adjust Prog. Horizon		Adjust # Measures	=	Participant Impact
2020	$548.85		1.00		.10		0.11		1		$6.25
2021	$548.85		1.00		.10		0.11		1		$6.25
2022	$548.85		1.00		.10		0.11		1		$6.25
2023	$548.85		1.00		.10		0.11		1		$6.25
2024	$548.85		1.00		.10		0.11		1		$6.25

- Limitations
  - Use of one fourth of the RIMS II economic impact multiplier calculated in a previous study.
  - Use of an IMPLAN model to estimate the adjustment from the output multiplier to the tax impact.
  - Use of all measure costs, as opposed to those that were incurred in CA.
  - Exclusion of other ESA costs including administration and evaluation.

- Applicability
  - We cannot assess whether the tax multiplier is applicable to the 2020 ESA impact because information on the model specification and the model output was not available.
  - We cannot assess whether the adjustment of 1/4 calculated from the IMPLAN model applies to the 2020 ESA impact because information on the model specification and the model output was not available.

- Duplication: This NEB may duplicate the impact of other NEBs.
  - The tax multiplier may include duplication of benefits in the Economic Output and Labor multipliers. Since neither the 2019 report nor the spreadsheet tool detail the model specifications or output, this cannot be assessed.

3. Emissions on Illnesses and Deaths

Emissions from power generation negatively impact public health. The 2019 report noted that many studies estimated an emissions impact, but only a few extended that impact to public health.

This NEB was excluded but may be reevaluated in a future study.

- ESA Impact: The 2019 study stated that ESA measures reduce emissions from electricity generation, which reduces the number of illnesses and deaths. They estimated a $43.06 average annual benefit per participant in 2020 and adjusted it for inflation in following years.

- Data: The following data were used as inputs in the research.

Table A-6A
Reduced Emissions on Illnesses and Deaths Data Inputs

	Input	Source	Value	Notes
A	Average kWh Saved	Utilities	345.1	Sum(Measure Savings * # of Measure)/Total Participants
B	Illnesses and Death Cost Impact per kWh	EPA's COBRA model, Skumatz unpub., 2019 CA Data	$0.12	
C	Inflation Factor	Bureau of Labor Statistics	1.05-1.15	
D	Weighted Measure Life (Years)	Utilities	14.4	Sum (Measure Lifetime * # of Measure)/Total # of Measures
E	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life is less than one.
F	Adjustment Factor # of Measures	Utilities	1	Reduced to less than one if average # of causal measures per household is less than one.

  - Average kWh Saved: The kWh savings per participant was calculated from utility data by dividing the estimated savings of all measures installed in a year by the number of participants in that year.
    - Estimated Savings of All Measures: 8,115,235 kWh
    - Total Number of Participants: 23,518
    - Average kWh Saved per Household: $\frac{Savings\ of\ All\ Measures}{Total\ Number\ of\ Participants}$ = 345.1 kWh

    The spreadsheet tool also has the capability to include the therm savings per participant, but did not do so.

    The most recent 2019 ESA Impact Evaluation for program years 2015 through 2017 found that average 2017 electric savings ranged from 30 to 187 kWh (varied by utility).[75] The estimate of 345.1 kWh saved is considerably higher.

[75] DNV-GL, Energy Savings Assistance Program Impact Evaluation Program Years 2015-2017, Southern California Gas Company, April 2019.

Table A-6B
Measure Savings Included in Average kWh Saved Calculation

Measure Name	Annual kWh Savings	# of Measures	Total kWh Savings
High Efficiency Clothes Washer (with electric water heating)	208	21	4,368
Refrigerator	463	1,002	463,926
Low-flow showerhead & thermostatic valve (with electric water heating)	64.98	135	8,772
Domestic Hot Water Bundle (with electric water heating)	102	4,054	413,508
Heat pump water heater	2799	25	69,975
Tub diverter (with electric water heating)	52.56	75	3,942
Enclosure bundle (with electric space heating and A/c)	137	2,258	309,346
Enclosure bundle (with gas space heating and A/c)	137	3,161	433,057
Central AC tune-up	25	3	75
Duct Testing & Sealing (with electric space heating and A/c)	101	1	101
Duct Testing & Sealing (with gas space heating and A/c)	101	136	13,736
Fan control	111	25	2,775
PCT (with CAC and gas heat)	150	875	131,250
Room AC Replacement	-102	203	-20,706
Exterior Hard wired LED fixtures	77.61	2,734	212,186
Interior Hard wired LED fixtures	68.17	8,419	573,923
LED diffuse bulb	14	148,722	2,082,108
LED reflector bulb	26.88	8,045	216,250
LED Torchiere	68.17	14,817	1,010,075
Smart Power Strip	64	9,456	605,184
Smart strip Tier 2	133.9	7,501	1,004,384
Variable speed pool pump	1154	500	577,000
Total	9,630	213,793	8,115,235
Average kWh Saved = 345.1 kWh			

- Illness and Death Cost Impact per kWh: The ESA impact on the number of illnesses and deaths was calculated as $0.12 per kWh saved based on a run of the EPA Co-Benefits Risk Assessment Health Screening and Mapping Tool (COBRA)[76] by Skumatz (unpublished) using 2018 CA data. The resulting value was then adjusted for inflation. The specifications and output for this model were not included in the 2019 report or spreadsheet tool.

[76] EPA, 2018, https://www.epa.gov/sites/production/files/2018-05/documents/cobra_user_manual_may2018_508.pdf

The COBRA model includes the following health endpoints.

- Mortality (Adult)
- Infant Mortality
- Acute Myocardial Infarction (Heart Attack), Nonfatal
- Hospitalizations, All Cardiovascular
- Hospitalizations, All Respiratory
- Hospitalizations, Asthma
- Hospitalizations, Chronic Lung Disease
- Asthma ER Visits
- Acute Bronchitis
- Lower Respiratory Symptoms
- Upper Respiratory Symptoms
- Minor Restricted Activity Days (MRAD)
- Work Loss Days
- Asthma exacerbations

COBRA requires the following inputs.

- Location: Users can select individual counties, states, or the entire country.
- Emissions Category: Industrial, electric utilities, or highway vehicles.
- Electric Generation or Emission Rates: COBRA accepts either the amount of electric generation or the amount of pollutants released over time.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for societal NEBs (3%) is less than one.

  Factor = minimum of 1 or
  pmt(discount rate, yr horizon, PV(discount rate, measure life, 1))

  - Discount Rate = 3% (utility data)
  - Year Horizon = 10 years (utility data)
  - Weighted Measure Life = $\frac{\sum(Measure\ Lifetime * \#\ of\ Measures)}{Total\ \#\ of\ Measures}$ = 14.4
  - pmt(discount rate, yr horizon, PV(discount rate, measure life, 1)) = 1.36
    If the weighted measure life was less than the program horizon, this function would determine the amount by which the NEB should be reduced.

  Table II-1C displays the measures included in the calculation of weighted measure life. This NEB included those same measures.

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household is less than one. This is the same

calculation as in the Reduced Arrearage Carrying Cost NEB review. No adjustment was made.

- Assumptions: Key assumptions that were made.
  - This NEB exclusively uses utility data and established EPA models.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	B	*	E	*	F		
Year	kWh Saved		Illness & Death Impact per kWh		Inflation		Adjust Prog. Horizon		Adjust # Measures	=	Annual Participant Impact
2020	345.1		$0.12		1.05		1.0		1.0		$43.06
2021	345.1		$0.12		1.07		1.0		1.0		$44.09
2022	345.1		$0.12		1.10		1.0		1.0		$45.15
2023	345.1		$0.12		1.13		1.0		1.0		$46.23
2024	345.1		$0.12		1.15		1.0		1.0		$47.34

- Limitations
  - Unknown because model specifications were not available.
  - Gas savings impact on emissions was not included.

- Applicability
  - This NEB exclusively uses utility data and established EPA models.

- Duplication: This NEB may duplicate the impact of other NEBs.
  - The COBRA estimate may include the societal NEB for Reduced Sick Days from Work because it includes estimates of lost days from work as a health endpoint in the model.
  - The COBRA estimate may include the societal NEB for Reduction in Asthma Incidences because it includes estimates of asthma costs and other respiratory conditions as health endpoints in the model.
  - The impact of emissions on illnesses and deaths may duplicate the avoided cost of greenhouse gas emissions that is already included in the cost-effectiveness analysis.

4. Water/Wastewater Infrastructure

Some of the ESA measures reduce water usage. The 2019 report noted that participant-level water savings are studied widely but few NEB studies addressed the societal benefits from these water savings.

This NEB was excluded, as there is no defensible estimation method available. The values used in the 2019 model do not match the sources that were referenced.

- ESA Impact: The 2019 study stated that the installation of some ESA measures reduces water usage, and thus the stress on water infrastructure. They estimated a $16.65 average annual benefit per participant in 2020 and adjusted that for inflation in the following years.

- Data: The following data were used as inputs in the research.

Table A-7A
Reduced Water and Wastewater Infrastructure Demand Data Inputs

	Input	Source	Value	Notes
A	Water Savings (Gallons per HH/Year)	Utilities	2,373	
B	Gallons to CCF	Conversion Metric	1/748	CCF = Hundred Cubic Feet
C	Water Rates per CCF	2015 CPUC / Navigant[77]	$0.59	
D	Inflation Factor	Bureau of Labor Statistics	1.11-1.22	
E	Sewer Rates per CCF	2015 CPUC / Navigant	$4.14	
F	Weighted Measure Life (Years)	Utilities	1	Sum (Measure Lifetime * # of Measure)/Total # of Measures, but NEB calculation overrides with 1.
G	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if average remaining weighted measure life is less than one.
H	Adjustment Factor Number of Measures	Utilities	1	Reduced to less than one if average # of causal measures per household is less than one.

  - Water Savings: Average water savings were calculated by multiplying the average water savings of each applicable group of ESA measures by the number of those measures per household. Table A-7B displays the data used in the calculation for each of the applicable measures.

Table A-7B
Reduced Water and Wastewater Infrastructure Impact Calculation

Measure Group Name	Savings Source	# of Measures	# of Measures per Household	Gallons Saved per Measure	Water Savings (Gallons per HH/Year)
Showerheads	EPA 2019[78]	4,500	0.19	2,900	554.89
DHW Bundles*	EPA 2019	20,256	0.86	1,800	1,550.34
Tub Diverters	EPA 2017[79]	2,500	0.11	1,500	159.45
Clothes Washers	A4WE 2017[80]	426	0.02	6,000	108.68

[77] CPUC / Navigant "Water/Energy Cost-Effectiveness Analysis" April 2015, Table ES-4; (pg. xvii).
[78] USEPA, WaterSense, www.epa.gov/watersense/showerheads, 2019.
[79] USEPA, WaterSense, "Bath and Shower Diverter NOI Public Meeting Presentation", www.epa.gov/watersense/bath-and-shower-diverter-update, 2017.
[80] Alliance for Water Efficiency, www.allianceforwaterefficiency.org/Residential_Clothes_Washer_Introduction.apx, 2019. This link no longer works.

Measure Group Name	Savings Source	# of Measures	# of Measures per Household	Gallons Saved per Measure	Water Savings (Gallons per HH/Year)
Total		27,682	1.18		2373.36

*The 2019 report and spreadsheet tool do not state what is included in DHW bundles, but the 2015-2017 ESA Impact Assessment states that "Other Hot Water" bundles included faucet aerators, low flow showerheads, thermostatic shower valves, and tub diverter/water spouts.

The following measure savings were used.

- Showerheads: The EPA's WaterSense program website states that the average family could save up to 2,700 gallons of water annually by using WaterSense labelled showerheads. The 2019 spreadsheet tool listed 2,900 gallons as the annual savings but did not state why this differs from the WaterSense estimate.

- DHW Bundle: The spreadsheet estimated this value as 50 percent of the total estimated savings from showerheads and faucet aerators based on the assumption that half of all Bundles come with these items. This resulted in annual savings of 1,800 gallons.

- Tub Diverter: The EPA's WaterSense program does not currently certify tub diverters but issued a Notice of Intent in 2016 to develop the certification. In a 2017 presentation, the EPA estimated that the average household could save 1,500 gallons per year by replacing all old, leaky diverters with new models. This was estimated using an average leak rate of .3 gallons per minute (gpm).

  This presentation was based on two field studies.
  - The 2011 Taitem Engineering, PC, LLC[81] study for the New York State Housing and Community Renewal Weatherization Assistance Program found that 34 percent of the 120 apartments and houses surveyed had tub diverters that leaked more than .1 gpm. Of the leaking diverters, the average one leaked .8 gpm.

  - The 2015 field study conducted in Fort Carson, Colorado by Johnson Controls, Inc. estimated an average leak of .7 gpm, but only looked at diverters greater than ten years old.

- Clothes Washer: The spreadsheet tool cited the Alliance for Water Efficiency (A4WE) estimate of 6,000 gallons savings per measure per year. The link

[81] Taitem Engineering, "Taitem TechTip: Leaking Shower Diverters", http://www.taitem.com/wp-content/uploads/Diverter-Valve-Tech-Tip-2011.7.20.pdf, 2011.

provided to this estimate in the spreadsheet no longer works and the original report could not be found.

The following information was not available to address the reliability of the research and applicability of the savings estimates to the CA ESA.

- National Estimates: The national estimates were based on studies in other parts of the country. California faces unique drought conditions that may impact water usage and the characteristics of participants' homes. Comparability to the ESA program cannot be known without understanding how California differs.

- Avoided Water Rates per CCF: The avoided water rate was estimated as $0.59 per hundreds of cubic feet (CCF) and adjusted for inflation. This estimate referenced a specific table from the 2015 CPUC/Navigant Study, which displayed the Annual Avoided Water Capacity Cost for California. The table presented results in millions of dollars per millions of gallons per day. It was not clear how these data were used to calculate the water rate per CCF included in the 2019 spreadsheet tool.

  The data from the CPUC/Navigant Study cited in the 2019 spreadsheet tool is displayed in Table A-7C. The rates used in the 2019 spreadsheet are also shown below the CPUC/Navigant study findings.

Table A-7C
Annual Avoided Water Capacity Cost (2014 $M/MGD) - CPUC/Navigant Study

Water System Component	Investor-Owned Utility	Municipality Owned Utility
Ocean Desalination	$2.09	$1.43
Brackish Desalination	$1.23	$1.05
Recycled – Tertiary + Disinfection	$0.42	$0.29
Recycled – Membrane Treatment	$1.04	$0.77
Groundwater Facility	$0.33	$0.19
Treatment – Chlorine Disinfection	$0.02	$0.02
Treatment – Contaminant Removal & Disinfection	$0.48	$0.29
Wastewater Treatment	$2.64	$2.02
2019 Spreadsheet Tool Avoided Water Rate = $0.59 per CCF		
2019 Spreadsheet Tool Avoided Sewer Rate = $4.14 per CCF		

- Avoided Sewer Rates per CCF: The avoided sewer rate was estimated as $4.14 per CCF and adjusted for inflation. This estimate cited the same data shown above in

Table A-7C. Again, it was not clear how these data were used to calculate the sewer rate per CCF included in the 2019 spreadsheet tool.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for societal NEBs (3%) is less than one.

  Factor = minimum of 1 or
  pmt(discount rate, yr horizon, PV(discount rate, measure life, 1))

  - Discount Rate = 3% (utility data)
  - Year Horizon = 10 years (utility data)
  - Weighted Measure Life = $\frac{\sum(Measure\ Lifetime * \#\ of\ Measures)}{Total\ \#\ of\ Measures}$ = 10.0

    The spreadsheet tool specified an override value of 1 for the weighted measure life but still used the 10-year weighted measure life.

  - pmt(discount rate, yr horizon, PV(discount rate, measure life, 1)) = 1.00
    If the weighted measure life was less than the program horizon, this function would determine the amount by which the NEB should be reduced.

Table A-7D
Measures Included in Reduced Water and Wastewater Infrastructure Demand Calculation

Measure Name	Measure Lifetime	# of Measures	Lifetime * # Measures
High Efficiency Clothes Washer (with electric water heating)	11	21	231
High Efficiency Clothes Washer (with gas water heating)	11	405	4,455
Low-flow showerhead & thermostatic valve (with electric water heating)	10	135	1,350
Low-flow showerhead & thermostatic valve (with gas water heating)	10	4,365	43,650
Domestic Hot Water Bundle (with electric water heating)	10	4,054	40,540
Domestic Hot Water Bundle (with gas water heating)	10	16,202	162,020
Tub diverter (with electric water heating)	10	75	750
Tub diverter (with gas water heating)	10	2,425	24,250
Total	82	27,682	277,246
Average Measure Life = 10 Years			

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household is less than one.

  Factor = minimum of 1 or average number of causal measures

  - Total Number of Measures = 27,682
  - Total Number of Participants = 23,518
  - Average Number of Causal Measures = $\frac{\sum(\#\ of\ Measures)}{Total\ \#\ of\ Participants}$ = 1.18

  This adjustment factor can be turned on or off by utilities in the sensitivity options.

- Assumptions: Key assumptions that were made.
  - Water savings equal those from national studies by the EPA, the Alliance for Water Efficiency, and EnergyStar.
  - Water savings of DHW Bundles equal 50 percent of the savings from low flow showerheads and faucet aerators. The spreadsheet tool estimated that 50 percent of all DHW Bundles included showerheads and aerators and did not include other items but did not explain how this percentage was calculated.
  - Avoided water and sewage rates equal those from the 2015 CPUC/Navigant study.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	(C	+	D)	*	E	*	G	*	H		
Year	Water Savings		Convert Gallons to CCF		Avoid Water Cost / CCF		Avoid Sewer Cost / CCF		Inflation		Adjust Prog. Horizon		Adjust # Measures	=	Annual Participant Impact
2020	2,373		1/748		$0.59		$4.14		1.11		1.0		1.0		$16.65
2021	2,373		1/748		$0.59		$4.14		1.14		1.0		1.0		$17.05
2022	2,373		1/748		$0.59		$4.14		1.16		1.0		1.0		$17.46
2023	2,373		1/748		$0.59		$4.14		1.19		1.0		1.0		$17.88
2024	2,373		1/748		$0.59		$4.14		1.22		1.0		1.0		$18.31

- Limitations
  - Use of national reports to estimate ESA measure impact.
  - Use of 2015 avoided water and sewer rates from CPUC/Navigant study.

- Applicability
  - Household water savings impacts from national reports may not be applicable to California.
  - CPUC/Navigant values for water and sewage rates were from California estimates but may not be applicable for 2020.

- Duplication: This NEB does not duplicate another benefit calculated in this NEB analysis or other benefits that are already accounted for in the ESA cost-benefit analysis.

5. Reduced Sick Days from Work

The ESA program may result in fewer sick days because of the program's impact on health. The 2019 report noted that participant-level sick day reductions are studied widely, but few NEB studies address the societal NEB from reducing the number of sick days.

This NEB was excluded, as the study referenced in the 2019 model is from 2001 and the more recent National WAP Evaluation found no impact on this indicator. This NEB also was not included in the 2019 model.

- ESA Impact: The 2019 study stated that ESA measures reduce the number of sick days, and thus the loss in productivity for employers. They estimated a $0.78 average annual benefit per participant in 2020 and adjusted that for inflation in the following years.

  This ESA benefit is specific to the societal cost of sick days, and not the cost related to the illness.

- Data: The following data were used as inputs in the research.

Table A-8A
Reduced Sick Days from Work Data Inputs

	Input	Source	Value	Notes
A	WAP HH with Employed Primary Wage Earner	WAP National Occupant Survey, APPRISE 2018[82]	31%	
B	HH with Sick Leave	Bureau of Labor Statistics 2019 Report[83]	47%	Percentage of individuals in private industry earning lowest 25% of salaries.
C	ESA Impact on Sick Leave	Skumatz LIPPT 2001[84]	0.07	
D	Estimated Hourly Wage	2013 National Low-Income Housing Coalition[85]	$17.99	
E	Inflation Factor	Bureau of Labor Statistics	1.13-1.24	
F	Hours per Workday	Assumed	8	
G	Weighted Measure Life (Years)	Utilities	13	Sum (Measure Lifetime * # of Measure)/Total # of Measures
H	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
I	Adjustment Factor # of Measures	Utilities	.47	Reduced to less than one if average # of causal measures per household was less than one.

[82] APPRISE, "National Weatherization Assistance Program Evaluation", 2018, http://www.appriseinc.org/wp-content/uploads/2018/02/WAP-Non-Energy-Benefits-Results-Report.pdf.
[83] https://www.bls.gov/news.release/pdf/ebs2.pdf, table 6.
[84] Skumatz LIPPT 2001, pg. 123.
[85] National Low-Income Housing Coalition, 2013, https://nlihc.org/oor/2013/ca.

- WAP Households with an Employed Primary Wage Earner: The percentage of households with an employed individual comes from a 2018 APPRISE study.

  - 2018 APPRISE Study: This study used data from the Weatherization Assistance Program (WAP) Evaluation. Results from the evaluation's national occupant survey were used to develop this estimate.

    WAP provides weatherization measures through grantees and subgrantees to households with income at or below 150 percent of the federal poverty level or 60 percent of state median income.

    The occupant survey collected data on whether the WAP participants had an employed household member. The 2019 ESA study used the pre-treatment WAP employment rate of 31 percent as the estimate of the employment rate for ESA participants.

    The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.
    - Employment by region: The APPRISE study did not break down employment by region. Comparability to the ESA program could not be known without understanding whether the national findings applied to the level of employment for ESA participants in California in 2020.

- Households with Sick Leave: The percentage of households with paid sick leave employment benefits was from the Bureau of Labor Statistics 2019 report on Employee Benefits in the United States. The value was for the lowest 25 percent of earners.
  - Bureau of Labor Statistics 2019 Report: The data in this report were from the March 2019 National Compensation Survey (NCS), which completed interviews with 15,822 individuals employed by civilian, private industry, and government out of 22,954 included in the sample for a completed interview rate of 69 percent.

    Selected results from the study are displayed in Table A-8B. The 2019 spreadsheet tool used the paid sick leave figure for the lowest 25 percent of earners, which is 47 percent.

Table A-8B
NCS March 2019 Paid Sick Leave Findings

	Paid Sick Leave
Lowest 10 percent of earners	30%
Lowest 25 percent of earners	47%
Second 25 percent of earners	77%

	Paid Sick Leave
Third 25 percent of earners	86%
Highest 25 percent pf earners	90%
Northeast	76%
South	68%
Midwest	66%
West	86%

The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.

- Regional variation: The NCS is a national study and the percentage of individuals with paid sick leave varied by geographic region. Since the Western region had a significantly higher rate of paid sick leave than the other three regions, the national estimate for the lowest 25 percent of earners used in the 2019 spreadsheet tool may have been an underestimate.

- Government workers: The NCS estimates were for individuals employed in private industry and excluded those employed by state and local government, which had higher rates of paid sick leave across all categories. If the ESA program included government workers, the statistic may have been an underestimate.

- ESA Sick Leave: The ESA impact of seven percent was based on the Skumatz 2001 LIPPT study.
  - Skumatz 2001 LIPPT Study: The study fielded a survey in 2001 with 321 LIEE participants. Respondents were evenly divided across the four utilities (PG&E, SDG&E, SCE, and SCG).

    The LIEE program provided the following measures.
    - CFL Light Bulbs
    - Refrigerators
    - Aerators
    - Low Flow Showerheads
    - Water Heater Blanket
    - Furnace
    - Caulking
    - Insulation
    - Home Repairs

    The sick leave results referenced throughout the LIPPT study are displayed in Table A-8C.

- Respondents were asked if they noticed any changes in the number of colds or similar illnesses after the weatherization measures were completed.
- If they responded yes, they were asked to report the change in the number of sick days.
- If they answered with zero days, no change, or don't know, they were asked whether it was more or fewer.

Table A-8C
Skumatz 2001 LIPPT Analysis of LIEE Households

	Sick Leave
Average reduction in the number of sick days lost from work	7.1%
Any Change	16%
If Any:	
Somewhat Fewer	26%
Many Fewer	56%

- Estimated Hourly Wage: The estimated hourly wage was $17.99 based on the value for a California renter in the 2013 National Low-Income Housing Coalition Out of Reach Report, adjusted for inflation. The 2013 report could not be found at the specified link. The updated report lists the average renter's wage as $22.79 in 2019.[86]

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for societal NEBs (3%) was less than one.

  Factor = minimum of 1 or
  pmt(discount rate, yr horizon, PV(discount rate, measure life, 1))

  - Discount Rate = 3% (utility data)
  - Year Horizon = 10 years (utility data)
  - Weighted Measure Life = $\frac{\sum(Measure\ Lifetime * \#\ of\ Measures)}{Total\ \#\ of\ Measures}$ = 13.0
  - pmt(discount rate, yr horizon, PV(discount rate, measure life, 1)) = 1.25
    If the weighted measure life was less than the program horizon, this function would determine the amount by which the NEB should have been reduced.

[86] National Low Income Housing Coalition, "Out of Reach Report 2019", https://reports.nlihc.org/oor.

Table A-8D displays the measures included in the calculation of weighted measure life. These measures were included based on settings that can be modified by the utility.

Table A-8D
Measures Included in Reduced Sick Days Calculation

Measure Name	Measure Lifetime	# of Measures	Lifetime * # Measures
Gas Furnace Clean and Tune	5	3,634	18,170
Gas furnace pilot light conversion	13	18	234
Gas Furnace Repair/Replace	20	4,933	98,660
PCT (with CAC and gas heat)	11	875	9,625
PCT (with gas heat and no CAC)	11	1,625	17,875
Total	95	11,085	144,564
Average Measure Life = 13.0 Years			

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one.

  Factor = minimum of 1 or average number of causal measures

  - Total Number of Measures = 11,085
  - Total Number of Participants = 23,518
  - Average Number of Causal Measures = $\frac{\sum(\#\ of\ Measures)}{Total\ \#\ of\ Participants}$ = 0.47

  This adjustment factor can be turned on or off by utilities in the sensitivity options.

- Assumptions: Key assumptions that were made.
  - The percentage of ESA households with an employed worker was 31 percent, equal to the finding of the APPRISE 2018 study.
  - The percentage of employees with paid sick leave was 47 percent, equal to the finding in the 2017 Bureau of Labor Statistics (BLS) report for the lowest 25 percent of earners nationally.
  - ESA reduces sick days by seven percent, equal to the finding from the Skumatz 2001 LIPPT study.
  - The estimated hourly wage was $17.99, equal to the finding from a 2013 National Low-Income Housing Coalition Report.
  - Eight-hour workday.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	D	*	E	*	F	*	H	*	I		
Year	Wage Earner		% with Sick Leave		ESA Sick Leave Impact		Wage		Inflation		Hrs in Workday		Adjust Prog. Horizon		Adjust # Measures	=	Annual Participant Impact
2020	31%		47%		0.07		$17.99		1.13		8		1.0		0.47		$0.78
2021	31%		47%		0.07		$17.99		1.16		8		1.0		0.47		$0.80
2022	31%		47%		0.07		$17.99		1.18		8		1.0		0.47		$0.82
2023	31%		47%		0.07		$17.99		1.21		8		1.0		0.47		$0.84
2024	31%		47%		0.07		$17.99		1.24		8		1.0		0.47		$0.86

- Limitations
  - Use of percentage of employed participants from 2013 WAP survey.
  - Use of percentage of employees with paid sick leave for bottom 25 percent of private industry workers from 2017 BLS report.
  - Use of 2001 LIPPT study impact on sick leave.
  - Use of hourly wage from the 2013 National Low-Income Housing Coalition Report adjusted for inflation.

- Applicability
  - Percentage of households with an employed worker may not apply to ESA participants in 2020.
  - Percentage of employees with paid sick leave nationally may not apply to ESA participants in 2020.
  - Estimate of the sick leave impact may not apply to 2020 ESA participants.
  - Hourly wage may not apply to 2020 given California minimum wage increases.
  - Hourly wage for renters may not apply to ESA participants who are homeowners.
  - Eight-hour workday may not apply to employed ESA participants.

- Duplication: This NEB did not duplicate another benefit calculated in this NEB analysis or other benefits that were already accounted for in the ESA cost-benefit analysis.

6. Reduced CO Poisonings

Deaths, hospitalizations, and emergency department visits due to carbon monoxide poisoning result in insurance, Medicaid and Medicare payouts and loss of life. The 2019 report noted that reducing CO poisoning was an NEB included in over a dozen studies from 2011 to 2018 but did not state whether those studies included the societal benefit or only the participant benefit.

This NEB was excluded because the number of CO poisonings is too low to measure a significant impact from the program. It was also excluded from the 2019 study.

- ESA Impact: The 2019 study stated that carbon monoxide monitors would have reduced the number of CO poisonings and deaths, which would have benefitted insurance companies and government programs and reduced loss of life. They estimated a $0.00 average annual benefit per participant in 2020 and would have adjusted that for inflation in the following years (no CO monitors were included in the utility data).

  Most of this NEB would have come from the calculation of avoided CO deaths. The estimated impact was $24.07 per participant in 2020 before adjusting for the number of CO monitors per household. The reduction in hospitalizations and emergency department visits were $0.04 and $0.15, respectively, per participant in 2020.

- Data: The following data were used as inputs in the research.

Table A-9A
Reduced CO Deaths and Poisonings Data Inputs

	Input	Source	Value	Notes
A	Individuals per Household	2010 U.S. Census[87]	2.58	
B	CO Deaths per Person	Sircar et al. 2015[88]	0.0000015	
C	ESA Impact on Deaths	Yoon et al. 1998[89]	65%	
D	Life Value	EPA Mortality Risk Valuation 2006[90]	$7,400,000	
E	Inflation Factor	Bureau of Labor Statistics	1.311-1.441	
F	CO Hospitalizations/ Person	Stearns and Sircar 2019[91]	0.0000041	
G	ESA Hospitalization Impact	Krenzelok et al. 1996[92]	92%	
H	Cost of CO Hospitalization	Hampson 2015[93]	$15,569	Acute medical costs, not lifetime.
I	Inflation Factor	Bureau of Labor Statistics	1.05-1.15	
J	Payment Out of Pocket	MEPS[94]	34%	

[87] 2010 U.S. Census, "Households and Families: 2010", *2010 Census Briefs*, https://www.census.gov/prod/cen2010/briefs/c2010br-14.pdf
[88] Sircar, Kanta; Clower, Jacquelyn; Shin, Mi Kyong; Bailey, Cathy; King, Michael; and Yup, Fuyuen; "Carbon monoxide poisoning deaths in the United States, 1999 to 2012", *The American Journal of Emergency Medicine*, September 2015, https://www.sciencedirect.com/science/article/pii/S0735675715003800
[89] Yoon et al. "Deaths From Unintentional Carbon Monoxide Poisoning and Potential for Prevention With Carbon Monoxide Detectors", *Journal of the American Medical Association*, https://www.ncbi.nlm.nih.gov/pubmed/9496987, 1998.
[90] EPA, 2006, https://www.epa.gov/environmental-economics/mortality-risk-valuation
[91] Stearns, Dorothy and Sircar, Kanta, "National unintentional carbon monoxide poisoning estimates using hospitalization and emergency department data", *The American Journal of Emergency Medicine*, March 2019, https://www.sciencedirect.com/science/article/pii/S0735675718304649
[92] Krenzelok et al., "Carbon monoxide … the silent killer with an audible solution", *The American Journal of Emergency Medicine* 1996, https://www.ajemjournal.com/article/S0735-6757(96)90159-X/pdf.
[93] Hampson, Neil B., "Cost of accidental carbon monoxide poisoning: A preventable expense", *Preventive Medicine Reports*, 2016 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4733068/pdf/main.pdf
[94] Department of Health and Human Services, MEPS, 2017, https://meps.ahrq.gov/mepstrends/hc_use/.

	Input	Source	Value	Notes
K	% on Medicare/Medicaid	Kaiser Family Foundation 2018[95]	37%	Equal to % on Medicare and Medicaid. Assumes no overlap.
L	CO ED Visits	2010-2013 UNFR Stearns Sircar	0.000048	
M	ESA Impact on ED Visits	Krenzelok et al. 1996	79%	
N	Cost of ED Visit	MEPS	$563.00	
O	Inflation Factor	Bureau of Labor Statistics	1.05-1.15	
P	# of CO Monitors Installed	Utilities	0	
Q	Weighted Measure Life (Years)	Utilities	0	Sum (Measure Lifetime * # of Measure)/Total # of Measures
R	Adjustment Factor Program Horizon	Utilities	0	Reduced to less than one if discounted remaining weighted measure life was less than one.
S	Adjustment Factor # of Measures	Utilities	1	Reduced to less than one if average # of causal measures per household was less than one.

- Individuals per Household: The number of individuals per household was estimated as 2.58 people from the 2010 U.S. Census. This was equal to the total 2010 population of 300.8 million divided by the total number of households, which was 116.7 million. This estimate was slightly below the 2000 estimate of 2.59 and did not include the 8.0 million people who lived in school dormitories, nursing homes, or prisons.

  The 2010 U.S. Census report included the number of individuals per household in California as 2.90, which would have been a more accurate estimate to use for ESA participants.

- CO Deaths per Person: The number of carbon monoxide deaths per person was estimated as 0.0000015 based on the 2015 study by Sircar et al.
  - Sircar et al. 2015 Study: This study used 1999-2012 data from the National Center for Health Statistics' National Vital Statistics System.[96] These data included death certificates for all 50 states and Washington, D.C. The study calculated the number of accidental deaths due to CO poisoning to be 1.46 per million after removing suicides. They calculated this figure by standardizing the crude number of deaths for age using census data for 2000 and 2010 and intercensal or postcensal estimates in all other years. The 2019 spreadsheet tool rounded this to 1.50 deaths.

    The Sircar et al. study estimated the specific effect for California to be 0.68 deaths per million, which was substantially lower than the national average used

[95] Kaiser Family Foundation, https://www.kff.org/other/state-indicator/total-population/?currentTimeframe=0&selectedRows=%7B%22states%22:%7B%22california%22:%7B%7D%7D%7D&sortModel=%7B%22colId%22:%22Location%22,%22sort%22:%22asc%22%7D,

[96] National Center for Health Statistics, National Vital Statistics System, https://www.cdc.gov/nchs/nvss/index.htm.

in the 2019 spreadsheet tool. The study also found that CO poisoning deaths occurred at a much higher rate during winter than any other season, which may explain why California's total was so low. If the California estimate was included instead of the national estimate, it would reduce the CO deaths part of the NEB from $24.07 to $11.06.

The estimates from the Sircar et al. Study are displayed in Table A-9B and compared with the rounded estimate used in the 2019 spreadsheet tool.

Table A-9B
Sircar et al. CO Impact on Death Incidence Results

	Estimate (per million)	Confidence Interval	NEB Estimate (per person)
Sircar et al. 2015 National Estimate	1.46	(1.42, 1.49)	$23.75
2019 Spreadsheet Tool Rounded Estimate	1.50	-	$24.07
Sircar et al. 2015 California Estímate	0.68	(0.60, 0.75)	$11.06

- ESA Impact on Deaths: The ESA impact on the number of deaths was estimated as 65 percent based on the Yoon et al. 1998 study.
  - Yoon et al. 1998 Study: This study used data on 136 deaths linked to CO poisoning from the New Mexico Office of the Medical Investigator in Albuquerque between 1980 and 1995. Of the 80 deaths that occurred in a residence, 52 did not have significant blood alcohol levels, which the authors argue would have allowed an electronic, audible CO detector to save their life. The 2019 spreadsheet tool used 65 percent (52/80) to estimate the percentage of deaths that could have been avoided per CO detector installed.

    The results from the Yoon et al. study are displayed in Table A-9C. The study stated that a carbon monoxide detector could have reduced 65 percent of residential deaths linked to carbon monoxide poisonings as these individuals did not have a high-blood alcohol level.

Table A-9C
Yoon et al. 1998 Impact on CO Deaths Results

Total Residential Deaths 1980-1995	Deaths Preventable with CO Monitor	% Preventable with CO Monitor
80	52	65%

The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.

- Causal Estimate: This study assumed that CO deaths in individuals did not have a significant blood alcohol level could have been saved by an audible detector, but they also note that factors such as deafness and size of the

device may be important. Without a study that explicitly tests this link and others, the percentage of deaths that could be avoided by a CO detector could not be assessed.

- Geography: This study used data from Albuquerque, New Mexico but the percentage of deaths that could be avoided may vary by climate or region.

- Value of a Life: The value of a life is estimated as $7.4 million based on the 2006 EPA valuation, adjusted for inflation. The EPA advised that this figure "be used in all benefits analyses that seek to quantify mortality risk reduction benefits regardless of the age, income, or other population characteristics of the affected population until revised guidance becomes available."[97]

- CO Hospitalizations per Person: The number of hospitalizations due to CO poisonings is estimated as 0.0000041 based on the Stearns and Sircar 2019 study.
  - Stearns and Sircar 2019 study: This study used data from the Healthcare Costs and Utilization Project (HCUP) National Inpatient Sample (NIS). NIS is the largest all-payer inpatient healthcare database in the U.S. The stratified probability sample approximated a 20 percent sample of hospitals nationwide. This study looked exclusively at unintentional non-fire-related CO hospitalizations from 2010 to 2013.

    The Stearns and Sircar study estimated the specific effect for the West region at 2.86 hospitalizations per million, lower than the national average of 4.13 used in the 2019 spreadsheet tool. The study found that hospitalizations from CO poisonings occur at a much higher rate during the winter, which may explain why the West region's total is lower. If the West region estimate was included instead of the national estimate, it would have reduced the hospitalizations subtotal for the NEB from $0.16 to $0.11.

    The estimates from the Sircar et al. Study are displayed in Table A-9D.

Table A-9D
Stearns and Sircar CO Impact on Hospitalizations Results

	Estimate (per million)	Confidence Interval	Estimate (per person)
Stearns and Sircar 2019 National Estimate	4.13	(4.06, 4.20)	$0.06
Stearns and Sircar 2019 West Estimate	2.86	(2.73, 2.99)	$0.05

[97] "Mortality Risk Valuation," EPA, https://www.epa.gov/environmental-economics/mortality-risk-valuation

- ESA Impact on CO Hospitalizations: The ESA impact on the number of hospitalizations was estimated as 92 percent based on the Krenzelok et al. 1996 study.
  - Krenzelok et al. 1996 Study: An advanced cardiac life support paramedic crew investigated 101 CO-related 911 calls in Pittsburgh, PA from January to March 1995. The study found that 92 percent of those without a CO monitor had symptoms of CO poisoning.

    The CO hospitalization results from the study are displayed in Table A-9E.

Table A-9E
Krenzelok et al. 1996 CO Detector Impact on Hospitalizations Results

CO Monitor Present	Total Individuals	Symptomatic Individuals	Percentage Symptomatic
Yes	60	2	7.69%
No	41	24	92.31%
Total	**101**	**26**	**100.00%**

- Cost of CO Hospitalization: The cost of hospitalizations due to CO poisoning was estimated as $15,569 based on the Miller and Bhattacharya 2013 study.[98]
  - Miller and Bhattacharya 2013 Study: This study reported that the mean hospital costs for carbon monoxide poisoning in the HCUP NIS 2007 data was $15,769, based on 243 nonfatal CO-related hospitalizations.

- Payment Out of Pocket: The percentage of medical costs not covered by insurance was estimated to be 34 percent based on the DHHS MEPS estimate for the percentage of people with insurance coverage.
  - DHHS MEPS: The insurance component of the DHHS MEPS survey was administered annually and typically includes around 40,000 private sector establishments and 3,000 state and local government units.

    The 2019 spreadsheet tool did not specify which year of the survey was used in calculating the value of 34 percent. The most recent value available was 29.4 percent from 2017.

    The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.
    - Data year: Comparability to ESA participants cannot be known without knowing which year the data was from and why it was chosen.

[98] The 2019 spreadsheet tool references a Hampson 2015 study, which incorrectly reports the findings of Miller and Bhattacharya 2013 as $15,569 instead of $15,769. This incorrect value is used in the spreadsheet.

- On Medicare/Medicaid: The percentage on Medicare or Medicaid in California was estimated as 37 percent based on Kaiser Family Foundation (KFF) 2018 California data. The KFF data were collected as part of the Census Bureau's American Community Survey (ACS)[99], which includes a one percent sample of the U.S. population. The 2018 ACS had a completed interview rate of 60 percent.

- CO ED Visits: Emergency department visits due to CO poisoning were estimated as .000048 per person based on the Stearns and Sircar 2019 Study.
  - Stearns and Sircar 2019 study: This study used data from the Healthcare Costs and Utilization Project (HCUP) National Emergency Department Sample (NEDS) described above.

    The Stearns and Sircar study estimated the specific effect for the West region to be 24.87 ED visits per million instead of the national average of 48.26. If the West region's estimate was used, it would reduce the ED Visits subtotal for the NEB from $0.04 to $0.02.

    The estimates from the Sircar et al. Study are displayed in Table A-9F.

Table A-9F
Stearns and Sircar CO Impact on ED Visits Results

	Estimate (per million)	Confidence Interval	NEB Estimate (per person)
Stearns and Sircar 2019 National Estimate	48.26	(47.96, 48.55)	$0.02
Stearns and Sircar 2019 West Estimate	24.87	(20.35, 21.08)	$0.01

- ESA Impact on ED Visits: The ESA impact on the number of emergency department visits was estimated as 79 percent based on the Krenzelok et al. 1996 study.
  - Krenzelok et al. 1996: See discussion in this section in the ESA Impact on Hospitalizations for full details regarding this study.

    The CO emergency department visits results from the study are displayed in Table A-9G.

Table A-9G
Krenzelok et al. 1996 Impact on CO ED Visits Results

CO Monitor Present	Total Individuals	Symptomatic Individuals	Percentage Symptomatic
Yes	60	7	21.21%
No	41	26	78.79%

[99] American Community Survey (ACS), U.S. Bureau of the Census, https://www.census.gov/programs-surveys/acs/

CO Monitor Present	Total Individuals	Symptomatic Individuals	Percentage Symptomatic
Total	**101**	**33**	**100.00%**

- Cost of ED Visit: The cost of an emergency department visit was estimated as $563 and referenced the DHHS MEPS mean expenditure for an individual with poisoning by medical and non-medical substances. The spreadsheet then adjusted the value for inflation. However, the MEPS summary tables reported this cost as $1,560 in 2016 and $1,269 in 2017. It was not clear how the $563 figure was calculated.

- Number of CO Monitors Installed: The number of CO detectors per household was estimated as 0 from utility data.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for societal NEBs (3%) was less than one.

  Factor = minimum of 1 or
  pmt(discount rate, yr horizon, PV(discount rate, measure life, 1))

  - Discount Rate = 3% (utility data)
  - Year Horizon = 10 years (utility data)
  - Weighted Measure Life = $\frac{\sum(Measure\ Lifetime * \#\ of\ Measures)}{Total\ \#\ of\ Measures}$ = 0.0
  - pmt(discount rate, yr horizon, PV(discount rate, measure life, 1)) = 0.0
    If the weighted measure life was less than the program horizon, this function would determine the amount by which the NEB should have been reduced.

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one.

  Factor = minimum of 1 or average number of causal measures

  - Total Number of Measures = 0
  - Total Number of Participants = 23,518
  - Average Number of Causal Measures = $\frac{\sum(\#\ of\ Measures)}{Total\ \#\ of\ Participants}$ = 0.0

This adjustment factor can be turned on or off by utilities in the sensitivity options.

- Assumptions: Key assumptions that were made.
  - Household size of 2.58, equal to the finding of the 2010 Census, national data.
  - Chance of a death from CO poisoning of 0.0000015, equal to the finding of the 2015 Sircar et al. 2015 study.
  - ESA impact on deaths of 65%, equal to the finding from the Yoon et al. 1998 study.
  - Chance of a hospitalization from CO poisoning of 0.0000041, equal to the finding of the Stearns and Sircar 2019 study.
  - ESA impact on hospitalizations of 9%, equal to the finding from the Krenzelok et al. 1996 study.
  - Cost of hospitalizations from CO poisoning of $15,569, equal to the finding from the Hampson 2015 study.
  - Payment out of pocket of 3%, equal to MEPS data.
  - Chance of an emergency department visit from CO poisoning of 0.000048, equal to the finding of the Stearns and Sircar 2019 study.
  - ESA impact on emergency department visits of 7%, equal to the finding from the Krenzelok et al. 1996 study.
  - Cost of emergency department visits from CO poisoning of $563, equal to the finding from the DHHS's MEPS survey.

- Calculation: The following calculation was made to compute the annual benefit. Note that the 2019 spreadsheet included the household size twice in the ED impact calculation, increasing the calculated benefit from $0.01 to the $0.04 shown in the table.

	A	*	B	*	C	*	D	*	E	=	Impact on
Year	HH Size		CO Deaths		ESA Impact		Life Value		Inflation		CO Deaths
2020	2.58		0.0000015		65%		$7,400,000		1.311		$24.07
2021	2.58		0.0000015		65%		$7,400,000		1.342		$24.65
2022	2.58		0.0000015		65%		$7,400,000		1.374		$25.24
2023	2.58		0.0000015		65%		$7,400,000		1.407		$25.85
2024	2.58		0.0000015		65%		$7,400,000		1.441		$26.47

	A	*	F	*	G	*	H	*	I	*	(1-J)	*	K	=	Impact on CO
Year	HH Size		CO Hospital		ESA Impact		Cost		Inflation		Payments		Medicare/ Medicaid		Hospitalization
2020	2.58		0.0000041		92%		$15,569		1.05		1-.34		37%		$0.04
2021	2.58		0.0000041		92%		$15,569		1.07		1-.34		37%		$0.04
2022	2.58		0.0000041		92%		$15,569		1.10		1-.34		37%		$0.04
2023	2.58		0.0000041		92%		$15,569		1.13		1-.34		37%		$0.04
2024	2.58		0.0000041		92%		$15,569		1.15		1-.34		37%		$0.04

	A	*	L	*	M	*	N	*	O	*	(1-J)	*	K	*	A		Impact on CO ED Visits
Year	HH Size		ED Visits		ESA Impact		Cost		Inflation		Payments		Medicare/ Medicaid		HH Size	=	
2020	2.58		0.000048		79%		$563.00		1.05		1-.34		37%		2.58		$0.04
2021	2.58		0.000048		79%		$563.00		1.07		1-.34		37%		2.58		$0.04
2022	2.58		0.000048		79%		$563.00		1.10		1-.34		37%		2.58		$0.04
2023	2.58		0.000048		79%		$563.00		1.13		1-.34		37%		2.58		$0.04
2024	2.58		0.000048		79%		$563.00		1.15		1-.34		37%		2.58		$0.04

	(	+		+	)	*	P	*	R	*	S		
Year	Impact on CO Deaths		Impact on CO Hospitalizations		Impact on CO ED Visits		CO Monitors per Home		Adjust Prog. Horizon		Adjust # Measures	=	Annual Participant Impact
2020	$24.07		$0.04		$0.15		0		0		1.0		$0.00
2021	$24.65		$0.04		$0.15		0		0		1.0		$0.00
2022	$25.24		$0.04		$0.16		0		0		1.0		$0.00
2023	$25.85		$0.04		$0.16		0		0		1.0		$0.00
2024	$26.47		$0.04		$0.16		0		0		1.0		$0.00

- Limitations
  - Use of 2.58 person household size.
  - Use of 0.0000015 rate of deaths from CO poisoning.
  - Use of 65 percent reduction in CO poisoning deaths.
  - Use of 0.0000041 rate of hospitalizations from CO poisoning.
  - Use of 92 percent reduction in CO poisoning hospitalizations.
  - Use of $15,569 cost for each CO poisoning hospitalization.
  - Use of 0.000048 rate of ED visits from CO poisoning.
  - Use of 79 percent reduction in CO poisoning ED visits.
  - Use of $563 cost for each CO poisoning ED visit.

- Applicability
  - 2010 Census estimate of household size may not apply to 2020 California ESA participants.
  - Number of hospitalizations for CO poisoning may not apply to California in 2020.
  - ESA impact on CO hospitalizations from 1996 Krenzelok study may not apply to California in 2020.
  - Cost of a CO Hospitalization from Miller and Bhattacharya 2013 study may not apply to California.
  - Number of ED visits for CO poisoning may not apply to California in 2020.
  - ESA impact on CO ED visits from 1996 Krenzelok study may not apply to California in 2020.

- Duplication: This NEB did not duplicate another benefit calculated in this NEB analysis or other benefits that were already accounted for in the ESA cost-benefit analysis.

7. Reduced Asthma Incidents

Households with old or faulty equipment may have poor air quality, which may impact asthma in children. This results in a societal cost because the associated medical costs are covered in part by programs like Medicare and Medicaid. The 2019 report noted that there was little literature examining this societal NEB, but existing studies valued the benefit at around $200 per household, making it important to include.

This NEB was excluded, as the 2019 model used a study with a very small sample size to measure the impact. The National WAP Evaluation did not find a significant impact on asthma incidents. Additionally, this NEB will only impact those with asthma. This NEB was also excluded from the 2019 model.

- ESA Impact: The 2019 study stated that ESA measures improved household air quality and reduced the number of children with asthma. They estimated a $0.69 average annual benefit per participant in 2020 and adjusted that for inflation in the following years.

- Data: The following data were used as inputs in the research.

Table A-10A
Reduced Asthma Incidents Data Inputs

	Input	Source	Value	Notes
A	Children per Home	2000 CA Census[100]	1.01	
B	Childhood Asthma Due to Environment	CA Chronic Disease Fact Sheet 2015[101]	30%	
C	Childhood Asthma Incidence	CA Dept of Public Health 2017[102]	9.9%	
D	Medical Costs of Asthma	CA Chronic Disease Fact Sheet 2015	$869	
E	Inflation Factor	Bureau of Labor Statistics	1.11-1.22	Skipped in calculation.
F	Covered by Insurance	MEPS	66%	
G	% on Medicare/Medicaid	Kaiser Family Foundation 2018[103]	37%	Equal to percentage on Medicare and Medicaid. Assumes no overlap.

[100] U.S. Bureau of the Census, September 2004, https://www.census.gov/population/socdemo/hh-fam/tabST-F1-2000.pdf
[101] California Environmental Health Tracking Program, "Costs of Environmental Health Conditions in California Children", June 2015, https://www.phi.org/uploads/files/2015ROI_CEHTP.pdf
[102] California Department of Public Health, "Asthma Prevalence in California: A Surveillance Report", January 2017, https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/EHIB/CPE/CDPH%20Document%20Library/Asthma_Surveillance_in_CA_Report_2017.pdf
[103] Kaiser Family Foundation, https://www.kff.org/other/state-indicator/total-population/?currentTimeframe=0&selectedRows=%7B%22states%22:%7B%22california%22:%7B%7D%7D%7D&sortModel=%7B%22colId%22:%22Location%22,%22sort%22:%22asc%22%7D, Healthcare Cost Information Tab

	Input	Source	Value	Notes
H	Reduction in Asthma Occurrence	Breysse 2014[104]	23%	
I	Weighted Measure Life (Years)	Utilities	13	Sum (Measure Lifetime * # of Measure)/Total # of Measures
J	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
K	Adjustment Factor # of Measures	Utilities	0.47	Reduced to less than one if average # of causal measures per household was less than one.

- Children per Home: The number of children per household was estimated as 1.01 based on the 2000 California U.S. Census.
  - 2000 U.S. Census: The 2000 U.S. Census reported that the total number of children under 18 in California in 2000 was 8,035,222 and the total number of families was 7,920,049, resulting in 1.01 children per family.

- Environmentally Attributable Childhood Asthma: The percentage of childhood asthma that was environmentally attributable was estimated as 30 percent based on the California Department of Public Health's 2015 Chronic Disease Fact Sheet.
  - 2015 Chronic Disease Fact Sheet: This fact sheet used California-specific data, including the prevalence of asthma in the population, the risk of having asthma associated with specific environmental hazards, and the prevalence of exposure among children, to calculate an Environmental Attributable Fraction (EAF) model, but the fact sheet did not state those specific values. The indoor factors included in the model are displayed in Table A-10B.

Table A-10B
CA Chronic Disease Fact Sheet
Environmentally Attributable Asthma Factors

Indoor	Outdoor
Secondhand Smoke	Air Pollutants
Mold and/or Dampness	Wood Burning
Pests (e.g. rodents, cockroaches	Pollen
Pet Dander	Extreme Weather Events
Dust Mites	
Chemicals (e.g. cleaning products, perfumes)	

[104] Breysse, Jill ; Dixon, Sherry; Gregory, Joel; Philby, Miriam; Jacobs, David; and Krieger, James, "Effect of Weatherization Combined with Community Health Worker In-Home Education on Asthma Control," *American Journal of Public Health*, January 2014, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3910032/pdf/AJPH.2013.301402.pdf. Spreadsheet also mentions 2014 ORNL study.

An EAF model outputs the percentage of a particular disease category that would be eliminated if environmental factors were reduced to their lowest feasible levels. The fact sheet did not provide the model specifications or outputs.

The environmentally attributable asthma results from the study are displayed in Table A-10C. The EAF estimate was 30 percent with a possible range of 20 to 41 percent.

Table A-10C
CA Chronic Disease Fact Sheet
Environmentally Attributable Asthma Calculation

Condition	EAF Estimate	Possible Range of Values
Asthma	30%	(20%, 41%)

The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.

- Model specification: The factsheet did not provide the model specifications or full output.

- Childhood Asthma Incidence: The incidence of childhood asthma was estimated as 9.9 percent based on the California Department of Public Health 2017 Asthma Surveillance in CA Report.
  - Asthma Surveillance in CA Report: This report used 2014 data from the CDC's California Health Interview Survey to calculate asthma rates in children and adults across various subpopulations. The 2019 spreadsheet tool used the estimate for those in the "poor" poverty level defined by the U.S. Census Bureau as those below the poverty line. The findings are displayed in Table A-10D.

Table A-10D
Asthma Surveillance in CA Report
Childhood Asthma Incidence

Poverty Level	Current Asthma Prevalence	95% Confidence Interval
Poor	9.9%	(5.1%, 14.6%)

- Medical Costs of Asthma: The medical costs of asthma were estimated to be $869 based on the California Department of Public Health's 2015 Chronic Disease Fact Sheet.
  - 2015 Chronic Disease Fact Sheet: See the discussion in this section for childhood asthma that is environmentally attributable for full details regarding this study.

    The direct costs of childhood asthma were calculated using the CDC's Chronic Disease Cost Calculator (Version 2)[105] and were estimated as $869 per year in 2013. The calculation included the costs of physician visits, ER visits, hospitalizations, and prescription medication, but complete specification and output for the CDC Chronic Disease Cost Calculator was not included in the fact sheet.

    The Chronic Disease Cost Calculator uses state-level estimates of medical expenditures and absenteeism costs related to conditions like asthma to estimate the total cost related to a disease. The tool uses data from the U.S. Census Bureau, the Kaiser Family Foundation, the 2008 Current Population Survey, and the DHHS MEPS.

    The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.
    - Calculation specifications: The factsheet did not provide the inputs or full output of the Chronic Disease Cost Calculator Tool.

- Asthma Costs Covered by Insurance: The percentage of asthma costs covered by insurance was estimated to be 66 percent based on the DHHS MEPS estimate for the percentage of people with insurance coverage under 65.
  - DHHS MEPS: See the discussion in A-B6: Reduced CO Poisonings and Deaths for details regarding this survey.

- On Medicare/Medicaid: The percentage on Medicare or Medicaid in California was estimated as 37 percent based on Kaiser Family Foundation (KFF) 2018 California data. The KFF data were collected as part of the Census Bureau's American Community Survey (ACS)[106], which included a one percent sample of the U.S. population. The 2018 ACS completed interviews with 2,143,000 individuals out of 3,544,000 selected addresses for a completed interview rate of 60 percent.

- Reduction in Asthma Occurrence: The ESA program's impact on asthma was estimated as 23 percent based in the Breyesse et al. 2014 study.

[105] CDC, "Chronic Disease Cost Calculator Version 2", https://snaped.fns.usda.gov/library/materials/chronic-disease-cost-calculator-version-2
[106] American Community Survey (ACS), U.S. Bureau of the Census, https://www.census.gov/programs-surveys/acs/

- Breyesse et al. 2014 Study: This study used data on low-income children in the Highline communities in southwest King County, Washington. The study provided weatherization to families that had one or more children with asthma, were low income as defined by the HUD (80 percent annual median income and 60 percent of state median income or 200 percent of the federal poverty level), and resided in a rental property with an owner willing to participate. The study provided the following measures to 50 percent or more of the included households (other measures were provided to a smaller number of households).
  - Bathroom Fan Timers
  - Bathroom Fan Replacement
  - Water Pipe Insulation
  - Carpet Replacement
  - CO Detectors
  - Ductwork
  - Insulation
  - Air Sealing
  - Smoke Detectors
  - Weather-Stripping
  - Duct Sealing and Insulation

  The study provided weatherization assistance to eleven apartments and 23 duplexes and single-family dwellings. The study compared this treatment group to a comparison group in the same neighborhood enrolled in an in-home education visit program with community health workers. The value used in the spreadsheet as the impact on childhood asthma was the difference between the percentage point change in the treatment and the control. Table A-10E displays the results from this study.

Table A-10E
Breyesse et al. Asthma Impact Results

	Pre # of Children	Pre Asthma Rate	Post Asthma Rate	Percentage Point Change	Statistically Significant
Treatment Group	33	100%	28.8%	-71.2%	Yes
Comparison Group	68	100%	51.6%	-48.4%	Yes
Net Change				-22.8%	Yes

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for societal NEBs (3%) was less than one. This is the same calculation as in Section A-B8 for Reduced Sick Days from Work. No adjustment was made.

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one. This is the same calculation as in Section A-B8 for Reduced Sick Days from Work. The average

number of causal measures was 0.47. This adjustment factor can be turned on or off by utilities in the sensitivity options.

- Assumptions: Key assumptions that were made.
  - Average number of children per household of 1.01, equal to the finding from the 2000 U.S. Census for California.
  - Percentage of healthcare costs covered by insurance of 66 percent, equal to the finding of the DHHS's MEPS survey.
  - Weatherization reduction in asthma of 23 percent, equal to the finding from the Breyesse 2014 study.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	D	*	F	*	G	*	H	*	J	*	K		
Year	Child/ HH		Environmentally Attributable Asthma		Children with Asthma		Medical Costs		Insured		Medicare Medicaid		Asthma Impact		Adjust Prog. Horizon		Adjust # Meas	=	Annual Participant Impact
2020	1.01		30%		10%		$869		66%		37%		23%		1.0		.47		$0.69
2021	1.01		30%		10%		$869		66%		37%		23%		1.0		.47		$0.69
2022	1.01		30%		10%		$869		66%		37%		23%		1.0		.47		$0.69
2023	1.01		30%		10%		$869		66%		37%		23%		1.0		.47		$0.69
2024	1.01		30%		10%		$869		66%		37%		23%		1.0		.47		$0.69

- Limitations
  - Use of environmentally attributable asthma estimate.
  - Use of 10% estimate of children with asthma.
  - Use of MEPS survey to approximate the percentage of asthma costs covered by insurance.
  - Use of 23% ESA impact on asthma.

- Applicability
  - 2000 Census estimate of household size may not apply to 2020 ESA participants.
  - Attributable asthma rate may not apply to 2020 ESA participants.

- Duplication: This NEB did not duplicate another benefit calculated in this NEB analysis or other benefits that were already accounted for in the ESA cost-benefit analysis.

8. Health Care Prescription Adherence

Households that cannot afford all their medical costs may forgo prescription medications, which results in societal costs. The 2019 report noted that there was little literature examining this societal NEB, but those that did valued it at around $1,000 per household, making it important to include.

This NEB was excluded because there was no reliable method to estimate the impact. This NEB was valued at $0 in the 2019 study and excluded from the 2019 model.

- ESA Impact: The 2019 study stated that the installation of ESA measures reduces energy bills, allowing households to spend more on prescription medicines. They estimated a $0.00 average annual benefit per participant in 2020 because no reliable estimate of the impact was available.

- Data: The following data were used as inputs in the research.

Table A-11A
Health Care Prescription Adherence Data Inputs

	Input	Source	Value	Notes
A	Impact on Medication Adherence	-	0%	2014 Tonn WAP[107] estimated a 9% reduction, not statistically significant.
B	Annual National Cost of Forgoing Prescriptions	2011 Fierce Healthcare News Article[108]	$258 Billion	
C	Inflation Factor	Bureau of Labor Statistics	1.18-1.29	
D	# Who Should Be Taking Prescriptions	2011 Fierce Healthcare	133 Million	
E	Prescription Use Compliance Rate	2011 Fierce Healthcare	50%	
F	U.S. Population	U.S. Census 2010[109]	311.6 Million	
G	U.S. Households	U.S. Census 2010	118.68 Million	
H	Weighted Measure Life (Years)	Utilities	14.4	Sum (Measure Lifetime * # of Measure)/Total # of Measures
I	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
J	Adjustment Factor # of Measures	Utilities	1	Reduced to less than one if average # of causal measures per household was less than one.

  - Households Able to Afford Medications: The impact on the percentage of households able to afford their medications was included as 0 percent because no statistically significant estimate could be found.

  - Annual National Cost of Not Taking Prescription Medicines: The annual national cost of individuals not taking prescription medications was estimated as $258 billion based on an article on FierceHealthCare.com.
    - FierceHealthCare.com 2011 article: This article stated that the national cost of individuals not taking prescription medications is "roughly" $258 billion per

[107] ORNL, Tonn et al., "Weatherization Works - Summary of Findings from the Retrospective Evaluation of the U.S. Department of Energy's Weatherization Assistance Program," September 2014, Reference ORNL/TM-2014/338.
[108] Bowman, Dan, "Patients not taking medications cost $300B", FierceHealthcare, May 27, 2011, http://www.fiercehealthcare.com/story/patients-not-taking-medications-cost-300b/2011-05-27
[109] U.S. Census Bureau, "Households and Families: 2010", April 2012, https://www.census.gov/prod/cen2010/briefs/c2010br-14.pdf

year. It provided hyperlinks to reports by ExpressScripts and CVS to support this, but both links no longer worked.

- Number of People Who Should Be Taking Prescription Medications: The number of people who should be taking prescription medications was estimated as 133 million based on an article on FierceHealthCare.com.
  - FierceHealthCare.com 2011 article: This referenced article did not include the figure of 133 million used in the 2019 spreadsheet.

- Prescription Use Compliance Rate: The prescription use compliance rate was estimated as 50 percent based on an article on FierceHealthCare.com.
  - FierceHealthCare.com 2011 article: This article stated that about 45 percent of care providers and support relatives do not take their own medication so that they can afford treatment for those they take care of. This article did not include the figure of 50 percent used in the 2019 spreadsheet.

- U.S. Population: The total U.S. population was estimated as 311.6 million based on a report from the United States Census Bureau using the 2010 U.S. Census.
  - 2010 Census Brief: This report stated that the 2010 Census enumerated 308.7 million people in the United States. It did not include the value of 311.6 million used in the 2019 spreadsheet tool.

- U.S. Households: The total number of U.S. households was estimated as 118.68 million based on a report from the United States Census Bureau using the 2010 U.S. Census.
  - 2010 Census Brief: This report stated that the 2010 Census enumerated 116.7 million households in the United States. It did not include the value of 118.68 million used in the 2019 spreadsheet tool.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for societal NEBs (3%) was less than one. This is the same calculation as in A-B3 for Emissions on Illnesses and Deaths. No adjustment was made.

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one. This is the same calculation as in the Reduced Arrearage Carrying Cost NEB review. No adjustment was made.

- Assumptions: Key assumptions that were made.
  - Affordability impact of 0%, because no statistically significant findings were available.
  - Annual national cost of not taking prescriptions of $258 billion, equal to that reported on Fiercehealthcare.com.

- Number of people who should be taking prescription medications of 133,000,000, and no support for this estimate could be found.
- Prescription use compliance rate of 50%, and no support for this estimate could be found.
- U.S. population equal to 2010 U.S. Census report.
- Number of U.S. households equal to 2010 U.S. Census report.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	(B	*	C)	/	D	*	E	*	(F	/	G)	*	I	*	J		
Year	ESA Impact		National Cost (Billions)		Inflation		Should Take Prescriptions (Millions)		Comp. Rate		U.S. Pop (Millions)		U.S. HH (Millions)		Adjust Prog. Horizon		Adjust # Measures	=	Annual Participant Impact
2020	0%		$258		1.18		133		50%		311.6		118.68		1.0		1.0		$0.00
2021	0%		$258		1.20		133		50%		311.6		118.68		1.0		1.0		$0.00
2022	0%		$258		1.23		133		50%		311.6		118.68		1.0		1.0		$0.00
2023	0%		$258		1.26		133		50%		311.6		118.68		1.0		1.0		$0.00
2024	0%		$258		1.29		133		50%		311.6		118.68		1.0		1.0		$0.00

- Limitations
  - Use of 0% ESA impact because no statistically significant finding was available.
  - Use of $258 billion as the national annual cost of not taking prescription medications.
  - Use of 133 million as the number of people who should be taking prescription medications nationally.
  - Use of 50 percent as the compliance rate.

- Applicability
  - National cost of individuals not taking their medications may not apply to California in 2020, even when adjusted for inflation.
  - National number of people who should be taking prescription medications may not apply to ESA participants in 2020.
  - National compliance rate may not apply to ESA participants.

- Duplication: This NEB did not duplicate another benefit calculated in this NEB analysis or other benefits that were already accounted for in the ESA cost-benefit analysis.

9. Low Birthweight Babies Costs

Households that struggle with high energy bills may sacrifice other necessities including food and healthcare. This can result in low birthweight babies, imposing costs on society. The 2019 report noted that the small amount of literature that researched this NEB valued it at around $20.00 per household, making it important to include.

This NEB was excluded because there was no reliable method to estimate the impact. This NEB was valued at $0 in the 2019 study and excluded from the 2019 model.

- ESA Impact: The 2019 study stated that the installation of ESA measures reduced energy bills, allowing households to spend more on food and other necessities, reducing the chance of low birthweight babies. They estimated a $0 average annual benefit per participant in 2020 because no reliable estimate of the impact was available.

- Data: The following data were used as inputs in the research.

Table A-12A
Low Birthweight Babies Cost Data Inputs

	Input	Source	Value	Notes
A	Average People per Household	2010 U.S. Census	2.58	
B	Births per Person per Year	2015 CDC Report[110]	0.0126	
C	Low Weight Births	2015 CDC Report	8%	
D	Decrease in Homes Trading Heat for Food or Food for Heat	2018 APPRISE WAP Evaluation[111]	0%	
E	Low Birth Weights Avoided by Fewer Trading "Heat or Eat"	2006 Frank et al. Study[112]	20%	
F	Excess First Year Hospitalization Costs for Low Birthweight	2005 Almond et al. Study[113]	$6,806	
G	Inflation Factor	Bureau of Labor Statistics	1.54-1.70	
H	On Medicare/Medicaid	Kaiser Family Foundation 2018[114]	37%	Equal to percentage on Medicare plus percentage on Medicaid. Assumes no overlap.
I	Weighted Measure Life (Years)	Utilities	14	Sum (Measure Lifetime * # of Measure)/Total # of Measures
J	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
K	Adjustment Factor Number of Measures	Utilities	1	Reduced to less than one if average # of causal measures per household was less than one.

  - Average Persons per Household: The number of individuals per household was estimated as 2.58 people from the 2010 U.S. Census. This was equal to the total 2010 population of 300.8 million divided by the total number of households, which was 116.7 million. This estimate was slightly below the 2000 estimate of 2.59 and

[110] Martin, Joyce; Hamilton, Brady; Osterman, Michelle; Driscoll, Anne; Mathews, T.J.; "Births: Final Data for 2015", U.S. Department of Health and Human Services, January 2017, https://www.cdc.gov/nchs/data/nvsr/nvsr66/nvsr66_01.pdf
[111] APPRISE, "National Weatherization Assistance Program Evaluation", 2018, www.appriseinc.org/wp-content/uploads/2018/02/WAP-Non-Energy-Benefit-Results-Report.pdf.
[112] Frank, Deborah; Neault, Nicole; Skalicky, Anne; Cook, John; Wilson, Jacqueline; Levenson, Suzette; Meyers, Alan;, Heeren, Timothy; Cutts, Diana; Casey, Patrick; Black, Maureen; and Berkowitz, Carol; "Heat or Eat: The Low Income Home Energy Assistance Program and Nutritional and Health Risks Among Children Less Than 3 Years of Age", *Pediatrics*, November 2006, http://pediatrics.aappublications.org/content/118/5/e1293
[113] Almond, Douglas; Chay, Kenneth; and Lee, David; "The Costs of Low Birthweight", *The Quarterly Journal of Economics*, August 2005, https://www.princeton.edu/~davidlee/wp/birthweight.pdf
[114] Kaiser Family Foundation, https://www.kff.org/other/state-indicator/total-population/?currentTimeframe=0&selectedRows=%7B%22states%22:%7B%22california%22:%7B%7D%7D%7D&sortModel=%7B%22colId%22:%22Location%22,%22sort%22:%22asc%22%7D, Healthcare Cost Information Tab

did not include the 8.0 million people who lived in school dormitories, nursing homes, or prisons.

The 2010 U.S. Census reported the number of individuals per household in California to be 2.90, which would have been a more accurate estimate to use for ESA participants.

- Births per Person per Year: The number of births per person per year was estimated as 0.0126 based on a 2017 CDC National Vital Statistics Report.
  - 2017 CDC National Vital Statistics Report: This report used data on 99.53 percent of all U.S. births in 2015. It stated that the birth rate in California in 2015 was 12.6 per thousand.

- Low Weight Births: The percentage of babies born with a low birth weight was estimated as eight percent based on a 2017 CDC National Vital Statistics Report.
  - 2017 CDC National Vital Statistics Report: This report used data on 99.53 percent of all U.S. births in 2015. It stated that the percentage of babies born nationally with low birthweight in 2015 was eight percent.

- Decrease in Homes Trading Heat for Food or Food for Heat: The percentage decrease in homes trading heat for food or food for heat was estimated as 0 percent based on a 2018 APPRISE study.
  - 2018 APPRISE Study: This study used data from the Weatherization Assistance Program (WAP) Evaluation. See the discussion in Section A-B5: Reduced Sick Days from Work for the full details regarding this study.

    The decrease in homes that experienced this tradeoff is displayed in Table A-12B. The 2019 spreadsheet tool used the 0 percent value for hot climates but noted the moderate climate estimate of 6 percent as well.

Table A-12B
APPRISE Analysis of WAP Households That Could
Not Buy Food to Pay for Energy Bills At Least Every Few Months

	Net Change	Statistically Significant
Hot	0%	No
Moderate	-6%	No
Cold	-5%	No
Very Cold	0%	No

- Low Birthweights Avoided by Fewer Households Trading "Heat or Eat": The percentage of low birthweight babies avoided by fewer households having to trade

between paying energy bills or food was estimated as 20 percent based on the Frank et al. 2006 study.

- Frank et al. 2006 Study: This study used data from the Children's Sentinel Nutrition Assessment Project (C-SNAP) from 1998 to 2004, which included medical chart audits from medical centers in Baltimore, Boston, Little Rock, Los Angeles, Minneapolis, and Washington, D.C. Caregivers for children less than three years of age were interviewed when their child entered acute/primary care clinics or hospitals. Out of 21,157 potential respondents, 16,968 interviews were completed for a completed interview rate of 80 percent. Only interviews with caregivers eligible for LIHEAP and on public or no insurance were included, resulting in a total sample size of 7,074 interviews.

  The results from this study are displayed in Table A-12C. There were significant differences between those who did and did not receive LIHEAP. The study reported that those who received LIHEAP were less likely to report that they were food insecure and to have low birthweight babies. The 2019 spreadsheet tool appears to use the percentage difference for food insecurity between those who did and did not receive LIHEAP.

Table A-12C
Frank et al. Analysis of Low Birthweight Children

	Received LIHEAP	Did not Receive LIHEAP	Percentage Point Change	% Change	Statistically Significant
Low Birthweight	14%	17%	-3%	-21.4%	Yes
Food Insecure	20%	24%	-4%	-20.0%	Yes

The 2019 spreadsheet tool did not state why the 20 percent reduction in food insecurity for those on LIHEAP was included as the percentage of low birthweights by fewer households having to trade heat for food.

The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.

- Non-causal analysis: The bivariate statistics reported for food insecurity and low birthweight babies were not stated as the causal effects of the LIHEAP program. The study included them to show that LIHEAP enrollment is appropriately targeting families that need greater assistance. Further data would need to be collected to estimate the impact of LIHEAP on food insecurity.

- Excess First Year Hospitalization Costs for Low Birthweight Babies: The excess first year hospitalization costs for low birthweight babies were estimated as $6,806 based on the Almond et al. 2005 Study.
  - Almond et al. 2005 Study: The study used data on twin births from the National Center for Health Statistics (NCHS) and the Healthcare Cost and Utilization

Project (HCUP). It estimated that the average excess hospital costs for a baby between 1,500 and 2,000 grams (3.3. to 4.4 pounds) was $6,806.

- On Medicare/Medicaid: The percentage on Medicare or Medicaid in California was estimated as 37 percent based on Kaiser Family Foundation (KFF) 2018 California data. The KFF data were collected as part of the Census Bureau's American Community Survey (ACS)[115], which included a one percent sample of the U.S. population. The 2018 ACS completed interviews with 2,143,000 individuals out of 3,544,000 selected addresses for a completed interview rate of 60 percent.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for societal NEBs (3%) was less than one. This is the same calculation as in A-B3 for Emissions on Illnesses and Deaths. No adjustment was made.

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one. This is the same calculation as in the Reduced Arrearage Carrying Cost NEB review. No adjustment was made.

- Assumptions: Key assumptions that were made.
  - Percentage of births with low birthweight babies of 8%, equal to the finding from 2015 CDC report.
  - Low birthweights due to families trading between food and heat of 0%, equal to the finding from the 2018 APPRISE WAP Evaluation.
  - Decrease in low birthweights of 20%, equal to the finding from 2006 Frank et al. study.
  - Low birthweight hospitalization cost of $6,806, equal to the finding from 2005 Almond et al. study.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	D	*	E	*	F	*	G	*	H	*	J	*	K		
Year	# per HH		Births per Person		Low Birth Weight		ESA Impact on Food Insecurity		Food Insecurity Impact on Low Birth Weight		Low Birth Weight Costs		Inflation		Medicare/ Medicaid		Adjust Prog. Horizon		Adjust # Meas	=	Annual Partic Impact
2020	2.58		0.0126		8%		0%		20%		$6,806		1.54		37%		1.0		1.0		$0.00
2021	2.58		0.0126		8%		0%		20%		$6,806		1.58		37%		1.0		1.0		$0.00
2022	2.58		0.0126		8%		0%		20%		$6,806		1.62		37%		1.0		1.0		$0.00
2023	2.58		0.0126		8%		0%		20%		$6,806		1.66		37%		1.0		1.0		$0.00
2024	2.58		0.0126		8%		0%		20%		$6,806		1.70		37%		1.0		1.0		$0.00

[115] American Community Survey (ACS), U.S. Bureau of the Census, https://www.census.gov/programs-surveys/acs/

- Limitations
  - Use of 8% low birthweight rate.
  - Used of 20% food insecurity impact on low birth weight.
  - Use of $6,806 hospitalization cost for low birthweight babies before inflation adjustment.

- Applicability
  - The number of people per household may not apply to ESA participants in 2020.
  - Percentage of births with low birthweight babies may not apply to ESA participants in 2020.
  - Decrease in low birthweights may not apply to ESA participants in 2020.

- Duplication: This NEB did not duplicate another benefit calculated in this NEB analysis or other benefits that are already accounted for in the ESA cost-benefit analysis.

C. Excluded Participant NEBs

This section reviews the participant NEBs that were not included in the Excel tool. The following benefits were excluded.

- Fewer Reconnects
- Customer Arrearage Changes
- Emissions on Illnesses & Deaths
- Fewer Fires
- Fewer Sick Days from Work
- Fewer Sick Days from School
- Fewer CO Poisonings
- Fewer Asthma Incidences
- Reduction in Allergies
- Reduction in Cold Symptoms
- Property Value Benefits
- Quality / Quantity of Lighting
- Measure Lifetime / Deferred Purchase
- Reduced Detergent Usage
- Improved Equipment Features / Performance
- Aesthetics / Appearance of Home
- Hardship Benefits
- Avoided Moves / Household Impacts
- Knowledge / Ability to Control Bill
- Contributing to Environmental Good

1. Fewer Reconnects

Reconnects following a shutoff caused by a customer's failure to pay result in an additional cost to the customer. The 2019 report noted that there are about a dozen studies from the late 1990s to 2018 that valued this NEB, making it important to include, but it also noted that the expected benefit combined with that of reducing shutoffs was usually less than $1.00 per household in these studies and could be as low as $0.00 per household.

This NEB was included in the Shutoff NEB instead of as a separate NEB. It was not included in the 2019 model.

- ESA Impact: The 2019 study stated that the installation of ESA measures improved payment behavior and thus reduced the number of reconnects that occur every year following a shutoff. They estimated a $0.02 average annual benefit per participant every year from 2020 to 2024.

  ESA measures can reduce customer usage and bills, improving payment behavior, but it is unclear whether that reduction would have a significant impact on the number of reconnections.

- Data: The following data were used as inputs in the research.

Table A-13A
Reduced Reconnects Data Inputs

	Input	Source	Value	Notes
A	Average Reconnects per CARE customer	Utilities	0.0221	
B	ESA Reconnect Impact	Skumatz, CT WRAP, 2002[116]	16%	No normalization
C	Utility Reconnect Fee	Utilities	$5.85	
D	Inflation Factor	Bureau of Labor Statistics	1.00	Assumed current
E	Weighted Measure Life (Years)	Utilities	14.4	Sum (Measure Lifetime * # of Measure)/Total # of Measures
F	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
G	Adjustment Factor Number of Measures	Utilities	1	Reduced to less than one if average number of causal measures per household was less than one.

[116] Skumatz, Lisa and Nordeen, Trevor. "Connecticut WRAP Program Non-Energy Benefits, March 2002.

- Average Reconnects per CARE Customer: The average number of reconnects per low-income customer per year, 0.0221, was based on 2018 utility CARE data.

- ESA Reconnect Impact: The ESA impact on reconnects was estimated to be a 16 percent reduction, based on the disconnect impact estimate in the Skumatz 2002 CT WRAP Study.
  - Skumatz 2002 CT Study: See the discussion in the Reduced Arrearage Carrying Cost NEB review for the full details regarding this study.

    The shutoff results from the study that were used for the reconnect results are displayed in Table A-13B. They estimated a 16 percent reduction in shutoffs, but the result was not statistically significant.

Table A-13B
CT WRAP Shutoff Impact Results
Used for Reconnect Estimate

	Pre	Post	Change		Significant (95% Confidence Level)
			$	%	
Participants	0.200%[117]	0.017%	-0.003%	-16%	No

- Utility Reconnect Fee: The fee charged to households to reconnect was included in the 2019 spreadsheet tool as $5.85 based on utility inputs. An accompanying input requiring the source year for this data was set to 2001. This date was used to update the value for inflation. Further information regarding the source of the 2001 value of $5.85 was not included in the spreadsheet tool.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for participant NEBs (18%) was less than one. This is the same calculation as in the Fewer Shutoffs NEB review. No adjustment was made.

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one. This is the same calculation as in the Reduced Arrearage Carrying Cost NEB review. No adjustment was made.

- Assumptions: Key assumptions that were made.
  - ESA reconnect impact of 16%, equal to the finding from the 2002 CT study.

[117] This is the value reported in the study, but given the other values in the table it may have been an error.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	D	*	F	*	G	=	
Year	Average Reconnects		Reconnect Impact		Reconnect Fee		Inflation		Adjust Prog. Horizon		Adjust # Measures		Annual Participant Impact
2020	0.0221		16%		$5.85		1.00		1		1		$0.02
2021	0.0221		16%		$5.85		1.00		1		1		$0.02
2022	0.0221		16%		$5.85		1.00		1		1		$0.02
2023	0.0221		16%		$5.85		1.00		1		1		$0.02
2024	0.0221		16%		$5.85		1.00		1		1		$0.02

- Limitations
  - Use of 16% as the shutoff reduction.

- Applicability
  - Reduction in reconnects may not apply to the level of savings achieved by the ESA program.

- Duplication: This NEB may have duplicated the effect of another NEB.
  - The calculation of this participant NEB included the fee charged to the participant to reconnect of $5.85, but the participant NEB for Shutoffs included the utility's cost to reconnect a customer of $17.36 (which includes the $5.85 customer charge).

  - The participant NEB for Fewer Shutoffs included the value of the time it takes a participant to reconnect. This value was not included in this calculation, but it was not explained in the 2019 report or spreadsheet tool why that value was included in the NEB for Fewer Shutoffs rather than the NEB for Fewer Reconnects.

2. Customer Arrearage Changes

A reduction in bills through the ESA program can reduce the level of arrearages. The 2019 report noted that there were just under a dozen studies from the late 1990s to 2010 that valued this NEB at between $25 and $400 per household.

This NEB was excluded because it is a duplication of the bill reduction value that is included in the energy impact. The value of reduced arrearages is accounted for in the Arrearage Carrying Cost NEB and the Bad Debt NEB. This NEB was not included in the 2019 model.

- ESA Impact: The 2019 study stated that the installation of ESA measures reduced energy bills, allowing customers to reduce their arrearages. They estimated a $4.84 average benefit per participant every year from 2020 to 2024.

- Data: The following data were used as inputs in the research.

Table A-14A
Customer Arrearage Changes Data Inputs

	Input	Source	Value	Notes
A	Average Low-Income Arrearage	Utilities	$218	
B	Inflation Factor	CPI	1.00	Assumed current.
C	ESA Arrearage Impact	Skumatz, CT WRAP, 2002[118]	32%	No normalization
D	Weighted Measure Life (Years)	Utilities	14.4	Sum (Measure Lifetime * # of Measure)/Total # of Measures
E	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
F	Adjustment Factor Number of Measures	Utilities	1	Reduced to less than one if average # of causal measures per household was less than one.

- Average Low-Income Arrearage: The average low-income arrearage was included in the 2019 spreadsheet tool as $218 based on utility inputs. An accompanying input requiring the source year for this data was set to 2001. Further information regarding where the 2001 value of $218 was from was not included in the spreadsheet tool.

- ESA Arrearage Impact: The ESA impact on customer arrearages was estimated as a 32 percent reduction based on the Skumatz 2002 CT WRAP Study.
  - Skumatz 2002 CT Study: See discussion in the Reduced Arrearage Carrying Cost NEB review for the full details regarding this study. The arrearage results from the study are displayed in Table A-14B. The average impact of a 32 percent reduction in arrearages was used, and the insignificant comparison group adjustment was not applied.

Table A-14B
CT WRAP Arrearage Impact Results

	Pre	Post	Change		Significant (95% Confidence Level)
			$	%	
Participants	$79.40	$54.31	-$25.09	-32%	Yes
Nonparticipants	$86.34	$97.78	$11.44	13%	No

[118] Skumatz, Lisa and Nordeen, Trevor. "Connecticut WRAP Program Non-Energy Benefits, March 2002.

- One-Time Benefit: The value for this NEB was assumed to be a one-time benefit, so it was divided by the measure life of 14.4 years.

  - Weighted Measure Life = $\frac{\sum(Measure\ Lifetime * \#\ of\ Measures)}{Total\ \#\ of\ Measures}$ = 14.4

  Table II-1C displays the measures included in the calculation of weighted measure life. This NEB included those same measures.

  The 2019 spreadsheet tool stated that no literature could be found on whether this NEB should be calculated as an annual or one-time benefit, so it was assumed to be a one-time benefit.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for participant NEBs (18%) was less than one. This is the same calculation as in the Fewer Shutoffs NEB review. No adjustment was made.

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one. This is the same calculation as in the Reduced Arrearage Carrying Cost NEB review. No adjustment was made.

- Assumptions: Key assumptions that were made.
  - ESA arrearage impact of 32%, equal to finding from the 2002 CT study.
  - NEB was assumed to be a one-time benefit because no literature was available on the subject. This implicitly assumed that savings in following years resulting from weatherization measures were not used to pay down remaining arrearages.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	/	D	*	E	*	F	=	
Year	Average Arrears		Inflation		Arrearage Impact		Measure Life		Adjust Prog. Horizon		Adjust # Measures		Annual Participant Impact
2020	$218		1.00		32%		14.4		1		1		$4.84
2021	$218		1.00		32%		14.4		1		1		$4.84
2022	$218		1.00		32%		14.4		1		1		$4.84
2023	$218		1.00		32%		14.4		1		1		$4.84
2024	$218		1.00		32%		14.4		1		1		$4.84

- Limitations
  - Use of 32% reduction in arrearages.

- Applicability
  - Magnitude of arrearage impact may not apply to the level of savings achieved by the ESA program.

- Duplication: This NEB may have duplicated the impact of other NEBs.
  - The value of the savings from the usage reduction is already accounted for.

3. Fewer Fires

Old or faulty appliances can increase the risk of fires. The 2019 report noted that there were more than a dozen studies from the early 2000s to 2018 that valued this NEB at about $50 per household.

This NEB was excluded because the number of fires is too low to measure a significant impact from the program. The National WAP Evaluation did not find a statistically significant impact on the net change in the number of fires.

- ESA Impact: The 2019 study stated that the installation of ESA measures reduced the risk of fires in participant households. They estimated a $0.02 average annual benefit per participant in 2020 and adjusted that for inflation in the following years.

  The calculation of this NEB included the following component benefits.
  - Avoided Fire-Related Deaths
  - Avoided Fire-Related Injuries
  - Avoided Fire-Related Property Damage

- Data: The following data were used as inputs in the research.

Table A-15A
Fewer Fires Data Inputs

	Input	Source	Value	Notes
Number of Fires Avoided by ESA Measures				
A	Fires per Household	NFPA 2017[119]	0.003	
B	Caused by Heating Equipment	NFPA 2019[120]	15%	
C	% with ESA Heating Measures	Utilities	47%	
D	Caused by Electrical / Lighting	NFPA 2018[121]	9%	
E	% with ESA Lighting Measures	Utilities	100%	

[119] Evarts, Ben, National Fire Protection Association, 2017, https://www.nfpa.org/News-and-Research/Data-research-and-tools/US-Fire-Problem.
[120] Evarts, Ben, National Fire Protection Association, 2019, https://www.nfpa.org/Public-Education/By-topic/Top-causes-of-fire/Heating
[121] Evarts, Ben, National Fire Protection Association, 2018, https://www.nfpa.org/News-and-Research/Data-research-and-tools/Electrical/Electrical

	Input	Source	Value	Notes
F	Fires Stopped by ESA	Tonn WAP 2014[122]	0.00047	
Benefit from Avoided Fire-Related Deaths				
G	Deaths per Fire	NFPA 2018[123]	0.007	
H	Life Value	EPA 2006	$7,400,000	
I	Inflation Factor	CPI	1.31-1.70	
Benefit from Avoided Fire-Related Injuries				
J	Injuries per Fire	NFPA 2017	0.0328	
K	Cost per Injury	Banfield et al. 2016[124]	$63,000	Spreadsheet says 2016 study, but links to 2014 study.
L	Inflation Factor	CPI	1.101-1.211	
M	Covered by Insurance	DHHS MEPS	34%	
Benefit from Avoided Fire-Related Property Damage				
N	Property Damage	NFPA 2017	$20,844	
O	Inflation Factor	CPI	1.049-1.153	
P	Covered by Insurance	Banfield et al. 2016	54%	Weighted average of 93% for homeowners (25% ESA participants) and 41% of renters (75% ESA participants).
Adjustment Factors				
Q	Weighted Measure Life (Years)	Utilities	13	Sum (Measure Lifetime * # of Measure)/Total # of Measures
R	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
S	Adjustment Factor # of Measures	Utilities	1	Reduced to less than one if average # of causal measures per household was less than one.

The following inputs were used to calculate the number of fires avoided by ESA measures.

- Fires per Household: The number of fires per household was estimated as 0.003 based on statistics available from the National Fire Protection Association's (NFPA) website. The average number of fires annually between 2014 and 2018 in residential properties was reported as 382,399. This value was divided by the total number of households in the U.S, which was estimated to be 127.59 million in 2018 according to statistica.com.[125]

[122] ORNL, Tonn et al., "Weatherization Works - Summary of Findings from the Retrospective Evaluation of the U.S. Department of Energy's Weatherization Assistance Program," September, 2014, Reference ORNL/TM-2014/338.

[123] Evarts, Ben, "Fire Loss in the United States During 2017", National Fire Protection Association, 2018, https://www.nfpa.org/News-and-Research/Data-research-and-tools/Electrical/Electrical

[124] Banfield, Joanne; Rehou, Sarah; Gomez, Manuel; Redellmeier, Donald; Jeschke, Marc; "Healthcare Costs of Burn Patients from Homes without Fire Sprinklers," *American Burn Association*, 2014. https://www.nfpa.org/-/media/Files/Fire-Sprinkler-Initiative/Fire-Threats-in-New-Homes-Research/Fire-Loss-and-Injuries/Healthcare_Costs_of_Burn_Patients_From_Homes_Without_Fire_Sprinklers.ashx?la=e

[125] "Number of Households in the U.S. from 1960 to 2019" *Statista*, https://www.statista.com/statistics/183635/number-of-households-in-the-us/.

The total number of fires was included in other calculations for this NEB as 379,000. The 2019 spreadsheet tool did not state why different values were used.

- NFPA Website: The statistics on the number of fires in the U.S. were calculated using the U.S. Fire Administration's National Fire Incident Reporting System (NFIRS) and the NFPA's annual Fire Experience Survey (FES).
  - The NFIRS collects data on each emergency response by a fire department. After the emergency response, departments submit paper or electronic NFIRS reports to state agencies which aggregate the data for the national system. The NFIRS data did not include fires reported by federal, state, and industrial fire brigades. Participation in the program is voluntary, so many local brigades also did not report data. The NFIRS documentation stated that 44 percent of all U.S. fire departments were included, but that they did receive data from brigades in every state.

    To calculate national estimates, the U.S. Fire Administration calculated the percentage of fires, deaths, injuries, and dollar loss in relevant categories in the NFIRS data and multiplied by the corresponding total estimates from the NFPA FES survey described below. The official discussion of this methodology[126] cautions that inconsistencies can occur because of nonrandom missing data, but also states that this is the best strategy given available data. The specific percentages and FES estimates used in the calculation of the national estimates could not be found in the referenced reports or in other supporting literature from FEMA, the U.S. Fire Administration, or the NFPA.

  - The FES is an annual survey of fire departments that uses a stratified sample of U.S. fire departments based on the population they serve. 21,488 fire departments were mailed the survey in 2018, and 2,592 responded for a completed survey rate of twelve percent. The NFPA website did not provide further details stating how FES survey responses were applied to the NFIRS to fill in missing data.

The 2019 spreadsheet tool used the average number of residential fires from 2014 to 2018 of 382,399, but the NFPA also provided a specific estimate for 2018 of 363,000 and noted that this was an increase of two percent since 2017.

In this section, the percentage of fires caused by heating equipment and the percentage cause by lighting and electrical sources were also calculated using

[126] "National Fire Estimation Using NFIRS Data: White Paper", U.S. Fire Administration, FEMA, May 2017, https://www.usfa.fema.gov/downloads/pdf/statistics/national_fire_estimation_using_nfirs_data.pdf

the NFIRS and FES. The number of deaths, number of injuries, and amount of property damage were calculated only from the FES.

The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.

- Missing data strategy: Without understanding which fire departments were missing in the NFIRS dataset and how the FES data were used to account for them, the accuracy of the data for the state of California cannot be assessed.

- National estimate: National estimates of the total number of fires may not have been applicable to California. Factors unique to California, such as its drier climate, may cause the number of fires to differ from the national average.

- Fires in ESA homes: If fires were more likely in ESA homes because of old or faulty heating or electrical equipment, a national average may have underestimated the average number of fires in ESA participant homes prior to the installation of ESA measures. For this estimate to be valid, it would be necessary to know how the number of fires in low-income households relative to the national average.

  - Statista: The number of households in the U.S. reported on Statista.com references the U.S. Census Bureau. It does not provide a citation to a specific report, but the figures were similar to those in the 2010 Census Brief discussed in section A-B6: Reduced CO Deaths and Poisonings. The 2019 spreadsheet tool did not state why the estimate from statistia.com was used instead of the U.S. Census Bureau briefs used in other NEB calculations.

- Caused by Heating Equipment: The percentage of fires caused by heating equipment was estimated as 15 percent based on the NFPA's "Home Fires Involving Heating Equipment" Report.
  - NFPA 2018 Home Fires Involving Heating Equipment Report: This study stated that 15 percent of home structure fires between 2012 and 2016 were caused by heating equipment. This report used data on the causes of structure fires from the NFIRS national database discussed in this section but did not provide further information regarding how that figure was calculated.

    The 2019 spreadsheet tool used this estimate to calculate the number of fires caused by heating equipment, but the U.S. Fire Administration's Residential Building Fire Trends report for 2018 provided a direct estimate of this value that differed substantially from the spreadsheet's calculation. Table A-15B

compares these values. The U.S. Fire Administration's report also used the NFIRS and FES data and the same missing data strategy.

Table A-15B
Number of Fires from Heating Equipment Calculation

Source	Date	Value
NFPA, Number of Fires	Not Stated.	379,000
NFPA, % Caused by Heating Equipment	2012-2016	15%
Total Number of Fires Caused by Heating Equipment		56,860
U.S. Fire Administration, Number of Fires Caused by Heating Equipment	2018	35,700

The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.

- Heating equipment type: This study stated that space heaters caused 44 percent of heating equipment fires. The accuracy of this measure could not be assessed without understanding whether ESA participants use similar heating solutions to those used nationally. If ESA participants used space heaters at a higher rate because of faulty furnaces or poor insulation, the number of fires avoided by new ESA measures may have been higher than this estimate for all households.

- ESA Heating Measures: The percentage of ESA participants with heating equipment installed by the ESA program was calculated from utility data as 47 percent.

  % with heating measures installed = $\frac{\sum(\#\ of\ Measures)}{\#\ or\ Participants} = \frac{11{,}085}{23{,}518} = 47\%$

  Table A-8E displays the measures included in the calculation of participants with heating measures installed. These measures were included based on settings that could be modified by the utility.

- Caused by Electrical or Lighting: The number of fires caused by electric or lighting equipment was estimated as 35,150 per year based on the NFPA's "Home Electrical Fires" Report. The 2019 spreadsheet tool divided this number by 379,000 to calculate the nine percent value used in this NEB. The spreadsheet tool did not state why this value for the total number of fires differed from the value of 382,399 used to estimate the number of annual fires earlier in this section.
  - NFPA 2019 Home Electrical Fires: This report stated that 35,150 fires were caused by electrical distribution and lighting equipment each year from 2012 to 2016. This report used data on the causes of structure fires from the NFIRS national database discussed in this section but did not provide further information regarding how that figure was calculated.

The U.S. Fire Administration's Residential Building Fire Trends for 2018 reported only 25,700 fires attributable to electrical malfunctions in 2018 after applying the same FES missing data strategy.

- ESA Lighting Measures Installed: The percentage of ESA participants with lighting and electrical equipment installed was calculated from utility data as 100 percent.

  % with lighting measures installed = $\frac{\sum(\#\ of\ Measures)}{\#\ or\ Participants} = \frac{182{,}737}{23{,}518} = 100\%$

  Table A-15C displays the measures included in the calculation of participants with electrical and lighting installed. These measures were included based on settings that could be modified by the utility.

Table A-15C
Electrical and Lighting Measures Included in Fewer Fires NEB Calculation

Measure Name	# of Measures
Exterior Hard-wired LED fixtures	2,734
Interior Hard-wired LED fixtures	8,419
LED diffuse bulb	148,722
LED reflector bulb	8,045
LED Torchiere	14,817
Total	182,737

The 2019 spreadsheet tool stated that this value was the share of program participants that had electrical equipment installed, but the only relevant measures were LED lighting. This likely overstated the effect that ESA measures had on fire reduction. The inclusion of energy-efficient power strips would also have been applicable given the discussion in the 2019 NFPA Home Electrical Fires Report, but they were not included as relevant measures in the 2019 spreadsheet tool.

- Fires Stopped by ESA: The percentage of fires stopped by the ESA program was estimated as 0.00047 based on the Tonn 2014 WAP study. The 2019 spreadsheet tool stated that 47 fires were avoided by WAP measures, which was divided by the approximate number of WAP participants of 100,000. However, the location of this information could not be found in the Tonn 2014 WAP study cited in the spreadsheet.

The following inputs were used to calculate the cost of fire-related deaths.

- Deaths per Fire: The number of deaths per fire was calculated as 0.007. The 2019 spreadsheet tool estimated the number of residential fire-related deaths as 2,710 and the total number of fires to be 379,000.
  - NFPA Fire Loss in the United States During 2017 Report: This report used data from the FES to estimate the total number of deaths from fires of 0.007. See the discussion earlier in this section for a full discussion of the FES.

    The number of deaths was estimated exclusively from the FES survey, unlike the fire-related estimates discussed earlier in this section that applied an estimate from the FES to the NFIRS data. While both suffer from missing data, the FES only has a completed survey rate of twelve percent for a sample of fire departments compared to the 44 percent of all fire departments in the NFIRS. The number of residential fire-related deaths reported by the U.S. Fire Administration using the FES on NFIRS data was only 1,310[127] compared to the estimate of 2,710 using only FES data.

    The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.
    - Fire and household type: This study did not differentiate the number of deaths by type of fire or household, which would be necessary to know the number of deaths that could have been avoided with ESA measures. If fires resulting from heating or lighting sources are more deadly than other types of fires, then this estimate would not be valid for approximating the number of fire-related deaths avoided by ESA measures.

    - Lighting versus electrical causes: The report stated that only 13 percent of these fires were caused by lamps, bulbs, or other lighting with the remaining 87 percent caused by wiring, cords, plugs, and transformers. Since the only applicable measures included in the ESA program were various forms of LED lighting, nine percent likely overestimated the percentage of fires that could have been avoided by the installation of ESA measures.

- Life Value: The value of a life was estimated as $7.4 million based on the 2006 EPA valuation and adjusted for inflation. The EPA advises that this figure "be used in all benefits analyses that seek to quantify mortality risk reduction benefits regardless of the age, income, or other population characteristics of the affected population until revised guidance becomes available."[128]

The following inputs were used to calculate the cost of fire-related injuries.

- Injuries per Fire: The number of injuries per fire was calculated as 0.0328. The 2019 spreadsheet tool estimated the number of residential fire-related injuries as

[127] U.S. Fire Administration, FEMA, "Residential Building Fire Trends", March 2019, https://www.usfa.fema.gov/downloads/pdf/statistics/res_bldg_fire_estimates.pdf, page 3.
[128] "Mortality Risk Valuation," EPA, https://www.epa.gov/environmental-economics/mortality-risk-valuation

10,910 and the total number of fires to be 379,000 based on the value reported in an NFPA 2017 report.

- NFPA Fire Loss in the United States During 2017 Report: For full details regarding this report, see the discussion earlier in this section for fire-related deaths. The estimate of 10,910 injuries was calculated from FES data but information on the exact calculation was not provided.

  As with the number of residential fire-related deaths, this estimate came exclusively from the FES data instead of applying a FES estimate to the NFIRS data. The U.S. Fire Administration's report calculated only about 8,600 injuries compared to the 10,910 calculated by the NFPA. Furthermore, the report stated that 3,100 of these were the result of cooking-related fires.

  The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.
  - Fire and household type: This study did not differentiate the number of injuries by type of fire or household, which would be necessary to know the applicability of this estimate to the ESA program. If, as stated in the U.S. Fire Administration's report, fires resulting from heating or lighting sources cause fewer injuries than other types of fires, then this estimate would not be valid for approximating the number of fire-related injuries avoided by ESA measures.

- Cost per Injury: The cost per fire-related injury was estimated to be $63,000 based on the Banfield et al. 2014 study.
  - Banfield et al. 2014 Study: This study used data from a hospital in Ontario, Canada from 1995 to 2012 to estimate the average cost of burns resulting from residential fires. The analysis included 1,139 adults with an average cost of CAN$84,678 or about $63,000 U.S.

    The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.
    - Canadian healthcare study: This study was conducted in Canada, which has a different healthcare system than the United States. While the appropriate currency conversion factor was applied, the findings still may not have applied if healthcare costs differed substantially between American and Canadian hospitals.

    - Only burn injuries: The 2019 spreadsheet tool used this estimate as the cost per fire-related injury, but this study exclusively considered burn injuries resulting from a flame. Other types of burns and injuries resulting from a home fire, such as smoke inhalation, were not included in this analysis.

    - Injury severity: The cost per patient was based on the severity of injuries suffered from fires in Ontario, Canada. 81 of the 1,139 patients died within

24 hours of hospital admission and had low costs as a result. A further 246 individuals suffered burns to over 20 percent of their body and experienced much higher costs than the average of $63,000. This estimate may not be comparable to ESA participants if the severity of burns differed from the distribution observed in this study.

- Covered by Insurance (Injury): The percentage of medical costs not covered by insurance was estimated to be 34 percent based on the DHHS MEPS estimate for the percentage of individuals with insurance coverage.
  - DHHS MEPS: The 2016 household component of the Department of Health and Human Service's Medical Expenditure Panel Survey had a sample size of 33,259 individuals across 13,587 families and had a response rate of 71.2 percent in the first wave.

    The 2019 spreadsheet used the mean expenditure per medical event statistic for the Western U.S. to calculate the percentage of the average medical expenditure that was not covered by any form of insurance ("out of pocket").[129] The calculation is displayed in Table A-15D. The percentage of costs not covered by insurance was calculated as the average percentage of out of pocket costs across three insurance types.

Table A-15D
DHHS MEPS Out-of-Pocket Costs Calculation

Payment Source	Mean $ per Event in Western U.S. (2016)	% Out of Pocket
Any Source	$304	Not Calculated.
Out of Pocket	$36	-
Private	$118	$36/($36+$118)= 23%
Medicare	$77	$36/($36+$77)= 32%
Medicaid	$43	$36/($36+$43) = 46%
Other	$30	Not Calculated.
Average % Out of Pocket = (23% + 32% + 46%)/3 = 34%		

The 2019 spreadsheet tool used this value for different types of medical expenses in various NEB calculations. This method of calculating the average percentage of out of pocket costs had the following limitations.

- Ignored "Other" category: The other category included payments by the Department of Veteran's Affairs, state and local sources (e.g. health departments, clinics), and non-medical forms of insurance. Excluding this category may not have accurately reflected the average percentage of costs

[129] Statistics can be found at https://www.meps.ahrq.gov/mepstrends/hc_use/, but specific tables cannot be linked to. Select "Use, expenditures, and population" from the drop down menu, then select "Mean Expenditure per Event ($)" and "Cross-sectional" and choose to sort data by region and source of payment.

paid for out of pocket, especially since ESA participants may more frequently have relied on these sources than the rest of the population.

- Weighted all sources equally: This calculation weighted private insurance, Medicare, and Medicaid equally, but a much smaller percentage of the population was on Medicare and Medicaid. Weighting these percentages by the prevalence of the source would have provided a more accurate estimate.

- All expenditure types: MEPS provided the mean expenditure type per event for different medical events, but the average across all events was used. Excluding irrelevant costs would have provided a more accurate estimate.

- Ignored Uninsured: This calculation assumed that all individuals have insurance. MEPS data showed that 6.3 percent of individuals in the Western U.S. did not have public or private health insurance in 2016, and this percentage was likely to be higher for low-income households. Uninsured individuals likely experienced much higher expenses per medical event than the average of 34 percent.

The following inputs were used to calculate the cost of fire-related property damage.

- Property Damage: The amount of property damage per fire was calculated as $28,000 based on the NFPA 2017 Fire Loss in the United States Report. The report estimated total property damage in 2017 at $7.7 billion, but the 2019 spreadsheet tool included it as $7.9 billion and divided it by the number of fires of 379,000 to calculate the final value of $28,000.
  - NFPA Fire Loss in the United States During 2017 Report: For full details regarding this report, see the discussion earlier in this section for fire-related deaths. The estimate of $7.7 billion was exclusively for property loss in home fires, but the report did not provide further details about how it was estimated.

    As with the number of fire-related deaths and injuries, this statistic was based exclusively on FES data instead of applying the FES multiplier to NFIRS data. The U.S. Fire Administration's report found only about $5 billion in property damage from residential fires in 2018. Furthermore, it stated that only $600 million were the result of heating causes other than an open flame and $1.2 billion were the result of electrical malfunctions. These estimates were lower than those calculated in the 2019 spreadsheet tool.

    The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.

    - Starting property value: The potential for property loss is related to the original value of the property. If ESA participants have smaller houses than the national average, this report may overestimate the potential property damage in ESA households.

- Covered by Insurance (Property Damage): The amount of property damage covered by insurance was calculated to be 54 percent. The 2019 spreadsheet tool stated that it was the weighted average of 93 percent for homeowners (which are 25 percent of ESA customers) and 41 percent for renters. The spreadsheet provided citations for both the Banfield et al. 2014 study and the KFF, but these estimates could not be found in either source.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for participant NEBs (18%) was less than one.

  Factor = minimum of 1 or
  pmt(discount rate, yr horizon, PV(discount rate, measure life, 1))

  - Discount Rate = 18% (utility data)
  - Year Horizon = 10 years (utility data)
  - Weighted Measure Life = $\frac{\sum(Measure\ Lifetime * \#\ of\ Measures)}{Total\ \#\ of\ Measures}$ = 13.0
  - pmt(discount rate, yr horizon, PV(discount rate, measure life, 1)) = 1.09
    If the weighted measure life was less than the program horizon, this function would determine the amount by which the NEB should have been reduced.

  Table A-8E displays the measures included in the calculation of weighted measure life. These measures were included based on settings that can be modified by the utility.

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one.

  Factor = minimum of 1 or average number of causal measures

  - Total Number of Measures = 11,085
  - Total Number of Participants = 23,518
  - Average Number of Causal Measures = $\frac{\sum(\#\ of\ Measures)}{Total\ \#\ of\ Participants}$ = 0.47

  This adjustment factor can be turned on or off by utilities in the sensitivity options.

- Assumptions
  - Average fires per residential property per year of 0.003, equal to the finding on the NFPA's website.

- Percent of fires caused by heating appliances of 15%, equal to the finding of the NFPA for 2012-2016.
- Percent of fires caused by lighting and electric of 9%, calculated from the findings of the NFPA for 2012-2016.
- ESA impact of 0.00047, equal to the finding of the Tonn ORNL 2014 study.
- Number of deaths per fire of 0.007, calculated from the findings of the NFPA.
- Number of injuries per fire of 0.0328, calculated from findings of the NFPA.
- Cost per injury of $63,000, equal to the finding from the 2016 Banfield et al. study.
- Insurance coverage of 34%, calculated from the findings of the DHHS's MEPS survey.
- Average property damage of $20,844, calculated from the findings of the NFPA.
- Property insurance coverage of 54%, equal to the weighted average of 93% of homeowners and 41% of renters.

- Calculation: The following benefit calculations were made to find the total value of this NEB.
  - Number of Avoided Fires
  - Benefit from Avoided Deaths
  - Benefit from Avoided Injuries
  - Benefit from Avoided Property Damage

	A	*	((B	*	C)	+	(D	*	E))	*	F	=	
Year	Fires /HH		Caused by Heating Equipment		% with ESA Heating Measures		Caused by Electrical		% with ESA Lighting Measures		ESA Impact		Avoided Fires
2020	0.003		15%		47%		9%		100%		0.00047		0.000000226
2021	0.003		15%		47%		9%		100%		0.00047		0.000000226
2022	0.003		15%		47%		9%		100%		0.00047		0.000000226
2023	0.003		15%		47%		9%		100%		0.00047		0.000000226
2024	0.003		15%		47%		9%		100%		0.00047		0.000000226

	G	*	H	*	I	*		=	
Year	Fire Deaths		Cost per Death		Inflation		Avoided Fires per HH		Benefit from Avoided Deaths
2020	0.007		$7,400,000		1.31		0.000000226		$0.02
2021	0.007		$7,400,000		1.58		0.000000226		$0.02
2022	0.007		$7,400,000		1.62		0.000000226		$0.02
2023	0.007		$7,400,000		1.66		0.000000226		$0.02
2024	0.007		$7,400,000		1.70		0.000000226		$0.02

	J	*	K	*	L	*	M	*		=	
Year	Fire Injuries		Cost per Injury		Inflation		Insurance Coverage		Avoided Fires per HH		Benefit from Avoided Injuries
2020	0.0328		$63,000		1.10		34%		0.000000226		$0.00
2021	0.0328		$63,000		1.13		34%		0.000000226		$0.00
2022	0.0328		$63,000		1.16		34%		0.000000226		$0.00
2023	0.0328		$63,000		1.18		34%		0.000000226		$0.00
2024	0.0328		$63,000		1.21		34%		0.000000226		$0.00

	N	*	O	*	P	*		=	Benefit from Avoided Property Damage
Year	Fire Damage		Inflation		Insurance Coverage		Avoided Fires / HH		
2020	$20,844		1.05		54%		0.000000226		$0.00
2021	$20,844		1.07		54%		0.000000226		$0.00
2022	$20,844		1.10		54%		0.000000226		$0.00
2023	$20,844		1.13		54%		0.000000226		$0.00
2024	$20,844		1.15		54%		0.000000226		$0.00

	(	+		+	)	*	R	*	S	=	Annual Participant Impact
Year	Avoided Death Benefit		Avoided Injury Benefit		Avoided Property Damage Benefit		Adjust Prog. Horizon		Adjust # Measures		
2020	$0.02		$0.00		$0.00		1		1		$0.02
2021	$0.02		$0.00		$0.00		1		1		$0.02
2022	$0.02		$0.00		$0.00		1		1		$0.02
2023	$0.02		$0.00		$0.00		1		1		$0.02
2024	$0.02		$0.00		$0.00		1		1		$0.02

- Limitations
  - Use of 0.0003 as number of fires per residential property
  - Use of 15% as percentage of fires caused by heating appliances.
  - Use of 9% as percentage of fires caused by lighting or electrical.
  - Use of 0.00047 as ESA impact.
  - Use of 0.007 as number of deaths per fire.
  - Use of $7,400,000 as value of a life.
  - Use of 0.0328 as number of injuries per fire.
  - Use of $63,000 as cost per fire related injury.
  - Use of 34% as percentage of medical costs covered by insurance.
  - Use of $20,844 as average property damage from a fire.
  - Use of 54% as percentage of property damage covered by insurance.

- Applicability
  - Estimate for the number of fires may not apply to ESA participants.
  - Estimate for the percentage of fires caused by heating appliances may not apply to ESA participants.
  - Estimate for the percentage of fires caused by lighting and electrical may not apply to ESA participants.
  - Measure impact may not be applicable to ESA.
  - Estimate for the number of deaths from a fire may not apply to California.
  - Estimate for the number of injuries from a fire may not apply to California.
  - Estimate for insurance coverage of fire related injuries may not apply to ESA participants.
  - Estimate for amount of property damage may not apply to ESA participants.
  - Estimate for insurance coverage of fire related property damage may not apply to ESA participants.

- Duplication: This NEB did not duplicate another benefit calculated in this NEB analysis or other benefits that were already accounted for in the ESA cost-benefit analysis.

4. Fewer Sick Days from Work

Individuals who live in households with old or faulty equipment may have worse health and miss more work as a result. The 2019 report noted that there were dozens of studies from the early 2000s to 2018 that valued this NEB at about $150 per household.

This NEB was excluded, as the study referenced in the 2019 study is from 2001 and the more recent National WAP Evaluation found no impact on this indicator. This NEB also was not included in the 2019 model.

- ESA Impact: The 2019 study stated that ESA measures reduced the number of sick days used by participants. They estimated a $0.88 average annual benefit per participant in 2020 and adjusted that for inflation in the following years.

- Data: The following data were used as inputs in the research.

Table A-16A
Fewer Sick Days from Work Data Inputs

	Input	Source	Value	Notes
A	WAP HH with Employed Primary Wage Earner	APPRISE 2018[130]	31%	
B	Households without Sick Leave	Bureau of Labor Statistics 2019 Report[131]	53%	Those with sick in private industry (versus civilian or government) earning lowest 25% of salaries.
C	ESA Impact	Skumatz LIPPT 2001[132]	0.07	
D	Hourly Wage	2013 CA National Low-Income Housing Coalition[133]	$17.99	
E	Inflation Factor	Bureau of Labor Statistics	1.13-1.24	
F	Hours per Workday	Assumed	8	
G	Weighted Measure Life (Years)	Utilities	13	Sum (Measure Lifetime * # of Measure)/Total # of Measures
H	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
I	Adjustment Factor # of Measures	Utilities	0.47	Reduced to less than one if average # of causal measures per household was less than one.

[130] APPRISE, "National Weatherization Assistance Program Evaluation", 2018, http://www.appriseinc.org/wp-content/uploads/2018/02/WAP-Non-Energy-Benefits-Results-Report.pdf.
[131] https://www.bls.gov/news.release/pdf/ebs2.pdf, table 6.
[132] Skumatz LIPPT 2001.
[133] National Low-Income Housing Coalition, 2013, https://nlihc.org/oor/2013/ca.

- WAP Households with Employed Primary Wage Earner: The percentage of households with an employed primary wage earner was estimated to be 31 percent based on the 2018 APPRISE Study.
  - APPRISE 2018 Study: See discussion in Section A-B5: Reduced Sick Days from Work for the full details regarding this study. The 2019 spreadsheet tool used the pre-treatment WAP employment rate of 31 percent from this study as the estimate of the employment rate for ESA participants.

- Households without Sick Leave: The percentage of households without paid sick leave employment benefits was from the Bureau of Labor Statistics 2019 report on Employee Benefits in the United States.
  - Bureau of Labor Statistics 2019 Report: See discussion in Section A-B5: Reduced Sick Days from Work for the full details regarding this study. Selected results from the study are displayed in Table A-16B. The 2019 spreadsheet tool used the paid sick leave figure for the lowest 25 percent of earners, which was 47 percent.

Table A-16B
NCS March 2019 Paid Sick Leave Findings

	Paid Sick Leave
Lowest 10 percent of earners	30%
Lowest 25 percent of earners	47%
Second 25 percent of earners	77%
Third 25 percent of earners	86%
Highest 25 percent pf earners	90%
Northeast	76%
South	68%
Midwest	66%
West	86%

- ESA Impact: The ESA impact of seven percent was based on the Skumatz 2001 LIPPT study.
  - Skumatz 2001 LIPPT Study: See discussion in Section A-B5: Reduced Sick Days from Work for the full details regarding this study. The sick leave results referenced in the LIPPT study are displayed in Table A-16C.

Table A-16C
Skumatz 2001 LIPPT Analysis of LIEE Households

	Sick Leave
Average reduction in the number of sick days lost from work	7.1%
Any Change	16%
If Any:	
Somewhat Fewer	26%
Many Fewer	56%

- Estimated Hourly Wage: The estimated hourly wage was $17.99 based on the value for a California renter in the 2013 National Low-Income Housing Coalition Out of Reach Report, adjusted for inflation. The 2013 report could not be found at the specified link. The most recent report stated the average renter's wage was $22.79 in 2019.[134]

  The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.
  - Renters versus homeowners: The 2019 spreadsheet stated that 25 percent of ESA customers were homeowners. This estimate of the hourly wage for renters may not apply to them.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for participant NEBs (18%) was less than one. This is the same calculation as in Section A-B3 for Fewer Fires. No adjustment was made.

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one. This is the same calculation as in Section A-B5 for Reduced Sick Days from Work. No adjustment was made.

- Assumptions: Key assumptions that were made.
  - Percentage of ESA households with an employed worker of 31%, equal to the finding from the APPRISE 2018 study.
  - Percentage of employees with paid sick leave of 47%, based on lowest 25% of earners in private industry from a 2017 Bureau of Labor Statistics (BLS) report.
  - ESA Impact of 0.07, equal to the finding from the Skumatz 2001 LIPPT study.
  - Estimated hourly wage of $17.99, equal to the finding from a 2013 National Low-Income Housing Coalition Report.

[134] National Low Income Housing Coalition, "Out of Reach Report 2019", https://reports.nlihc.org/oor.

- Workday of eight hours.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	D	*	E	*	F	*	H	*	I	=	Annual
Year	Wage Earner		Sick Leave		ESA Impact		Hr. Wage		Inflation		Hours/ Day		Adjust Prog. Horizon		Adjust # Measures		Participant Impact
2020	31%		53%		0.07		$17.99		1.13		8		1		0.47		$0.88
2021	31%		53%		0.07		$17.99		1.16		8		1		0.47		$0.90
2022	31%		53%		0.07		$17.99		1.18		8		1		0.47		$0.92
2023	31%		53%		0.07		$17.99		1.21		8		1		0.47		$0.95
2024	31%		53%		0.07		$17.99		1.24		8		1		0.47		$0.97

- Limitations
  - Use of 31% as the percentage of households with an employed individual.
  - Use of 53% as the percentage of employees with paid sick leave.
  - Use of 0.07 as the ESA impact.
  - Use of $17.99 as the hourly wage.
  - Use of an eight-hour workday.

- Applicability
  - Percentage of households with an employed worker may not be applicable to ESA participants in 2020.
  - Percentage of employees with paid sick leave nationally may not apply to ESA participants in 2020.
  - Hourly wage may not apply in 2020 given CA minimum wage increases.
  - Hourly wage for renters may not apply to ESA participants who are homeowners.
  - Eight-hour workday may not apply to employed ESA participants.

- Duplication: This NEB did not duplicate another benefit calculated in this NEB analysis or other benefits that were already accounted for in the ESA cost-benefit analysis.

5. Fewer Sick Days from School

Individuals who live in households with old or faulty equipment may have worse health and miss more school as a result. The 2019 report noted that there were a few studies from the early 2000s that valued this NEB at about $10 per household.

This NEB was excluded, as the report referenced in the 2019 study found no statistically significant impacts and the indicator is not correctly applied in the 2019 model. The referenced study explicitly stated that there were "no meaningful changes" in this indicator. This NEB also was excluded from the 2019 model.

- ESA Impact: The 2019 study stated that ESA measures reduce the number of days of school missed by participants. They estimated a $0.25 average annual benefit per participant in 2020 and adjusted that for inflation in the following years.

- Data: The following data were used as inputs in the research.

Table A-17A
Fewer Sick Days from School Data Inputs

	Input	Source	Value	Notes
Total Reduction in Sick Days				
A	ESA Impact on Absent Students	National Occupant Survey, APPRISE 2018[135]	2%	
B	Likelihood of Dropping Out	Utah Education Policy Center 2012[136]	2.21	
C	Average Children per Household	CA 2000 Census	1.95	For families with children.
D	Households with Children	CA 2000 Census	52%	
E	ESA Impact (days)	National Occupant Survey, APPRISE 2018	0.31	Displayed in spreadsheet tool as 31%.
Cost of Childcare				
F	Daily Wage for Childcare	Childcareaware.org	$96.88	Assumes an 8-hour workday.
G	Inflation Factor	Bureau of Labor Statistics	1.05-1.15	
H	Families Needed Some Form of Childcare	Childcareaware.org	73%	
Adjustment Factors				
I	Weighted Measure Life (Years)	Utilities	13	Sum (Measure Lifetime * # of Measure)/Total # of Measures
J	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
K	Adjustment Factor Number of Measures	Utilities	0.47	Reduced to less than one if average # of causal measures per household was less than one.

The following inputs were used to calculate the total reduction in missed schooldays due to illness per household.

- ESA Impact on Chronically Absent Students: The ESA impact was estimated as two percent based on the 2018 APPRISE WAP study.
  - 2018 APPRISE Study: See discussion in Section A-B5: Reduced Sick Days from Work for the full details regarding this study.

    Table A-17B displays the missed school days results from the study. The 2019 spreadsheet tool did not clearly state which category was used, but it was most

[135] APPRISE, "National Weatherization Assistance Program Evaluation", 2018, http://www.appriseinc.org/wp-content/uploads/2018/02/WAP-Non-Energy-Benefits-Results-Report.pdf.
[136] Utah Education Policy Center, "Research Brief: Chronic Absenteeism", The University of Utah, July 2012, https://www.attendanceworks.org/wp-content/uploads/2017/09/UTAH-Chronic-AbsenteeismResearch-Brief-July-2012.pdf

likely the net change between the treatment and comparison groups for students missing eleven to 30 days of school.

Table A-17B
APPRISE Analysis of WAP School Days Missed due to Illness or Injury

Days Missed	Treatment Group			Comparison Group Change			Net Change
	Pre	Post	Percentage Point Change	Pre	Post	Percentage Point Change	
No days	6%	6%	0%	4%	6%	1%	-1%
1-5 days	9%	10%	2%	10%	7%	-2%	4%*
6-10 days	4%	2%	-2%**	4%	4%	0%	-2%
11-30 days	4%	2%	-2%***	2%	1%	-1%	-2%*
More than 30 days	0%	0%	0%	1%	0%	-1%	0%
Not in School	76%	79%	2%	80%	82%	2%	0%
Average	1.64	0.78	-0.86***	1.30	0.75	-0.55*	-0.31

The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.

- Missed school days by region: The APPRISE study did not break down missed school days by region. Comparability to the ESA program could not be known without understanding whether the national findings applied to the level of missed school days for ESA participants in California.

- Likelihood of Dropping Out: The likelihood of dropping out was estimated to be 2.21 times as likely for students that were chronically absent based on a research brief by the Utah Education Policy Center.
  - Utah Education Policy Center 2012 Research Brief: This study used data on the class of 2010 in Utah public schools to estimate that on average students who were chronically absent were 2.21 times as likely to drop out as students who were not.

  Table A-17C displays the odds of dropping out because of chronic absenteeism in each grade. The research brief stated that a log odds model was used to calculate the effect of chronic absenteeism on dropouts. The model included dichotomous indicator variables for low GPA, low income, special education, English proficiency, and racial minority.

Table A-17C
Utah Education Policy Center Research Brief
Odds of Dropping Out

Chronically Absent in:	Odds of Dropping Out
12th Grade	1.69
11th Grade	2.32
10th Grade	2.70
9th Grade	2.25
8th Grade	2.10
Average	2.21

The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.

- Unclear covariate cutoffs: The model used to calculate the odds of dropping out included dichotomous indicator variables defined by cutoffs that were not discussed in the study. Without understanding these coding choices, the applicability of this estimate could not be known.

- Low-income students: The study also found that low-income students were 1.9 times as likely to be chronically absent compared to other students. Given this evidence that absenteeism varies by income, the likelihood of dropping out may as well. Understanding how these results would change for the subpopulation of ESA participants is necessary for knowing the applicability of this estimate.

- Statistical significance: Although this study mentioned in the discussion that a few values were statistically significant, no metrics of statistical confidence were reported for the dropout likelihood of 2.21. This information would be necessary to fully assess the validity of this finding.

- Average Children per Household: The number of children per household with at least one child was estimated as 1.95 based on the 2000 California U.S. Census.
  - 2000 U.S. Census: The 2019 spreadsheet tool cited the U.S. Census Bureau housing homepage but did not state the dataset or publication explaining how this value was calculated.

- Households with Children: The percentage of households with children was estimated as 52 percent based on the 2000 California U.S. Census.
  - 2000 U.S. Census: The 2019 spreadsheet tool cited the U.S. Census Bureau housing homepage but did not state the dataset or publication explaining this estimate.

When combined with the previous estimate of 1.95 children per household with at least one child, the 2019 spreadsheet tool calculated 0.998 children per household. This is slightly below the estimate of 1.01 used in other NEBs. The spreadsheet tool did not explain why different methods for the same statistic were used.

- ESA Impact: The ESA impact was estimated as 0.31 fewer missed school days based on the 2018 APPRISE WAP study.
  - 2018 APPRISE Study: See discussion in Section A-B5: Reduced Sick Days from Work and in this section for the full details regarding this study. Table A-17C displays the results of this study for school days missed due to illness or injury.

    The estimate of a 0.31-day reduction in missed school was reported as the average across all groups in the study. This finding was not statistically significant, and the study explicitly stated that there were "no meaningful changes" in this indicator.

    The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.
    - Unclear categorization: The estimated ESA reduction of 0.31 fewer missed school days was the average across all groups of students. However, this reduction is only applied to the percentage of students who were chronically absent, which is defined in the Utah Education Policy Brief used in this section as students who missed ten percent of the school year or more. This average estimate for all students is likely not correct for that subpopulation.

The following inputs were used to calculate the cost of each missed school day.

- Daily Wage for Childcare: The median California 2016 hourly wage was estimated as $12.11 from the U.S. Bureau of Labor Statistics, based on data collected from employers in all industry sectors in all areas of California.

  The median wage in 2016 was adjusted for inflation but did not consider annual increases in the California minimum wage that began in 2017 and are scheduled to continue through 2023.

  The hourly wage was then multiplied by eight to estimate the total cost of childcare per day of $96.88, but the 2019 spreadsheet tool acknowledged this was a conservative estimate.

- Families Needing Some Form of Childcare: The percentage of families that require some amount of childcare was 73 percent. The 2019 spreadsheet tool cited

childcareaware.org but did not state the specific report where this estimate was obtained.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for participant NEBs (18%) was less than one. This is the same calculation as in A-C3 for Reduced Fires. No adjustment was made.

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one. This is the same calculation as in A-C3 for Reduced Fires. No adjustment was made.

- Assumptions: Key assumptions that were made.
  - ESA impact on child absenteeism of 2%, equal to the finding from the 2018 APPRISE study.
  - Likelihood of dropping out of 2.21 times higher for students that are chronically absent compared to those that are not, equal to the finding from a 2012 Utah Education Policy Center policy brief.
  - Average number of children per household with at least one child of 1.95, equal to the finding from the 2000 U.S. Census for California.
  - Percentage of households with at least one child of 52%, equal to the finding from the 2000 U.S. Census for California.
  - ESA impact of 0.31 school days, equal to the finding in the 2018 APPRISE study but not statistically significant.
  - Workday of eight hours for childcare workers in California.
  - Percentage of families that need some form of childcare of 73%, equal to the finding cited from childcareaware.org.

- Calculation: The following calculation was made to compute the annual benefit.

  This calculation included subtotals for the total reduction in missed school days and the daily cost of childcare, but the following components were not clearly explained.
  - This NEB is meant to capture the benefit from fewer missed school days, but this calculation multiplied the reduction in missed school days by the expected ESA impact on chronically absent students (those who missed 10 percent or more of the school year) and the likelihood of dropping out as a result of being chronically absent. The 2019 spreadsheet tool did not state why these adjustments were made.

	A	*	B	*	C	*	D	*	E	=	Total Reduction in Missed School Days
Year	ESA Impact on Chronically Absent		Dropping Out Multiplier		Average Children per HH		HH w. Children		ESA Reduction in Missed Days		
2020	2%		2.21		1.95		52%		0.31		0.014
2021	2%		2.21		1.95		52%		0.31		0.014
2022	2%		2.21		1.95		52%		0.31		0.014
2023	2%		2.21		1.95		52%		0.31		0.014
2024	2%		2.21		1.95		52%		0.31		0.014

	F	*	G	*	H	*	D	=	Childcare Cost per Day
Year	Daily Wage		Inflation		Families Needing Childcare		Households with Children		
2020	$96.88		1.05		73%		52%		$38.61
2021	$96.88		1.07		73%		52%		$39.35
2022	$96.88		1.10		73%		52%		$40.45
2023	$96.88		1.13		73%		52%		$41.56
2024	$96.88		1.15		73%		52%		$42.29

		*		*	J	*	K	=	Annual Participant Impact
Year	Total Reduction in Missed School Days		Childcare Savings per Day		Adjust Prog. Horizon		Adjust # Measures		
2020	0.014		$38.61		1		0.47		$0.25
2021	0.014		$39.35		1		0.47		$0.26
2022	0.014		$40.45		1		0.47		$0.26
2023	0.014		$41.56		1		0.47		$0.27
2024	0.014		$42.29		1		0.47		$0.28

- Limitations
  - Use of 2% as impact on absenteeism.
  - Use of 2.21 times as likely that a student drops out for those that are chronically absent compared to those that are not.
  - Use of 1.95 as number of children at home for households with at least one child.
  - Use of 52% as percentage of households with children.
  - Use of 0.31 days as ESA impact on fewer missed school days.
  - Use of 73% as percentage of families in need of childcare.
  - Use of an eight-hour workday.

- Applicability
  - Estimate of absenteeism may not apply to ESA participants.
  - Estimate of likelihood of dropping out may not apply to ESA participants.
  - Number of children per household with at least one child may not apply to ESA participants in 2020.
  - Percentage of households with children may not apply to ESA participants in 2020.
  - ESA reduction in missed school days may not apply to ESA participants.
  - Percentage of families that need childcare may not apply to ESA participants.

- Duplication: This NEB did not duplicate another benefit calculated in this NEB analysis or other benefits that were already accounted for in the ESA cost-benefit analysis.

6. Fewer CO Poisonings

Hospitalizations and emergency department visits due to carbon monoxide poisoning have costs. The 2019 report noted dozens of studies from the early 2000s to 2018 that valued this NEB at about $5.00 per household.

This NEB was excluded because the number of CO poisonings is too low to measure a significant impact from the program. It is included as part of the general health impact in the 2020 model.

- ESA Impact: The 2019 study stated that the installation of carbon monoxide monitors would reduce the number of CO poisonings and deaths, which would benefit participants by reducing medical costs. They estimated a $0 average annual benefit per participant in 2020 and adjusted that for inflation in the following years (no CO monitors were included in the utility data).

  The reduction in hospitalizations and emergency department visits would have been about $0.07 per household if one monitor were installed per household.

- Data: The following data were used as inputs in the research.

Table A-18A
Fewer CO Poisonings Data Inputs

	Input	Source	Value	Notes
Impact of CO Related Hospitalizations				
A	Individuals per Household	2010 U.S. Census[137]	2.58	
B	CO Hospitalizations per Person	2010-2013 UNFR from Stearns and Sircar 2019[138]	0.0000041	
C	ESA Impact of Hospitalizations	ORNL 2014 WAP[139]	92%	
D	Cost of CO Hospitalization	Hampson 2015; Miller and Bhattacharya 2013[140]	$15,569	Acute medical costs, not lifetime.

[137] 2010 U.S. Census, https://www.census.gov/prod/cen2010/briefs/c2010br-14.pdf
[138] Stearns, Dorothy and Sircar, Kanta, "National unintentional carbon monoxide poisoning estimates using hospitalization and emergency department data", *The American Journal of Emergency Medicine,* March 2019, https://www.sciencedirect.com/science/article/pii/S0735675718304649
[139] APPRISE, "National Weatherization Assistance Program Evaluation", 2018, http://www.appriseinc.org/wp-content/uploads/2018/02/WAP-Non-Energy-Benefits-Results-Report.pdf.
[140] Hampson, Neil B., "Cost of accidental carbon monoxide poisoning: A preventable expense", *Preventive Medicine Reports,* 2016 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4733068/pdf/main.pdf; Miller, T., Bhattacharya, S., 2013. "Incidence and cost of carbon monoxide poisoning for all ages, pool and spa submersions for ages 0–14, and lead poisoning for ages 0–4. Final report."

	Input	Source	Value	Notes
E	Inflation Factor	Bureau of Labor Statistics	1.05-1.15	
F	Payment Out of Pocket	MEPS[141]	34%	
Impact of CO Related Emergency Department Visits				
G	ED Visits	2010-2013 UNFR Stearns Sircar Study	0.000048	
H	ESA Impact on ED Visits	ORNL 2014 WAP	79%	
I	Cost of ED Visit	MEPS	$563	
J	Inflation Factor	Bureau of Labor Statistics	1.11-1.12	Spreadsheet tool includes inflation factor to adjust cost of ED Visit, but does not include it in the calculation.
K	Number of CO Monitors Installed	Utilities	0	
Adjustment Factors				
L	Weighted Measure Life (Years)	Utilities	0	Sum (Measure Lifetime * # of Measure)/Total # of Measures
M	Adjustment Factor Program Horizon	Utilities	0	Reduced to less than one if discounted remaining weighted measure life was less than one.
N	Adjustment Factor Number of Measures	Utilities	1	Reduced to less than one if average # of causal measures per household was less than one.

The following inputs were used to calculate the potential ESA impact of CO-related hospitalizations.

- Individuals per Household: The number of individuals per household was estimated as 2.58 people from the 2010 U.S. Census. This was equal to the total 2010 population of 300.8 million divided by the total number of households, which was 116.7 million. This estimate was slightly below the 2000 estimate of 2.59 and did not include the 8.0 million people who lived in school dormitories, nursing homes, or prisons.

  The 2010 U.S. Census report included the number of individuals per household in California as 2.90, which would have been a more accurate estimate to use for ESA participants.

- CO Hospitalizations per Person: The number of hospitalizations due to CO poisonings was estimated as 0.0000041 based on the Stearns and Sircar 2019 study.
  - Stearns and Sircar 2019 Study: See discussion in Section A-B6: Reduced CO Deaths and Poisonings for the full details regarding this study. The national estimate from the Sircar et al. study is displayed in Table A-18B. The more applicable estimate for the Western region of the U.S. is also included in this table.

Consumer Product Safety Commission Contract D-09-003. http://www.cpsc.gov//Global/Research-and-Statistics/Injury-Statistics/Carbon-Monoxide-Posioning/IncidenceandCostofCarbonMonoxidePoisoningPoolandSpaSubmersionandLeadPosioning.pdf

[141] Department of Health and Human Services, MEPS, 2017, https://meps.ahrq.gov/mepstrends/hc_use/.

Table A-18B
Stearns and Sircar CO Impact on Hospitalizations Results

	Estimate (per million)	Confidence Interval	Estimate (per person)
Stearns and Sircar 2019 National Estimate (used in 2019 spreadsheet tool)	4.13	(4.06, 4.20)	$0.06
Stearns and Sircar 2019 West Estimate	2.86	(2.73, 2.99)	$0.05

- ESA Impact of Hospitalizations: The ESA impact on the number of hospitalizations was estimated as 92 percent based on the Krenzelok et al. 1996 study.
  - Krenzelok et al. 1996 Study: See discussion in Section A-B6: Reduced CO Deaths and Poisonings for the full details regarding this study. The CO hospitalization results from the study are displayed in Table A-18C.

Table A-18C
Krenzelok et al. 1996 CO Detector Impact on Hospitalizations Results

CO Monitor Present	Total Individuals	Symptomatic Individuals	Percentage Symptomatic
Yes	60	2	7.69%
No	41	24	92.31%
Total	**101**	**26**	**100.00%**

- Cost of CO Hospitalization: The cost of hospitalizations due to CO poisonings was estimated as $15,569 based on the Miller and Bhattacharya 2013 study.[142]
  - Miller and Bhattacharya 2013 Study: This study reported that the mean hospital costs for carbon monoxide poisoning in the HCUP NIS 2007 data was $15,769, based on 243 nonfatal CO-related hospitalizations. See discussion in Section A-B6: Reduced CO Deaths and Poisonings for the full details regarding the HCUP NIS dataset.

- Payment Out of Pocket: The percentage of medical costs not covered by insurance was estimated to be 34 percent based on the DHHS MEPS estimate for the percentage of people with insurance coverage.
  - DHHS MEPS: See discussion in Section A-B3: Fewer Fires for the full details regarding this survey and the limitations of this calculation.

    The 2019 spreadsheet used the mean expenditure per medical event statistic for the Western U.S. to calculate the percentage of the average medical expenditure

[142] The 2019 spreadsheet tool referenced a Hampson 2015 study, which incorrectly reported the findings of Miller and Bhattacharya 2013 as $15,569 instead of $15,769. This incorrect value was used in the spreadsheet.

that was not covered by any form of insurance ("out of pocket").[143] The calculation is displayed in Table A-18D. The percentage of costs not covered by insurance was calculated as the average percentage of out of pocket costs across three insurance types.

Table A-18D
DHHS MEPS Out-of-Pocket Costs Calculation

Payment Source	Mean $ per Event in Western U.S. (2016)	% Out of Pocket
Any Source	$304	Not Calculated.
Out of Pocket	$36	-
Private	$118	$36/($36+$118)= 23%
Medicare	$77	$36/($36+$77)= 32%
Medicaid	$43	$36/($36+$43)= 46%
Other	$30	Not Calculated.
Average % Out of Pocket = (23% +32% + 46%)/3= 34%		

The following inputs were used to calculate the potential ESA impact of CO related emergency department visits.

- ED Visits: Emergency department visits due to CO poisoning were estimated as 0.000048 per person based on the Stearns and Sircar 2019 study.
  - Stearns and Sircar 2019 study: See discussion in Section A-B6: Reduced CO Deaths and Poisonings for the full details regarding this study. The national estimate from the Sircar et al. Study is displayed in Table A-18E. The more applicable estimate for the Western region of the U.S. is also included in this table.

Table A-18E
Stearns and Sircar CO Impact on ED Visits Results

	Estimate (per million)	Confidence Interval	NEB Estimate (per person)
Stearns and Sircar 2019 National Estimate (used in 2019 spreadsheet tool)	48.26	(47.96, 48.55)	$0.02
Stearns and Sircar 2019 West Estimate	24.87	(20.35, 21.08)	$0.01

- ESA Impact on ED Visits: The ESA impact on the number of emergency department visits was estimated as 79 percent based on the Krenzelok et al. 1996 study.

[143] Statistics can be found at https://www.meps.ahrq.gov/mepstrends/hc_use/, but specific tables cannot be linked to. Select "Use, expenditures, and population" from the drop down menu, then select "Mean Expenditure per Event ($)" and "Cross-sectional" and choose to sort data by region and source of payment.

- Krenzelok et al. 1996: See discussion in Section A-B6: Reduced CO Deaths and Poisonings for the full details regarding this study. The CO ED visits results from the study are displayed in Table A-18F.

Table A-18F
Krenzelok et al. 1996 Impact on CO ED Visits Results

CO Monitor Present	Total Individuals	Symptomatic Individuals	Percentage Symptomatic
Yes	60	7	21.21%
No	41	26	78.79%
Total	**101**	**33**	**100.00%**

- Cost of ED Visit: The cost of an emergency department visit was estimated as $563 and referenced the DHHS MEPS mean expenditure for an individual with poisoning by medical and non-medical substances. The spreadsheet then adjusted the value for inflation. However, the MEPS summary tables reported this cost as $1,560 in 2016 and $1,269 in 2017. It is not clear how the $563 figure was calculated.

- Number of CO Monitors Installed: The number of CO detectors per household was estimated as 0 from utility data.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for participant NEBs (18%) was less than one.

  Factor = minimum of 1 or
  pmt(discount rate, yr horizon, PV(discount rate, measure life, 1))

  - Discount Rate = 18% (utility data)
  - Year Horizon = 10 years (utility data)
  - Weighted Measure Life = $\frac{\sum(Measure\ Lifetime * \#\ of\ Measures)}{Total\ \#\ of\ Measures}$ = 0.0
  - pmt(discount rate, yr horizon, PV(discount rate, measure life, 1)) = 0.0

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household were less than one.

  Factor = minimum of 1 or average number of causal measures

  - Total Number of Measures = 0

- Total Number of Participants = 23,518
- Average Number of Causal Measures = $\frac{\sum(\#\ of\ Measures)}{Total\ \#\ of\ Participants}$ = 0.0

This adjustment factor can be turned on or off by utilities in the sensitivity options.

- Assumptions: Key assumptions that were made.
  - Household size of ESA participants of 2.58, equal to the finding of the 2010 Census, national data.
  - Chance of a hospitalization resulting from CO poisoning of 0.0000041, equal to the finding of the Stearns and Sircar 2019 study.
  - ESA impact on hospitalizations of 92%, equal to the finding from the Krenzelok et al. 1996 study.
  - Cost of hospitalizations from CO poisoning of $15,569, equal to the finding from the Miller and Bhattacharya 2013 study.
  - Payment out of pocket of 34%, equal to the finding from the DHHS MEPS survey.
  - Chance of an emergency department visit resulting from CO poisoning of 0.000048, equal to the finding of the Stearns and Sircar 2019 study.
  - ESA impact on emergency department visits of 79%, equal to the finding from the Krenzelok et al. 1996 study.
  - Cost of emergency department visits from CO poisoning of $563, equal to the finding from the DHHS MEPS survey.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	D	*	E	*	F	=	Impact on
Year	HH Size		CO Hospital.		ESA Impact		Cost per Hospital.		Inflation		Insurance Coverage		CO Hospital
2020	2.58		0.0000041		92%		$15,569		1.05		0.34		$0.05
2021	2.58		0.0000041		92%		$15,569		1.07		0.34		$0.06
2022	2.58		0.0000041		92%		$15,569		1.10		0.34		$0.06
2023	2.58		0.0000041		92%		$15,569		1.13		0.34		$0.06
2024	2.58		0.0000041		92%		$15,569		1.15		0.34		$0.06

	A	*	G	*	H	*	I	*	F	=	Impact on CO
Year	HH Size		ED Visits		ESA Impact		Cost per ED Visit		Insurance Coverage		ED Visits
2020	2.58		0.000048		79%		$563		0.34		$0.02
2021	2.58		0.000048		79%		$563		0.34		$0.02
2022	2.58		0.000048		79%		$563		0.34		$0.02
2023	2.58		0.000048		79%		$563		0.34		$0.02
2024	2.58		0.000048		79%		$563		0.34		$0.02

	(	+	)	*	K	*	M	*	N	=	
Year	Impact on CO Hospitalizations		Impact on CO ED Visits		CO Monitors per Home		Adjust Prog. Horizon		Adjust # Measures		Annual Participant Impact
2020	$0.05		$0.02		0		0		1		$0.00
2021	$0.06		$0.02		0		0		1		$0.00
2022	$0.06		$0.02		0		0		1		$0.00
2023	$0.06		$0.02		0		0		1		$0.00
2024	$0.06		$0.02		0		0		1		$0.00

- Limitations
  - Use of 2.58-person as household size.
  - Use of 0.0000041 as rate of hospitalizations from CO poisoning.
  - Small sample size (41 households) used to calculate the 92% reduction in CO poisoning hospitalizations and the 79% reduction in CO poisoning ED visits.
  - Use of $15,569 as cost for each CO poisoning hospitalization.
  - Use of 0.000048 as rate of ED visits from CO poisoning.
  - Use of $563 as cost for each CO poisoning ED visit.

- Applicability
  - Number of hospitalizations for CO poisoning may not apply to California in 2020.
  - Impact on CO hospitalizations may not apply to ESA participants.
  - Cost of a CO hospitalization may not apply to California.
  - Number of ED visits for CO poisoning may not apply to California in 2020.
  - Impact on CO emergency department visits may not apply to ESA participants.

- Duplication: This NEB did not duplicate another benefit calculated in this NEB analysis or other benefits that were already accounted for in the ESA cost-benefit analysis.

7. Fewer Asthma Incidences

Households with old or faulty equipment may have poor air quality, which can impact childhood asthma. The 2019 report noted that there are over a dozen studies from the mid to late 2010s that value this NEB at around $15 per household, making it important to include.

This NEB was excluded, as the 2019 model used a study with a very small sample size to measure the impact. The National WAP Evaluation did not find a significant impact on asthma incidents. Additionally, this NEB will only impact those with asthma.

- ESA Impact: The 2019 study stated that ESA measures improved household air quality and reduced the number of children with asthma. They estimated a $0.95 average annual benefit per participant in 2020 and adjusted that for inflation in the following years.

- Data: The following data were used as inputs in the research.

Table A-19A
Reduced Asthma Incidents Data Inputs

	Input	Source	Value	Notes
A	Children per Home	2000 CA Census[144]	1.01	
B	Childhood Asthma Environmentally Attributable	CA Chronic Disease Fact Sheet 2015[145]	30%	
C	Childhood Asthma Incidence	CA Department of Public Health 2017[146]	10%	
D	Medical Costs of Asthma	DHHS MEPS 2005	$629.69	Adjusted to 2016 by previous study and adjusted again in the spreadsheet tool.
E	Inflation Factor	Bureau of Labor Statistics	1.36-1.49	
F	Not Covered by Insurance	DHHS MEPS	34%	
G	Reduction in Asthma Occurrence	Breysse 2014[147]	23%	
H	Weighted Measure Life (Years)	Utilities	13	Sum (Measure Lifetime * # of Measure)/Total # of Measures
I	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
J	Adjustment Factor Number of Measures	Utilities	0.47	Reduced to less than one if average # of causal measures per household was less than one.

  - Children per Home: The number of children per household was estimated as 1.01 based on the 2000 California U.S. Census.
    - 2000 U.S. Census: The 2000 U.S. Census reported that the total number of children under 18 in California in 2000 was 8,035,222 and the total number of families was 7,920,049, resulting in 1.01 children per family.

  - Childhood Environmentally Attributable Asthma: The percentage of childhood asthma that was environmentally attributable was estimated as 30 percent based on the California Department of Public Health's 2015 Chronic Disease Fact Sheet.

[144] U.S. Bureau of the Census, September 2004, https://www.census.gov/population/socdemo/hh-fam/tabST-F1-2000.pdf
[145] California Environmental Health Tracking Program, "Costs of Environmental Health Conditions in California Children", June 2015, https://www.phi.org/uploads/files/2015ROI_CEHTP.pdf
[146] California Department of Public Health, "Asthma Prevalence in California: A Surveillance Report", January 2017, https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/EHIB/CPE/CDPH%20Document%20Library/Asthma_Surveillance_in_CA_Report_2017.pdf
[147] Breysse, Jill ; Dixon, Sherry; Gregory, Joel; Philby, Miriam; Jacobs, David; and Krieger, James, "Effect of Weatherization Combined with Community Health Worker In-Home Education on Asthma Control," *American Journal of Public Health*, January 2014, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3910032/pdf/AJPH.2013.301402.pdf. Spreadsheet also mentions 2014 ORNL study.

- 2015 Chronic Disease Fact Sheet: See discussion in Section A-B7: Reduced Asthma Incidents for the full details regarding this study. The environmentally attributable asthma results from the study are displayed in Table A-19B. The EAF estimate was 30 percent with a possible range of 20 to 41 percent.

Table A-19B
CA Chronic Disease Fact Sheet
Environmentally Attributable Asthma Calculation

Condition	EAF Estimate	Possible Range of Values
Asthma	30%	(20%, 41%)

- Childhood Asthma Incidence: The incidence of childhood asthma was estimated as 9.9 percent based on the California Department of Public Health 2017 Asthma Surveillance in CA Report.
  - Asthma Surveillance in CA Report: See discussion in Section A-B7: Reduced Asthma Incidents for the full details regarding this study. The 2019 spreadsheet tool used the estimate for those in the "poor" poverty level defined by the U.S. Census Bureau as those below the poverty line. The findings are displayed in Table A-19C.

Table A-19C
Asthma Surveillance in CA Report
Childhood Asthma Incidence

Poverty Level	Asthma Prevalence	95% Confidence Interval
Poor	9.9%	(5.1%, 14.6%)

- Medical Costs of Asthma: The direct medical cost of asthma was estimated using the cost of allergic rhinitis from the 2005 DHHS MEPS survey. This value was updated to 2016 by a second study but not modified in any other way. It was then adjusted again for inflation in the 2019 spreadsheet tool.[148]
  - DHHS MEPS: The household component of the DHHS MEPS survey is administered annually to a nationally representative sample of households and included 12,810 families and 32,320 individuals in 2005. Household surveys were supplemented with additional data from their medical providers.

    The cost of allergic rhinitis was used as an approximation for the cost of asthma. The 2019 spreadsheet tool cited the Mudarri 2016 study, which stated that total

[148] The 2019 spreadsheet tool cited a Mudarri 2016 (Mudarri, David. "Valuing the Economic Costs of Allergic Rhinitis, Acute Bronchitis, and Asthma from Exposure to Indoor Dampness and Mold in the US," *Journal of Environmental Public Health*, 2016.) study of the costs of allergic rhinitis and asthma caused by dampness and mold. This study provided a discussion and sensitivity analysis regarding willingness to pay and cost of illness estimates for the total costs of allergic rhinitis and asthma, but the 2019 spreadsheet used the direct cost of allergic rhinitis reported as an input for these analyses.

direct medical expenses from asthma should be $879 instead of $629.29 in 2016. However, this value was not used in the 2019 spreadsheet tool.

The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.

- Adult versus child costs: The DHHS MEPS estimate used was for the medical costs of adult asthma, but this NEB specifically considers the benefit for asthma in children. The applicability of this value could not be assessed without understanding whether the costs differed between children and adults.

- Asthma Costs Not Covered by Insurance: The percentage of asthma costs not covered by insurance was estimated to be 34 percent based on the DHHS MEPS estimate from 2016.
  - DHHS MEPS: See discussion in Section A-C3: Fewer Fires for the full details regarding this survey and the limitations of this calculation.

  The 2019 spreadsheet used the mean expenditure per medical event statistic for the Western U.S. to calculate the percentage of the average medical expenditure that was not covered by any form of insurance ("out of pocket").[149] The calculation is displayed in Table A-19D. The percentage of costs not covered by insurance was calculated as the average percentage of out of pocket costs across three insurance types.

Table A-19D
DHHS MEPS Out-of-Pocket Costs Calculation

Payment Source	Mean $ per Event in Western U.S. (2016)	% Out of Pocket
Any Source	$304	Not Calculated.
Out of Pocket	$36	-
Private	$118	$36/($36+$118)= 23%
Medicare	$77	$36/($36+$77)= 32%
Medicaid	$43	$36/($36+$43) = 46%
Other	$30	Not Calculated.
Average % Out of Pocket = (23% + 32% + 46%)/3 = 34%		

- Reduction in Asthma Occurrence: The ESA impact on asthma occurrence was estimated as 23 percent based on the Breysse et al. 2014 study.

[149] Statistics can be found at https://www.meps.ahrq.gov/mepstrends/hc_use/, but specific tables cannot be linked to. Select "Use, expenditures, and population" from the drop down menu, then select "Mean Expenditure per Event ($)" and "Cross-sectional" and choose to sort data by region and source of payment.

- Breysse et al. 2014 Study: See discussion in Section A-B7: Reduced Asthma Incidents for the full details regarding this study. The value used in the spreadsheet as the impact on childhood asthma was the difference between the percentage point change in the treatment and the comparison group. Table A-19E displays the results from this study.

Table A-19E
Breysse et al. Asthma Impact Results

	# of Children	Pre Asthma Rate	Post Asthma Rate	Percentage Point Change	Statistically Significant
Treatment Group	33	100%	28.8%	-71.2%	Yes
Comparison Group	68	100%	51.6%	-48.4%	Yes
Net Change				-22.8%	Yes

  - Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for participant NEBs (18%) was less than one. This is the same calculation as in Section A-C3 for Reduced Fires. No adjustment was made.

  - Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one. This is the same calculation as in Section A-C3 for Reduced Fires.

- Assumptions: Key assumptions that were made.
  - Average number of children per household of 1.01, equal to the finding from the 2000 U.S. Census for California.
  - Medical costs of asthma of $629.69, equal to the finding of the DHHS's MEPS survey for allergic rhinitis.
  - Percentage of healthcare costs not covered by insurance of 34%, equal to the calculation from the findings of the DHHS's MEPS.
  - ESA impact of 2%, equal to the finding from the Breyesse 2014 study.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	D	*	E	*	F	*	G	*	I	*	J	=	
Year	Child per HH		Environ. Asthma		Asthma Incidence		Medical Costs		Inflation		Insured		ESA Impact		Adjust Prog. Horizon		Adjust # Measures		Annual Participant Impact
2020	1.01		30%		10%		$629.69		1.34		34%		23%		1		0.47		$0.95
2021	1.01		30%		10%		$629.69		1.39		34%		23%		1		0.47		$0.97
2022	1.01		30%		10%		$629.69		1.42		34%		23%		1		0.47		$0.99
2023	1.01		30%		10%		$629.69		1.46		34%		23%		1		0.47		$1.02
2024	1.01		30%		10%		$629.69		1.49		34%		23%		1		0.47		$1.04

- Limitations
  - Use of 1.01 as average number of children per household.
  - Use of $629.69 as medical costs of asthma.
  - Use of 34% as percent of asthma costs not covered by insurance.
  - Small sample size of 33 children used to calculation the 23% ESA impact.

- Applicability
  - Household size may not apply to ESA participants in 2020.
  - Medical costs of asthma may not apply to California in 2020.
  - ESA impact from 2014 Breysse study may not apply to ESA program.

- Duplication: This NEB did not duplicate another benefit calculated in this NEB analysis or other benefits that were already accounted for in the ESA cost-benefit analysis.

8. Reduction in Allergies

ESA program services can impact air quality by improving systems and ventilation and sealing the home to reduce outdoor pollutants. This can reduce allergy symptoms. The 2019 report noted that there are several studies from the mid-2000s to late 2010s that valued this NEB at below $1.00 per household.

This NEB was included in the 2020 model as part of the Health NEB instead of as a separate NEB.

- ESA Impact: The 2019 study stated that ESA measures improved household air quality and reduced the number of individuals with allergy symptoms. They estimated a $3.73 average annual benefit per participant in 2020 and adjusted that for inflation in the following years.

- Data: The following data were used as inputs in the research.

Table A-20A
Reduced Allergy Data Inputs

	Input	Source	Value	Notes
A	% with Allergies	www.healthline.com[150]	7.8%	
B	Average # per HH	2010 U.S. Census	2.58	
C	Medical Costs of Allergies	2016 Mudarri Study[151]	$629.69	
D	Inflation Factor	Bureau of Labor Statistics	1.43-1.58	

[150] "Allergy Statistics and Facts", https://www.healthline.com/health/allergies/statistics#1
[151] Mudarri, David. "Valuing the Economic Costs of Allergic Rhinitis, Acute Bronchitis, and Asthma from Exposure to Indoor Dampness and Mold in the US," *Journal of Environmental Public Health,* 2016.

	Input	Source	Value	Notes
E	Costs Not Insured	MEPS	34%	
F	ESA Impact	[152]Francisco et al. 2016 Study	13%	
G	Weighted Measure Life (Years)	Utilities	13	Sum (Measure Lifetime * # of Measure)/Total # of Measures
H	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
I	Adjustment Factor Number of Measures	Utilities	.47	Reduced to less than one if average # of causal measures per household was less than one.

- Population with Allergies: The percentage of the population with allergies was estimated as 7.8 percent from a healthline.com fact sheet.
  - Healthline.com Fact Sheet: The fact sheet reported that 17.9 million adults were diagnosed with hay fever according to the 2010 U.S. National Health Interview Survey (NHIS), which equaled approximately 7.8 percent of the population. The fact sheet did not provide a specific citation for how the figure of 17.9 million adults was calculated. The NHIS is an annual survey administered by the CDC. In 2010, it included 89,976 adults, but it was not clear which questions in the survey were used to calculate the number of Americans with hay fever.

    The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.
    - Data calculation: Without knowing which questions from the NHIS were used and how the value of 17.9 million adults was calculated, it could not be known whether this is a reliable estimate for ESA participants in California.

- Average People per Household: The number of individuals per household was estimated as 2.58 people from the 2010 U.S. Census. This was equal to the total 2010 population of 300.8 million divided by the total number of households, which was 116.7 million. This estimate was slightly below the 2000 estimate of 2.59 and does not include the 8.0 million people who lived in school dormitories, nursing homes, or prisons.

  The 2010 U.S. Census report stated the number of individuals per household in California was 2.90, which would have been a more accurate estimate to use for ESA participants.

- Medical Costs of Allergies: The direct medical cost of allergies was estimated using the cost of allergic rhinitis from the 2005 DHHS MEPS survey. This value was

[152] Francisco et al. "Ventilation, Indoor Air Quality, and Health in Homes Undergoing Weatherization," October 2016, https://pubmed.ncbi.nlm.nih.gov/27490066/.

updated to 2016 by a second study but not modified in any other way. It was then adjusted again for inflation in the 2019 spreadsheet tool and rounded to $629.00.[153]

- DHHS MEPS: See discussion in Section A-B7: Reduced Asthma Incidents for the full details regarding this survey. The 2019 spreadsheet tool cited the Mudarri 2016 study, which updated the 2005 DHHS MEPS value with inflation to $629.29 in 2016.

- Costs Not Covered by Insurance: The percentage of allergy costs not covered by insurance was estimated to be 34 percent based on the DHHS MEPS estimate for the percentage of people with insurance coverage under 65.
  - DHHS MEPS: See discussion in Section A-C3: Fewer Fires for the full details regarding this survey and the limitations of this calculation.

    The 2019 spreadsheet used the mean expenditure per medical event statistic for the Western U.S. to calculate the percentage of the average medical expenditure that was not covered by any form of insurance ("out of pocket").[154] The calculation is displayed in Table A-20B. The percentage of costs not covered by insurance was calculated as the average percentage of out of pocket costs across three insurance types.

Table A-20B
DHHS MEPS Out-of-Pocket Costs Calculation

Payment Source	Mean $ per Event in Western U.S. (2016)	% Out of Pocket
Any Source	$304	Not Calculated.
Out of Pocket	$36	-
Private	$118	$36/($36+$118)= 23%
Medicare	$77	$36/($36+$77)= 32%
Medicaid	$43	$36/($36+$43) = 46%
Other	$30	Not Calculated.
Average % Out of Pocket = (23% + 32% + 46%)/3 = 34%		

- ESA Impact: The ESA impact was estimated to be 13 percent based on the Francisco et al. 2013 study.
  - Francisco et al. 2013 study: This study used data on 81 weatherization projects in Cook County, IL and various locations in Indiana from 2012 to 2014 to

[153] The 2019 spreadsheet tool cited a Mudarri 2016 (Mudarri, David. "Valuing the Economic Costs of Allergic Rhinitis, Acute Bronchitis, and Asthma from Exposure to Indoor Dampness and Mold in the US," *Journal of Environmental Public Health*, 2016.) study of the costs of allergic rhinitis and asthma caused by dampness and mold. This study provided a discussion and sensitivity analysis regarding willingness to pay and cost of illness estimates for the total costs of allergic rhinitis and asthma, but the 2019 spreadsheet used the direct cost of allergic rhinitis reported as an input for these analyses.

[154] Statistics can be found at https://www.meps.ahrq.gov/mepstrends/hc_use/, but specific tables cannot be linked to. Select "Use, expenditures, and population" from the drop-down menu, then select "Mean Expenditure per Event ($)" and "Cross-sectional" and choose to sort data by region and source of payment.

compare two sets of ventilation standards in weatherization projects. Households were given a health survey before and after weatherization measures were applied. This study was conducted as part of a larger program that provided weatherization measures to households, but it did not state the name of that program.[155] The relevant measures for this study were automated ventilation and insulation, but others may also have been provided.

The 2019 spreadsheet tool used the net change in the percent of people that reported eczema or skin allergies after receiving weatherization projects using the newer ventilation standards. This may have been in error as a second referenced report, the E4 Occupant Health Benefits of Residential Energy 2016 report,[156] cited this value from the Francisco et al. 2013 study as the reduction in "eczema and allergies" without clarifying that it only applied to skin allergies. The Francisco et al. study also considered the impact of hay fever and respiratory allergies and found them to be smaller and not statistically significant. Table A-20C displays the relevant findings from the study, but only the reduction in eczema and skin allergies was used in the 2019 spreadsheet tool.

Table A-20C
Francisco et al. Allergies Impact Results

	# of Households	Pre-Weatherization	Post-Weatherization	Percentage Point Change	Statistically Significant
Eczema or Skin Allergy	39	28%	15%	-13%	90% level
Hay Fever	39	10%	5%	-5%	No
Respiratory Allergy	39	26%	18%	-8%	No

The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.

- Midwest study: This study focused on a small number of households in one area of Illinois and Indiana, which may not be comparable to those in the ESA program.

- Not a weatherization study: This study compared two groups, which both received ventilation measures according to different standards. The full allergy reduction of the weatherization could not be known without a comparison group that did not receive any weatherization measures during the same period.

[155] The acknowledgements thanked both the local Department of Energy Weatherization programs in Indiana and Chicago and the U.S. Department of Housing and Urban Development, but they did not clarify the name of any specific program.
[156] E4The Future, "Occupant Health Benefits of Residential Energy Efficiency", November 2016, https://e4thefuture.org/wp-content/uploads/2016/11/Occupant-Health-Benefits-Residential-EE.pdf.

- Applicable measures: The ventilation measures considered in this study were only a subset of those provided through the ESA program. Comparability to the ESA program could not be known without understanding how the other measures provided through the ESA program impact household allergies.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for participant NEBs (18%) was less than one. This is the same calculation as in Section A-C3 for Fewer Fires. No adjustment was made.

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one. This is the same calculation as in Section A-A3 for Utility Health & Safety - Insurance. No adjustment was made.

- Assumptions: Key assumptions that were made.
  - Percentage of population with allergies of 8%, equal to the finding from the U.S. National Health Interview.
  - Average number of people per household of 2.58, equal to the finding from the 2010 U.S. Census.
  - Medical cost of allergies of $629, equal to the finding of the 2008 U.S. national government study.
  - Allergy costs covered by insurance of 34%, equal to the calculation from the findings of the DHHS MEPS survey.
  - ESA allergy impact reduction of 13%, equal to the finding from the 2016 Francisco et al. study for eczema and skin allergies.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	D	*	E	*	F	*	H	*	I	=	
Year	Allergies Incidence		HH Size		Medical Costs		Inflation		Insurance Coverage		ESA Allergy Impact		Adjust Prog. Horizon		Adjust # Measures		Annual Participant Impact
2020	7.8%		2.58		$629.00		1.43		34%		13%		1		0.47		$3.73
2021	7.8%		2.58		$629.00		1.47		34%		13%		1		0.47		$3.82
2022	7.8%		2.58		$629.00		1.50		34%		13%		1		0.47		$3.91
2023	7.8%		2.58		$629.00		1.54		34%		13%		1		0.47		$4.01
2024	7.8%		2.58		$629.00		1.58		34%		13%		1		0.47		$4.10

- Limitations
  - Use of 7.8% as percentage of people with allergies.
  - Use of 2.58 as average number of people per household.
  - Use of $629 as average medical costs of allergies.
  - Use of 34% as percentage of asthma costs not covered by insurance.

- Small sample size of 39 households used to calculate the 13% reduction in allergies as the ESA impact.

- Applicability
  - Number with allergies may not apply to ESA participants in 2020.
  - Household size likely does not apply to ESA participants in 2020.
  - Medical costs of allergies from 2008 may not be applicable to California in 2020.
  - ESA impact may not apply to ESA program and did not apply to all types of allergies.

- Duplication: This NEB may have duplicated the impact of other NEBs.
  - The Fendrick et al. 2003 study used in the Reduction in Cold Symptoms NEB stated that asthmatic children were much more likely to experience noticeable colds. If weatherization measures decreased cold symptoms by decreasing allergy symptoms, there may have been some duplication between these two NEBs.

9. Reduction in Cold Symptoms

ESA services can reduce drafts and improve heating, which can reduce colds. The 2019 report noted that there were five studies that valued this NEB at less than $10 per household.

This NEB was included in the 2020 model as part of the Health NEB instead of as a separate NEB. It was not included in the 2019 model.

- ESA Impact: The 2019 study stated that ESA measures improved household air quality and reduced the number of individuals with cold symptoms. They estimated a $0 average annual benefit per participant in 2020 because no statistically significant estimate of the ESA impact could be found. The cost per cold was calculated as $18.73 before applying the zero percent impact.
- Data: The following data were used as inputs in the research.

Table A-21A
Reduction in Cold Symptoms Data Inputs

	Input	Source	Value	Notes
A	National Cost of Cold Related Doctor Visits	Fendrick et al. 2003[157]	$7,700,000,000	
B	Out of Pocket	MEPS	42%	
C	Over the Counter Cold Medicine	Fendrick et al. 2003	$2,900,000,000	
D	Prescription Cold Medicine	Fendrick et al. 2003	$1,500,000,000	

[157] Fendrick et al., "The Economic Burden of Non–Influenza-Related Viral Respiratory Tract Infection in the United States", February 2003, https://jamanetwork.com/journals/jamainternalmedicine/fullarticle/215118 2003.

	Input	Source	Value	Notes
E	Out of Pocket	MEPS	35%	
F	Inflation Factor	Bureau of Labor Statistics	1.43-1.58	
G	Number of National Colds	Fendrick et al. 2003	500,000,000	
H	ESA Impact	-	0%	Notes APPRISE 2018 WAP survey is not statistically significant.
I	Weighted Measure Life (Years)	Utilities	13	Sum (Measure Lifetime * # of Measure)/Total # of Measures
J	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
K	Adjustment Factor Number of Measures	Utilities	0.47	Reduced to less than one if average # of causal measures per household was less than one.

- National Cost of Cold Related Doctor Visits: The national cost of cold-related doctor's visits was estimated to be $7.7 billion based on the Fendrick et al. 2003 study.
  - Fendrick et al. 2003: This study used a national telephone survey conducted in 2000 to 2001 to estimate the national incidence and costs of non-influenza viral respiratory tract infections. Of 84,239 random phone calls, 4,051 adult respondents completed a full interview and provided information for 2,247 additional children.

    72.3 percent of respondents reported that they had one or more colds in the last year. Those that had at least one cold reported 2.48 colds on average. The study assumed the U.S. population to be 281,421,906 based on the 2000 U.S. Census and used that value to calculate a total of 503,528,989 colds per year.

    Adults saw a doctor for 16.1 percent of colds and children for 31.7 percent of colds. The study calculated a weighted average of 22.0 percent and assumed an average cost per doctor's visit of $57.84 from the 1997 DHHS MEPS. It also stated that 1.26 percent of colds resulted in emergency department visits with an average cost of $211.92 based on a Mainous et al. 1996 study. The Mainous et al. 1996 study could not be located. The resulting total national cost of doctor's visits resulting from colds was $7.7 billion dollars. Table A-21B displays the steps in this calculation.

Table A-21B
Fendrick et al. Cost of Doctor's Visits from Colds

	Value	Source
U.S. Population (2000)	281,41,906	2000 Census
Cold Incidence Rate	72.3%	Survey
Colds per Person with at Least One Cold	2.48	Survey

	Value	Source
Subtotal: Total Colds	**503,528,989**	
% of Colds With Doctor's Visit (weighted for adults and children)	22.0%	Survey
Cost of a Doctor's Visit	$57.84	MEPS
% Who Visited an Emergency Department	1.26%	Mainous et al. 1996[158]
Cost of an Emergency Department Visit	$211.92	MEPS
Approximate National Costs of Cold-Related Doctor's Visits	**$7,700,000,000**	

The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.

- Environmental determinants: The premise of this NEB was that ESA participants may be prone to more colds or more severe colds than the rest of the population because of old or faulty equipment. If this is the case, the use of a national study likely understates the total number of colds expected per participant household prior to measure installation.

The full calculation provided by the study required multiplying by the total number of colds to create a national estimate of the cost, but the 2019 spreadsheet tool then divides by the total number of colds to create a per cold cost. The spreadsheet tool did not state why these additional steps were taken instead of using the per cold costs reported in the Fendrick et al. 2003 study from the DHHS MEPS and other studies. The spreadsheet tool rounded all national costs to the closest 100 million, resulting in different values for cost per cold than reported in the Fendrick et al. study.

- Out of Pocket: The percentage of doctor's visit costs not covered by insurance was estimated to be 42 percent based on a DHHS MEPS estimate.
  - DHHS MEPS: See discussion in A-C3: Fewer Fires for the full details regarding this survey.

The 2019 spreadsheet used the mean expenditure per medical event described as "prescription medicines" to calculate the percentage of doctor's visit costs that were not covered by any form of insurance ("out of pocket").[159] The calculation is displayed in Table A-21C. The percentage of costs not covered by insurance was calculated as the average percentage of out of pocket costs across three insurance types.

[158] Mainous, AH III, Hueston, WJ, Clark, JR, "Antibiotics and upper respiratory infection; do some folks think there is a cure for the common cold?" *J Farm Pract.* 1996.

[159] Statistics can be found at https://www.meps.ahrq.gov/mepstrends/hc_use/, but specific tables cannot be linked to. Select "Use, expenditures, and population" from the drop down menu, then select "Mean Expenditure per Event ($)" and "Cross-sectional" and choose to sort data by medical event and source of payment.

Table A-21C
DHHS MEPS Out-of-Pocket Costs Calculation

Payment Source	Mean $ per Doctor's Visit in Western U.S. (2016)	% Out of Pocket
Any Source	$223	Not Calculated.
Out of Pocket	$33	-
Private	$97	$33/($33+$97)= 25%
Medicare	$53	$33/($33+$53)= 38%
Medicaid	$20	$33/($33+$20)= 62%
Other	$20	Not Calculated.
Average % Out of Pocket = $(25\% + 38\% + 62\%)/3 = 42\%$		

This method of calculating the average percentage of out of pocket costs had the following additional limitation.

- National estimate: Unlike similar calculations of insurance coverage using MEPS data in other NEBs, this calculation used statistics for the entire U.S. instead of the Western U.S., which was likely less accurate for the state of California.

- Over the Counter Cold Medicine: The national cost of cold-related over-the-counter medications was estimated to be $2.9 billion based on the Fendrick et al. 2003 study.
  - Fendrick et al. 2003: See discussion earlier in this section for full details regarding this study. The cost of over-the-counter medications was estimated as $8.31 based on the average cost of ten brand name cold medications available in 2001. Table A-21D displays the values in this calculation.

Table A-21D
Fendrick et al. Cost of Over-the-Counter Medications from Colds

	Value	Source
U.S. Population (2000)	281,41,906	2000 Census
Cold Incidence Rate	72.3%	Survey
Colds per Person with at Least One Cold	2.48	Survey
Subtotal: Total Colds	**503,528,989**	
Percentage Who Took Over-the-Counter Medications	69.1%	Survey
Cost of Over-the-Counter Medications	$8.31	Average Cost
Approximate National Costs of OTC Medication	**$1,500,000,000**	

The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.

- Over-the-counter medication cost: ESA participants may be less likely to purchase over-the-counter medications because of their cost, which would reduce the average spending per cold.

- Brand name over-the-counter medication cost: ESA participants may not choose brand name medications if less expensive generic options are available.

- Prescription Cold Medicine: The national cost of prescription cold-related medicines was estimated to be $1.5 billion based on the Fendrick et al. 2003 study.
  - Fendrick et al. 2003: See discussion earlier in this section for full details regarding this study. Respondents were prescribed and took antibiotic medications for 8.2 percent of colds and symptomatic medications for 3.1 percent. The costs of these medications came from the *Drug Topics Red Book.* Table A-21E displays the values in this calculation.

Table A-21E
Fendrick et al. Cost of Prescription Medications from Colds

	Value	Source
U.S. Population (2000)	281,41,906	2000 Census
Cold Incidence Rate	72.3%	Survey
Colds per Person with at Least One Cold	2.48	Survey
Subtotal: Total Colds	**503,528,989**	
Percentage Who Took Antibiotic Medications	8.2%	Survey
Cost of Antibiotic Medications	$26.44	Cardinale[160]
Percentage Who Took Symptomatic Medications	3.1%	Survey
Cost of Symptomatic Medications	$25.13	Cardinale
Approximate National Costs of Prescriptions	**$1,500,000,000**	

- Out of Pocket: The percentage of doctor's visit costs not covered by insurance was estimated to be 35 percent based on a DHHS MEPS estimate.
  - DHHS MEPS: See discussion in Section A-C3: Fewer Fires for the full details regarding this survey and the limitations of this calculation.

    The 2019 spreadsheet used the mean expenditure per medical event described as "office-based events" to calculate the percentage of doctor's visit costs that

[160] Cardinale, V, ed. *Drug Topics Red Book*. Motvale, NJ: Medical Economics Books; 2001.

were not covered by any form of insurance ("out of pocket").[161] The calculation is displayed in Table A-21F. The percentage of costs not covered by insurance was calculated as the average percentage of out of pocket costs across three insurance types.

Table A-21F
DHHS MEPS Out-of-Pocket Costs Calculation

Payment Source	Mean $ per prescription in U.S. (2016)	% Out of Pocket
Any Source	$117	Not Calculated.
Out of Pocket	$14	-
Private	$42	$14/($14+$42)= 25%
Medicare	$42	$14/($14+$42)= 25%
Medicaid	$12	$14/($14+$12)= 54%
Other	$7	Not Calculated.
Average % Out of Pocket = (25% + 25% + 54%)/3 = 35%		

This method of calculating the average percentage of out of pocket costs had the following additional limitation:

- National estimate: Unlike similar calculations in other NEBs, this calculation used statistics for the entire U.S. instead of the Western U.S., which was likely less accurate for the state of California.

- Number of National Colds: The number of colds nationally was estimated to be 500,000,000. This value was rounded from the finding in the Fendrick et al. 2003 study.
  - Fendrick et al. 2003: See discussion earlier in this section for full details regarding this study. The study calculated the total number of colds to be 503,528,989, which was rounded for inclusion in the 2019 spreadsheet. Table A-21G displays the full calculation.

Table A-21G
Fendrick et al. Cost of Doctor's Visits from Colds

	Value	Source
U.S. Population (2000)	281,41,906	2000 Census
Cold Incidence Rate	72.3%	Survey
Colds per Person with at Least One Cold	2.48	Survey
Approximate Total Colds	**500,000,000**	

[161] Statistics can be found at https://www.meps.ahrq.gov/mepstrends/hc_use/, but specific tables cannot be linked to. Select "Use, expenditures, and population" from the drop down menu, then select "Mean Expenditure per Event ($)" and "Cross-sectional" and choose to sort data by medical event and source of payment.

- ESA Impact: The ESA impact was assumed to be 0 because no strong estimate could be found. The 2019 spreadsheet tool stated that the APPRISE 2018 WAP Evaluation estimated an eleven percent impact, but that it was not statistically significant.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for participant NEBs (18%) was less than one. This is the same calculation as in Section A-C3 for Fewer Fires. No adjustment was made.

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one. This is the same calculation as in Section A-A3 for Utility Health & Safety - Insurance. No adjustment was made.

- Assumptions: Key assumptions that were made.
  - Total national cost of cold related doctor's visits of $7.7 billion, equal to the finding from the Fendrick et al. 2003 study. In the calculation of this value, this study assumed the following.
    - Average cost of a doctor's visit of $57.84, equal to the findings from the 1997 DHHS MEPS.
    - Average cost of an emergency department visit of $211.92, equal to the findings from the 1997 DHHS MEPS.
  - Out of pocket doctor's visit cost of 42%, equal to the calculation from findings of the DHHS's MEPS.
  - National amount spent on cold related over the counter medications of $2.9 billion, equal to the finding from the Fendrick et al. 2003 study. In the calculation of this value, this study assumed the following.
    - Average cost of over the counter medications of $8.31, equal to the average cost of major name brands in 2003.
  - National amount spent on cold related prescription medications of $1.5 billion, equal to the finding from the 2003 Fendrick et al. study. In the calculation of this value, this study assumed the following.
    - Average cost of prescription antibiotic medications of $26.44, equal to the finding from the 2001 *Drug Topics Red Book*.
    - Average cost of prescription symptomatic medications of $25.13, equal to the finding from the 2001 *Drug Topics Red Book*.
  - Out of pocket medication cost of 35%, equal to the calculation from findings of the DHHS's MEPS.
  - Total number of colds of U.S. colds of 500,000,000, equal to the finding from the 2003 Fendrick et al. study.

- Calculation: The following calculation was made to compute the annual benefit. This calculation produces the average cost per cold. It would be multiplied by an ESA

impact if a statistically significant estimate were available. This calculation did not include an estimation of how frequently ESA participants experienced a cold, which implicitly assumed one cold per household per year.

	((A	*	B)	+	C	+	(D	*	E))	*	F	=	
Year	Doctor's Visits Cost ($ Millions)		Insurance Coverage		Over the Counter Cost ($ Millions)		Prescription Cost ($ Millions)		Out of Pocket		Inflation		Total Cost of Colds ($ Millions)
2020	$7,700		42%		$2,900		$1,500		34%		1.43		$9,501
2021	$7,700		42%		$2,900		$1,500		34%		1.47		$9,7667
2022	$7,700		42%		$2,900		$1,500		34%		1.50		$9,966
2023	$7,700		42%		$2,900		$1,500		34%		1.54		$10,232
2024	$7,700		42%		$2,900		$1,500		34%		1.58		$10,498

	(	/	G)	*	H	*	J	*	K	=	
Year	Total Cost of Colds ($ Millions)		Total Colds (Millions)		ESA Impact		Adjust Prog. Horizon		Adjust # Measures		Annual Participant Impact
2020	$9,501		500		0%		1		0.47		$0.00
2021	$9,7667		500		0%		1		0.47		$0.00
2022	$9,966		500		0%		1		0.47		$0.00
2023	$10,232		500		0%		1		0.47		$0.00
2024	$10,498		500		0%		1		0.47		$0.00

- Limitations
  - Use of $7.7 billion as national cost of cold related doctor's visits.
  - Use of 42% as the percentage of doctor's visit costs not covered by insurance.
  - Use of $2.9 billion as national cost of cold related over the counter medications.
  - Use of $1.5 billion as national cost of cold related prescription medications.
  - Use of 35% as the percentage of prescription medication costs not covered by insurance.
  - Use of 500 million as total number of U.S. colds.
  - No ESA impact estimate was available.

- Applicability
  - National cost of cold related doctor's visits may not apply to California in 2020.
  - Insurance coverage for doctor's visits may not apply to ESA participants in 2020.
  - National cost of cold-related over the counter medications may not apply to California in 2020.
  - National cost of cold-related prescription medications may not apply to California in 2020.
  - Insurance coverage for medications may not apply to ESA participants in 2020.
  - National estimate of the total number colds in the U.S. may not apply to California in 2020.

- Duplication: This NEB may have duplicated the impact of other NEBs.
  - Allergy and cold symptoms are similar. If an estimate of the ESA impact could be found, it would need to specifically address the potential for overlap in how cold and allergy symptoms are perceived.

10. Fewer Scaldings

Hot water settings that are too high or faulty equipment can cause scaldings. The 2019 report noted that just under a dozen reports discussed this NEB but there were not strong estimates for this NEB.

This NEB was excluded because there is not literature to support the NEB. It was valued at $0 in the 2019 model for this reason.

- ESA Impact: The 2019 study stated that ESA measures like thermostatic shower valves or water heater temperature checks can reduce the number of scaldings. They estimated an average annual benefit per participant that was less than $0.00 in 2020 and adjusted that for inflation in the following years.

- Data: The following data were used as inputs in the research.

Table A-22A
Fewer Scaldings Data Inputs

	Input	Source	Value	Notes
Cost of Child Scaldings				
A	Tap Water Burns	Shields et al. 2014[162], Bapitste and Feck 1980[163]	25%	
B	Children Scaled Annually	Shields et al. 2014[164], Safe Kids 2006 Fact Sheet	21,000	
C	Children in U.S.	www.childtrends.org[165] U.S. Census Bureau	74,000,000	
D	Children per HH	2000 U.S. Census	1.01	
E	$ per Child Scalding	MEPS	$1,077	Trauma Related Expense
F	Inflation Factor	Bureau of Labor Statistics	1.11-1.22	
Cost of Elderly Scaldings				
G	Elderly per Household	2010 U.S. Census	0.33	
H	Elderly Tap Water Scalding Incidence	CDC 2009 Report[166]	.0000714	
I	Cost per Elderly Scalding	MEPS	$4,368	
J	Out of Pocket	MEPS	34%	

[162] Shields et al., "Still too hot: Examination of water temperature and water heater characteristics 24 years after manufacturers adopt voluntary temperature setting", March 2014, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3605550/
[163] Baptiste MS, Feck G. Preventing tap water burns. Am J Public Health. 1980; 70(7):727–729. [PubMed: 7386711]
[164] American Burn Association. Scald injury prevention educator's guide. A community fire and burn prevention program supported by the United States Fire Administration Federal Emergency Management Agency. available from http://ameriburn.org/wp-content/uploads/2017/04/scaldinjuryeducatorsguide.pdf
[165] https://www.childtrends.org/indicators/number-of-children
[166] Centers for Disease Control and Prevention, "Nonfatal Scald-Related Burns Among Adults Aged ≥65 Years --- United States, 2001--2006", *MMWR*, September 2009, https://www.cdc.gov/mmwr/preview/mmwrhtml/mm5836a1.htm

	Input	Source	Value	Notes
ESA Related Reduction				
K	Incidence of Unsafe Water Temperatures	Shields et al. 2014	41%	
L	ESA Impact	Han et al. 2007[167]; Erdmann et al. 1991[168]	0.56	
Adjustment Factors				
M	Weighted Measure Life (Years)	Utilities	11	Sum (Measure Lifetime * # of Measure)/Total # of Measures
N	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
O	Adjustment Factor Number of Measures	Utilities	0.05	Reduced to less than one if average # of causal measures per household was less than one.

The following inputs were used to calculate the cost of accidental child scaldings.

- Burns Caused by Tap Water: The percentage of burns caused by tap water was estimated to be 25 percent. The 2019 spreadsheet tool cited the Shields et al. 2014 study, which cited the Baptiste and Feck 1980 study.
  - Baptiste and Feck 1980 Study: This study used data from the New York Burn Survey. The New York Burn Survey included all individuals hospitalized for at least one day in upstate New York in 1974 and 1975. The data included 1,656 individuals hospitalized for liquid burns, but only 793 included a known cause. Of those 793, 196 (24.7 percent) were caused by tap water. The value 24.7 percent was rounded to 25 percent in the Shields et al. 2014 study that the 2019 spreadsheet tool cites. Over 50 percent of those tap water burns were in children under the age of five.

    The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.
    - 1980's voluntary setting: The Shields et al. 2014 study stated that water heater manufacturers adopted a voluntary standard in the 1980's to pre-set thermostats to 120°F to avoid scaldings. This standard likely reduced the percent of burns from tap water observed by the Baptiste and Feck 1980 study, meaning that the estimate of 25 percent likely does not apply in 2020.
    - Upstate New York climate: The climate of upstate New York differs from that of California. Comparability to California cannot be known without understanding whether hot water was used differently in the two locations.
    - Other types of burns: The study did not state what caused the other types of liquid burns. Without understanding the other types of burns in the study

[167] Han et al. "Cost-effectiveness analysis of a proposed public health legislative/educational strategy to reduce tap water scald injuries in children", *Injury Prevention*, August 2007, https://www.ncbi.nlm.nih.gov/pmc/articles/pmc2598349/.
[168] Erdmann T, Feldman K, Rivara F, et al. Tap water burn prevention: the effect of legislation. Pediatrics 1991;88:572–7. https://pediatrics.aappublications.org/content/88/3/572

and whether they were possible in California as well, the accuracy of this value could not be assessed.

- Children Scaled Annually: The number of children scalded annually was estimated to be 21,000. The 2019 spreadsheet tool cited the Shields et al. 2014 study, which cited the American Burn Association Educator's Guide. This guide cited the 2006 "Facts about Childhood Burns" resource from Safe Kids Worldwide. The 2006 fact sheet could not be found, and the most recent fact sheet from 2015 did not include a similar estimate.

- Children in U.S.: The number of children in the U.S. was included as 74 million based on the estimate of 73.7 million reported on childtrends.org, which cites raw 2017 data from the U.S. Census Bureau but did not discuss the exact calculation of that estimate.

- Average Children per Household: The number of children per household was estimated as 1.01 based on the 2000 California U.S. Census.
  - 2000 U.S. Census: The 2000 U.S. Census reported that the total number of children under 18 in California in 2000 was 8,035,222 and the total number of families was 7,920,049, resulting in 1.01 children per family.

- Cost per Child Scalding: The medical cost of a child scalding was estimated as $1,077 based on the DHHS MEPS value for a trauma-related expense.
  - DHHS MEPS: The household component of the DHHS MEPS survey is administered annually to a nationally representative sample of households and typically includes between 12,000 and 14,000 families and between 30,000 and 34,000 individuals. Household surveys were supplemented with additional data from their medical providers.

    The 2019 spreadsheet tool did not specify which year or subgroup of the survey was used in calculating the value of $1,077. A review of DHHS MEPS tables of trauma-related expenses for recent years and relevant subgroups could not find this exact value.

The following inputs were used to calculate the cost of accidental elderly scaldings.

- Average Number of Elderly per Household: The average number of elderly individuals per household was 0.33 based on values from the U.S. Census Households and Families: 2010 Census Brief.
  - U.S. Census 2010 Policy Brief: The value was calculated by dividing the total elderly population living in households by the total household population and multiplying the average number of people per household by that percentage. This calculation is displayed in Table A-22B.

Table A-22B
Values in the Elderly Individuals per Household Calculation

	Notes
Elderly Household Population	38,810,278
Total Household Population	300,758,215
Subtotal: Percentage Elderly	12.8%
Individuals per Household	2.58
Approximate # Elderly per Household	0.33

- Elderly Tap Water Scalding Incidence: The incidence of elderly scaldings from tap water was calculated as .0000714 from values reported in the CDC's 2009 "Nonfatal Scald-Related Burns Among Adults Aged ≥65 Years 2001-2006" Report.
  - CDC 2009 Report: This report used data from the National Electronic Injury Surveillance System All Injury Program (NEISS-AIP) for 2001 to 2006. This dataset includes all emergency department visits for a nationally representative sample of 66 hospitals. The data used in the analysis included 51,700 emergency department visits from 2001 to 2006 that were admitted for nonfatal scald burns.

    The report stated that 23.8 individuals over 65 experienced a scalding per 100,000, and 30 percent of them were the result of hot water or steam.

- Cost per Elderly Scalding: The medical cost of an elderly scalding was estimated as $4,368 based on the DHHS MEPS value for a trauma related expense.
  - DHHS MEPS: The household component of the DHHS MEPS survey is administered annually to a nationally representative sample of households and typically includes between 12,000 and 14,000 families and between 30,000 and 34,000 individuals. Household surveys are supplemented with additional data from their medical providers.

    The 2019 spreadsheet tool does not specify which year of the survey was used in calculating the value of $4,368. A review of DHHS MEPS tables of trauma-related expenses for recent years and relevant subgroups could not find this exact value.

- Out of Pocket: The percentage of doctor's visit costs not covered by insurance was estimated to be 34 percent based on a DHHS MEPS estimate.
  - DHHS MEPS: See discussion in Section A-C3: Fewer Fires for the full details regarding this survey and the limitations of this calculation.

The 2019 spreadsheet used the mean expenditure per medical event statistic for the Western U.S. to calculate the percentage of the average medical expenditure that was not covered by any form of insurance ("out of pocket").[169] The calculation is displayed in Table A-22C. The percentage of costs not covered by insurance was calculated as the average percentage of out of pocket costs not covered by insurance for three insurance types.

Table A-22C
DHHS MEPS Out-of-Pocket Costs Calculation

Payment Source	Mean $ per Event in Western U.S. (2016)	% Out of Pocket
Any Source	$304	Not Calculated.
Out of Pocket	$36	-
Private	$118	$36/($36+$118)= 23%
Medicare	$77	$36/($36+$77)= 32%
Medicaid	$43	$36/($36+$43) = 46%
Other	$30	Not Calculated.
Average % Out of Pocket = (23% + 32% + 46%)/3 = 34%		

The following inputs were used to calculate the ESA impact on child and elderly scaldings.

- Incidence of Unsafe Water Temperatures: The incidence of unsafe water temperatures was estimated as 41 percent based on the Shields et al. 2014 study.
  - Shields et al. 2014 Study: This study used data from 986 surveyed households in Baltimore in 2011. The surveyed households were part of a community intervention trial by the Baltimore City Fire Department. Surveyors accompanied fire fighters to each of these households to test the water temperature. Of the 986, 278 were non-participant households that did not receive smoke detectors or educational resources.

    Surveyors tested the water temperature in 975 of the 986 homes. 401 homes, or 41 percent, were found to have unsafe water temperatures of 120°F or higher.

    The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.

    - Renters versus homeowners: The study stated that homeowners were significantly more likely to have safe water temperatures than renters. Given that most ESA participants are renters, the value provided by this study may underestimate the incidence of unsafe water temperatures experienced by ESA participants.

[169] Statistics can be found at https://www.meps.ahrq.gov/mepstrends/hc_use/, but specific tables cannot be linked to. Select "Use, expenditures, and population" from the drop-down menu, then select "Mean Expenditure per Event ($)" and "Cross-sectional" and choose to sort data by region and source of payment.

- Baltimore climate: The climate of Baltimore differs from that of California. Comparability to California cannot be known without understanding whether hot water is used differently in the two locations.

- Community trial selection: This study did not state how homes were chosen for inclusion in the community trial. The Gielen et al. 2014 study[170] that reported the results of the fire alarm and education trial used a subset of those used in the Shields et al. study. This subset was chosen so that the treatment group resembled the comparison group, but both groups were used in the Shields et al. study. Comparability to the ESA program cannot be known without understanding why households were selected into the study and how they differed from the ESA population.

- ESA Impact: The ESA impact on scaldings was estimated as 56 percent. The 2019 spreadsheet tool cited the Han et al. 2007 study, which cited the Erdmann et al. 1991 study.
  - Erdmann et al. 1991 Study: This study used hospital admissions rates for all abusive and nonintentional tap water burn injuries in children 15 and younger in Seattle from 1969 to 1988. This included all admissions from the Children's Hospital Medical Center and a sample of admissions from the Harborview Medical Center since only select years of data were available. The study stated that a public awareness campaign was initiated in 1978 to encourage households to set their water heaters to 120°F and that a state law went into effect in 1983 mandating it. The study reported that the hospital admission rate for burns fell from 5.5 per year between 1969 to 1976 to 2.4 per year between 1979 and 1988, a 56 percent reduction.

    Table A-22D displays the results of this study. In the results section, the study reported the pre and post 1983 law periods separately, but combined them to estimate the effect of the public awareness campaign.

Table A-22D
Measures Included in Erdmann et al. 1991 Study

	Total Admissions		Admission Rate		Rate Reduction	% Reduction (Diff. Divided by 1969-1979 Rate)
	1969-1976	1979-1988	1969-1976	1979-1988		
Abuse	10	9	1.6	1.3	0.3	19%
Nonintentional	22	9	3.9	1.0	2.9	76%
Total	**32**	**18**	**5.5**	**2.4**	**3.1**	**56%**

[170] Gielen AC, Shields W, Frattaroli S, McDonald E, Jones V, Bishai D, O'Brocki R, Perry E, Bates-Hopkins B, Tracey P, Parsons S. Enhancing Fire Department Home Visiting Programs: Results of a Community Intervention Trial. Journal of Burn Care and Research. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3610828/

The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.

- Only children: The study only included children under the age of 15 years old, but it stated that elderly and handicapped populations are also at risk from tap water burns. Without knowing the reduction in those groups, a complete estimate could not be known.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for participant NEBs (18%) was less than one.

  Factor = minimum of 1 or
  pmt(discount rate, yr horizon, PV(discount rate, measure life, 1))

  - Discount Rate = 18% (utility data)
  - Year Horizon = 10 years (utility data)
  - Weighted Measure Life = $\frac{\sum(Measure\ Lifetime * \#\ of\ Measures)}{Total\ \#\ of\ Measures}$ = 11.0
  - pmt(discount rate, yr horizon, PV(discount rate, measure life, 1)) = 1.04
    If the weighted measure life was less than the program horizon, this function would have determined the amount by which the NEB should have been reduced.

  Table A-22E displays the measures included in the calculation of weighted measure life.

Table A-22E
Measures Included in Scalding Reduction Calculation

Measure Name	Measure Lifetime	# of Measures	Lifetime * # Measures
Heat pump water heater	13	25	325
Water Heater Repair/Replace	11	1,154	12,694
Total	24	1,179	13,019
Average Measure Life = 11.0 Years			

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one.

  Factor = minimum of 1 or average number of causal measures

  - Total Number of Measures = 24
  - Total Number of Participants = 23,518
  - Average Number of Causal Measures = $\frac{\sum(\#\ of\ Measures)}{Total\ \#\ of\ Participants}$ = 0.05

  This adjustment factor can be turned on or off by utilities in the sensitivity options.

- Assumptions: Key assumptions that were made.
  - Percentage of burns caused by tap water of 25%, equal to the national finding from the 1980 Baptiste and Feck study.
  - Number of child scaldings in California of 21,000, equal to the national finding from the Safe Kids Worldwide 2006 Fact Sheet.
  - Number of children in California of 74 million, equal to the finding from the finding of childtrends.org.
  - Average number of children per home of 1.01, equal to the finding from the 2000 U.S. Census for California.
  - Cost per child scalding of $1,077, equal to the finding for a trauma related expense in the MEPS survey adjusted for inflation.
  - Average number of elderly individuals per home of 0.33, equal to the finding from the 2010 U.S. Census.
  - Incidence of elderly tap water scaldings was 0.0000714, equal to the finding from the 2009 CDC report.
  - Cost per elderly scalding of $4,368, equal to the finding for a trauma related expense in the DHHS's MEPS survey adjusted for inflation.
  - Out of pocket medical costs of 34%, equal to the calculation from findings of the DHHS MEPS.
  - Incidence of unsafe water temperatures in homes of 41%, equal to the national finding from the 2014 Shields et al. study.
  - ESA impact reduction of 56%, equal to the finding from Erdmann et al. 1991 study.

- Calculation: The following calculations were made to find the final value of this NEB.
  - Impact on Child Scaldings
  - Impact on Elderly Scaldings

	A	*	(B	/	C)	*	D	*	E	*	F	*	J	*	K	*	L	=	Impact on Child Scaldings
Year	Tap Water Burns		Children Scalded		Total Children (Millions)		Children per HH		Burn Cost		Inflation		Out of Pocket		Unsafe Temp		ESA Impact		
2020	25%		21,000		74		1.01		$1,077		1.11		34%		41%		56%		$0.01
2021	25%		21,000		74		1.01		$1,077		1.14		34%		41%		56%		$0.01
2022	25%		21,000		74		1.01		$1,077		1.16		34%		41%		56%		$0.01
2023	25%		21,000		74		1.01		$1,077		1.19		34%		41%		56%		$0.01
2024	25%		21,000		74		1.01		$1,077		1.22		34%		41%		56%		$0.01

	A	*	G	*	H	*	I	*	F	*	J	*	K	*	L	=	Impact on Elderly Scaldings
Year	Tap Water Burns		Elderly per HH		Elderly Scalding Incidence		Burn Cost		Inflation		Out of Pocket		Unsafe Temp		ESA Impact		
2020	25%		0.33		0.0000714		$4,368		1.11		34%		41%		56%		$0.00
2021	25%		0.33		0.0000714		$4,368		1.14		34%		41%		56%		$0.00
2022	25%		0.33		0.0000714		$4,368		1.16		34%		41%		56%		$0.00
2023	25%		0.33		0.0000714		$4,368		1.19		34%		41%		56%		$0.00
2024	25%		0.33		0.0000714		$4,368		1.22		34%		41%		56%		$0.00

	(	+	)	*	N	*	O	=	Annual Participant Impact
Year	Impact on Child Scaldings		Impact on Elderly Scaldings		Adjust Prog. Horizon		Adjust # Measures		
2020	$0.01		$0.00		1		0.47		$0.00
2021	$0.01		$0.00		1		0.47		$0.00
2022	$0.01		$0.00		1		0.47		$0.00
2023	$0.01		$0.00		1		0.47		$0.00
2024	$0.01		$0.00		1		0.47		$0.00

- Limitations
  - Use of 25% as percent of burns caused by tap water.
  - Use of 21,000 as number of children scalded annually.
  - Use of $1,077 as medical cost per child scalded.
  - Use of 0.33 as average number of elderly individuals per household.
  - Use of 0.0000714 as incidence of elderly scaldings.
  - Use of $4,368 as medical cost per elderly individual scalded.
  - Use of 34% as percentage of scalding medical costs not covered by insurance.
  - Use of 41% as the incidence of unsafe water temperatures.
  - Use of 56% as ESA impact.

- Applicability
  - Number of burns caused by tap water may not apply to ESA households in 2020 and did not account for scaldings from all sources.
  - Number of children scalded annually may not apply to ESA households in 2020.
  - Average number of children per household in 2000 may not apply to 2020.
  - Medical costs per child scalding may not apply to California.
  - Average number of elderly individuals per household in 2010 may not apply to ESA households in 2020.
  - Out of pocket medical costs may not apply to ESA participants in 2020.
  - Incidence of elderly scaldings may not apply to ESA households in 2020.

- Medical costs per elderly scalding may not apply to California in 2020.
- Incidence of unsafe water temperatures may not apply to ESA households in 2020.
- Impact may not apply to 2020 California ESA program.

- Duplication: This NEB did not duplicate another benefit calculated in this NEB analysis or other benefits that are already accounted for in the ESA cost-benefit analysis.

11. Property Value Benefits

Weatherization measures may include structural repairs that increase the value of the home. The 2019 report noted that there were dozens of studies from the early 2000s to 2017 that valued this NEB.

This NEB was excluded because it is included in the energy benefit and the Operations and Maintenance NEB.

- ESA Impact: The 2019 study stated that the installation of ESA measures would improve property values if they included structural repairs. This NEB was included in the spreadsheet tool in case such measures were included in the ESA program in the future. They estimated a $0 average annual benefit per participant.

- Data: The following data were used as inputs in the research.

Table A-23A
Property Value Benefits Data Inputs

	Input	Source	Value	Notes
A	Housing Repairs	Utilities	$0.00	
B	Inflation Factor	CPI	1.00	Assumed current.
C	Customers Receiving Repairs	Utilities	0	
D	Years of Benefit	Utilities	10	
E	Weighted Measure Life (Years)	Utilities	0	Sum (Measure Lifetime * # of Measure)/Total # of Measures
F	Adjustment Factor Program Horizon	Utilities	0	Reduced to less than one if discounted remaining weighted measure life was less than one.
G	Adjustment Factor Number of Measures	Utilities	1	Reduced to less than one if average number of causal measures per household was less than one.

- Housing Repairs: The annual cost of housing repairs was included as $0.00 because ESA does not currently provide this measure.

- Customers Receiving Home Repairs: The percentage of customers receiving home repairs was included as zero percent because the ESA program did not provide relevant measures.

- Years of Benefit: If the ESA program provided home repairs, this would be the total number of years over which the benefit should be spread. The 2019 spreadsheet tool did not explain how this was different from the measure life. Since home repairs were not provided, the placeholder value of ten years was used.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for participant NEBs (18%) was less than one.

  Factor = minimum of 1 or
  pmt(discount rate, yr horizon, PV(discount rate, measure life, 1))

  - Discount Rate = 18% (utility data)

  - Year Horizon = 10 years (utility data)

  - Weighted Measure Life = $\frac{\sum(Measure\ Lifetime * \#\ of\ Measures)}{Total\ \#\ of\ Measures}$ = 0.0

  - pmt(discount rate, yr horizon, PV(discount rate, measure life, 1)) = 0.0
    If the weighted measure life was less than the program horizon, this function would determine the amount by which the NEB should have been reduced.

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one.

  Factor = minimum of 1 or average number of causal measures

  - Total Number of Measures = 0
  - Total Number of Participants = 23,518
  - Average Number of Causal Measures = $\frac{\sum(\#\ of\ Measures)}{Total\ \#\ of\ Participants}$ = 0.0

  This adjustment factor can be turned on or off by utilities in the sensitivity options.

- Assumptions: Key assumptions that were made.
  - Additional property value would have been equal to the amount of the repairs divided by the life of the repair.

- Calculation: The following calculation was made to compute the annual benefit.

	(A	*	B	*	C)	/	(D)	*		F	*	G	=	Annual Participant Impact
Year	Home Repair Cost		Inflation		Customers with Repairs		Years of Benefit			Adjust Prog. Horizon		Adjust # Measures		
2020	$0.00		1.00		0%		10			0		1		$0.00
2021	$0.00		1.00		0%		10			0		1		$0.00
2022	$0.00		1.00		0%		10			0		1		$0.00
2023	$0.00		1.00		0%		10			0		1		$0.00
2024	$0.00		1.00		0%		10			0		1		$0.00

- Limitations
  - No data were available to calculate this NEB.

- Applicability
  - Data on ESA repairs were not available to determine applicability.

- Duplication: This NEB is already accounted for in the energy savings and the Operations and Maintenance NEB.

12. Quality / Quantity of Lighting

New lightbulbs and fixtures can improve the lighting quality. The 2019 report noted that this was a highly valued benefit and there were about a dozen studies from the mid-2000s that valued this NEB at about $28.

This NEB was excluded because no literature to support improved lighting from program installations. It was not included in the 2019 model.

- ESA Impact: The 2019 study stated that the installation of ESA measures improved internal lighting. They estimated a $3.04 average annual benefit per participant from 2020 to 2024.

  The 2019 report stated that the value of NEBs like additional lighting were difficult to calculate directly and instead applied a multiplier to participant energy savings. This multiplier was estimated from survey findings.

- Data: The following data were used as inputs in the research.

Table A-24A
Quality / Quantity of Lighting Data Inputs

	Input	Source	Value	Notes
A	Average Bill Savings	Utilities	$30.42	
B	Inflation Factor	CPI	1.00	Assumed current.
C	NEB Value Multiplier	Skumatz 2005 WI[171]	0.10	No normalization
D	Weighted Measure Life (Years)	Utilities	16	Sum (Measure Lifetime * # of Measure)/Total # of Measures
E	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
F	Adjustment Factor Number of Measures	Utilities	1	Reduced to less than one if average # of causal measures per household was less than one.

- Average Bill Savings: Program attributable savings was calculated as $30.42 per participant per year using utility data (as shown in the Thermal Comfort NEB review).

  Table II-10B displays the kWh and therm savings for each measure included in this calculation. Because the NEB value multiplier was applied to total bill savings, all measures were included in this calculation instead of the relevant subset that was used to calculate weighted measure life later in this section.

- NEB Value Multiplier: The quantity and quality of lighting multiplier value per dollar saved was calculated as 0.10 based on the finding from the Skumatz 2005 WI study.
  - Skumatz 2005 WI Study: This study used data from a 2004 survey of participants in Wisconsin's Low-Income Weatherization Assistance Program (WAP). The Wisconsin WAP provides energy conservation measures to households with income below 150 percent of the Federal Poverty Guidelines (FPG). The program provides the following measures.
    - Furnace Repair or Replacement
    - Hot Water Heater Repair or Replacement
    - Insulation
    - New CFL Lightbulbs
    - New Appliances
    - Testing for Drafts
    - Caulk on Windows
    - New Thermostats

    The telephone survey began with a starting sample of 816 participants and completed 362 interviews for a completed interview rate of 44.4 percent.

[171] https://library.cee1.org/content/non-energy-benefits-wisconsins-low-income-weatherization-assistance-program-revised-report

Respondents were asked whether they experienced a positive or negative effect from the program for each NEB in the study and whether that effect was a small or large amount.

The authors calculated the share each NEB had in the total NEB value by quantifying the responses and dividing the sum of all positive and negative reported effects for each NEB by the sum of all reported effects for all NEBs.

$$NEB\ Share = \frac{\sum Positive\ and\ Negative\ Responses\ for\ NEB}{\sum Positive\ and\ Negative\ Responses\ for\ All\ NEBs}$$

The share of the total NEB multiplier value for the quantity and quality of lighting was calculated to be 0.07.

The total NEB value multiplier was calculated from the self-reported multiplier value of 1.56 and the relative verbal scaling multiplier of 1.22.

- The self-reported multiplier relied on survey respondents to provide a percentage for how much more valuable or costly a benefit was relative to their energy savings.
- The relative verbal scaling approach assigned a coefficient that was larger than one to positive survey responses and a coefficient less than one to negative responses, but it did not require the participant to provide a specific percentage. The study stated that these coefficients were developed for other research on NEBs by the authors but did not include the specific values.

The final value included in the 2019 spreadsheet tool calculation was 1.32. The self-reported multiplier, the relative verbal scaling multiplier, and the final value were calculated using the survey responses and the savings of each participant using utility data, but the study did not state the exact calculation.

Table A-24B displays the calculation of the 0.10 multiplier value used in the 2019 spreadsheet. The average total NEB value multiplier was multiplied by the share of the NEB benefits attributed to lighting.

Table A-24B
Skumatz 2005 WI Quantity and Quality of Lighting Results

	Number of Respondents	Multiplier
Total NEB Value Multiplier	362	1.32
Share of NEB Benefits Attributed to Lighting		0.07
2019 Spreadsheet Lighting Multiplier		0.10

The total NEB value multiplier of 1.32 was higher than the value of 1.156 used in other NEB calculations from the Skumatz 2010 Xcel study (See the Thermal Comfort NEB review for full details).

The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.

- Energy savings: The study stated that participants in that program saved $220 on average compared to the $30 program attributable bill savings for the ESA program. Applicability to the ESA program could not be known without understanding how the NEB multipliers relate to the level of savings.

- CFL versus LED: The 2019 report and spreadsheet tool noted that no existing studies consider the effect of LED lightbulbs. This study looked exclusively at CFL replacement bulbs.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for participant NEBs (18%) was less than one.

  Factor = minimum of 1 or
  pmt(discount rate, yr horizon, PV(discount rate, measure life, 1))

  - Discount Rate = 18% (utility data)

  - Year Horizon = 10 years (utility data)

  - Weighted Measure Life = $\frac{\sum(Measure\ Lifetime * \#\ of\ Measures)}{Total\ \#\ of\ Measures}$ = 16.0

  - pmt(discount rate, yr horizon, PV(discount rate, measure life, 1)) = 1.15
    If the weighted measure life was less than the program horizon, this function would determine the amount by which the NEB should have been reduced.

  Table A-24C displays the measures included in the calculation of weighted measure life.

Table A-24C
Measures Included in Quality/Quantity of Lighting

Measure Name	Measure Lifetime	# of Measures	Lifetime * # Measures
Exterior Hard wired LED fixtures	16	2,734	43,744
Interior Hard wired LED fixtures	16	8,419	134,704
LED diffuse bulb	16	148,722	2,379,552
LED reflector bulb	16	8,045	128,720
LED Torchiere	16	14,817	237,072
Total	80	435,787	6,570,392
Average Measure Life = 16.0 Years			

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one.

  Factor = minimum of 1 or average number of causal measures

  - Total Number of Measures = 435,787
  - Total Number of Participants = 23,518
  - Average Number of Causal Measures = $\frac{\sum(\#\ of\ Measures)}{Total\ \#\ of\ Participants}$ = 7.770

  This adjustment factor can be turned on or off by utilities in the sensitivity options.

- Assumptions: Key assumptions that were made.
  - Value multiplier of 0.010, equal to the finding from the Skumatz 2005 WI study.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	E	*	F	=	Annual
Year	Bill Savings		Inflation		Value Multiplier		Adjust Prog. Horizon		Adjust # Measures		Participant Impact
2020	$30.42		1.00		0.10		1		1		$3.04
2021	$30.42		1.00		0.10		1		1		$3.04
2022	$30.42		1.00		0.10		1		1		$3.04
2023	$30.42		1.00		0.10		1		1		$3.04
2024	$30.42		1.00		0.10		1		1		$3.04

- Limitations
  - Use of 0.010 as NEB value multiplier.

- Applicability
  - Lighting multiplier may not apply to the ESA program given that the 2005 WI participants saved $220 on average compared to the $30 program attributable bill savings for the ESA program.
  - The 2005 WI studied assessed the impact of CFLs not LEDs.

- Duplication: This NEB did not duplicate another benefit calculated in this NEB analysis or other benefits that were already accounted for in the ESA cost-benefit analysis.

13. Measure Lifetime / Deferred Purchase

Old and faulty appliances would need replacement at some point if they were not by the ESA program. The 2019 report noted that dozens of studies from the early 2000s to 2011 valued this NEB at about $40.

This NEB was excluded because there is no literature to support it. Low-income households often use home equipment well past its expected useful life and many of the measures listed for this NEB only impact the efficiency of the home. This NEB is not included in the 2019 model.

- ESA Impact: The 2019 study stated that the installation of ESA measures deferred the need for appliances to be replaced by the participant. They estimated a $26.20 average annual benefit per participant in 2020 and adjusted it for inflation every year until 2024.

- Data: The following data were used as inputs in the research.

Table A-25A
Measure Life / Deferred Purchase Data Inputs

	Input	Source	Value	Notes
A	Likelihood Participant Would Need to Replace	Not Noted	10%-90%	Value Varies by Measure.
B	Interest Rate	Utilities	8%	Assumption Set by Utilities.
C	Remaining Useful Lifetime	Utilities	0.33	Assumption Set by Utilities.
D	Measure Life	Not Noted	5-16 years	Value Varies by Measure.
E	Measure Cost	Not Noted	$9-$5,500	Value Varies by Measure.
F	Number of Measures per Household	Utilities	0.001-6.324	Value Varies by Measure.

  - Likelihood Participant Would Need to Replace Measure: The likelihood a measure would need to be replaced varied by measure and was included from utility inputs. Table A-25B displays this value for each measure.

Table A-25B
Measure Specific Inputs Included in Measure Life / Deferred Purchase Calculation

Measure Name	Likelihood of Replacement	Measure Lifetime	Measure Cost	# of Measures per Household
High Efficiency Clothes Washer (with electric water heating)	20%	11	$825	0.001
High Efficiency Clothes Washer (with gas water heating)	20%	11	$825	0.017
Refrigerator	20%	14	$850	0.043
Low-flow showerhead & thermostatic valve (with electric water heating)	25%	10	$40	0.006
Low-flow showerhead & thermostatic valve (with gas water heating)	25%	10	$40	0.186
Domestic Hot Water Bundle (with electric water heating)	25%	10	$0	0.172
Domestic Hot Water Bundle (with gas water heating)	25%	10	$0	0.689
Heat pump water heater	10%	13	$2,100	0.001
Tub diverter (with electric water heating)	25%	10	$115	0.003
Tub diverter (with gas water heating)	25%	10	$115	0.103
Water Heater Repair/Replace	10%	11	$1,200	0.049
Enclosure bundle (with electric space heating and A/c)	0%	11	$0	0.096
Enclosure bundle (with gas space heating and A/c)	0%	11	$0	0.134
Enclosure bundle (with gas space heating and no A/c)	0%	11	$0	0.250
Central AC tune-up	10%	10	$160	0.000
Duct Testing & Sealing (with electric space heating and A/c)	10%	18	$250	0.000
Duct Testing & Sealing (with gas space heating and A/c)	10%	18	$0	0.006
Duct Testing & Sealing (with gas space heating and no A/c)	10%	18	$0	0.011
Fan control	10%	11	$150	0.001
Gas Furnace Clean and Tune	10%	5	$65	0.155
Gas furnace pilot light conversion	10%	13	$0	0.001
Gas Furnace Repair/Replace	10%	20	$700	0.210
PCT (with CAC and gas heat)	10%	11	$0	0.037
PCT (with gas heat and no CAC)	10%	11	$0	0.069
Room AC Replacement	50%	9	$850	0.009
Exterior Hard wired LED fixtures	90%	16	$75	0.116
Interior Hard wired LED fixtures	50%	16	$50	0.358
LED diffuse bulb	90%	16	$17	6.324
LED reflector bulb	90%	16	$28	0.342
LED Torchiere	50%	16	$65	0.630
Smart Power Strip	10%	8	$40	0.402
Smart strip Tier 2	10%	8	$75	0.319
Variable speed pool pump	10%	10	$1,300	0.021

Measure Name	Likelihood of Replacement	Measure Lifetime	Measure Cost	# of Measures per Household
Total		546	$24,944	10.78

- Interest Rate: The interest rate is included as eight percent from utility inputs.

- Remaining Useful Lifetime: The remaining useful lifetime was included as 0.33 from utility inputs.

- Measure Life: The measure life was included from utility inputs. Table A-25B displays this value for each measure.

- Measure Cost: The measure cost was included from utility inputs. Table A-25B displays this value for each measure.

- Number of Measures per Household: The number of measures per household was included from utility inputs. Table A-25B displays this value for each measure. It was calculated by diving the number of each measure installed, which is displayed in Table II-1C, by the total number of participants, which was 23,518.

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one. This is the same calculation as in the Reduced Arrearage Carrying Cost NEB review. No adjustment was made.

- Assumptions: Key assumptions that were made.
  - Interest rate of 8%, set by the utility.
  - Remaining Useful Life (RUL) of 0.33, set by the utility.
  - Likelihood that participant would need to replace a specific measure of between 10% and 90%, set by the utility.

- Calculation: The following calculation was made to compute the annual benefit for each ESA measure.

  - Benefit = (Likelihood of Replacement) *
    (-Value of Remaining Useful Life for Replaced Measure + Value of Entire Lifetime for New Measure) *
    (Number of Measures)

  - Value of Remaining Useful Life for Replaced Measure = PMT(Interest Rate, (Remaining Useful Life * Total Measure Lifetime), Measure Cost)

    The PMT function is most often used to calculate payments on a loan given a constant interest rate. Here, it was used to calculate the annual value of the replaced measure based on the utility's interest rate.

- Value of Entire Lifetime for New Measure = PMT(Interest Rate, Total Measure Lifetime, Measure Cost)

  This PMT function was used to calculate the annual value of the new measure based on the utility's interest rate.

The total value of the NEB was calculating by taking the sum of the resulting values across all measures for a total of $26.20.

			-ANNUAL VALUE OF REMAINING USEFUL LIFE FOR REPLACED MEASURE										
	SUM(A	*	-PMT(	B	,	(C	*	D)	,	E	)	+
Year	Likelihood of Replacement			Interest Rate		Remaining Useful Life		Total Measure Life		Measure Cost		
2020	Table A-25B			8%		0.33		Table A-25B		Table A-25B		
2021	Table A-25B			8%		0.33		Table A-25B		Table A-25B		
2022	Table A-25B			8%		0.33		Table A-25B		Table A-25B		
2023	Table A-25B			8%		0.33		Table A-25B		Table A-25B		
2024	Table A-25B			8%		0.33		Table A-25B		Table A-25B		

ANNUAL VALUE OF ENTIRE LIFETIME FOR NEW MEASURES										
PMT(	B	,	D	,	E	)	*	F)	=	Annual Participant Impact
	Interest Rate		Total Measure Life		Measure Cost			Number of Measures		
	8%		Table A-25B		Table A-25B			Table A-25B		$26.20
	8%		Table A-25B		Table A-25B			Table A-25B		$26.20
	8%		Table A-25B		Table A-25B			Table A-25B		$26.20
	8%		Table A-25B		Table A-25B			Table A-25B		$26.20
	8%		Table A-25B		Table A-25B			Table A-25B		$26.20

- Limitations
  - All values came from utility data or assumptions that were specifically stated by the utility.

- Applicability
  - All values were set by the utilities, so this NEB should be applicable if the data were accurate for ESA participants in 2020.

- Duplication: This NEB did not duplicate another benefit calculated in this NEB analysis or other benefits that were already accounted for in the ESA cost-benefit analysis.

14. Reduced Detergent Usage

There is a claim that new washing machines use less detergent. The 2019 report noted that this NEB was supported by a study from 2001.

This NEB was excluded because it refers to a study from 2001 and may no longer apply to current washing machine replacements.

- ESA Impact: The 2019 study stated that the installation of ESA measures reduced the amount of detergent a household would need to use. They estimated a $0.97 average annual benefit per participant in 2020 and adjusted it for inflation every year until 2024.

- Data: The following data were used as inputs in the research.

Table A-26A
Reduced Detergent Use Data Inputs

	Input	Source	Value	Notes
A	ESA Washer Replace Rate	Utilities	0.018	
B	Reduced Detergent Value	LIEE 2001[172]	$43.96	Spreadsheet notes this is a conservative estimate.
C	Special Detergent Cost	Web Search	$7.50	
D	Inflation Factor (2018)	Bureau of Labor Statistics	1.05-1.15	
E	Inflation Factor (2001)	Bureau of Labor Statistics	1.49-1.64	
F	Weighted Measure Life (Years)	Utilities	11	Sum (Measure Lifetime * # of Measure)/Total # of Measures
G	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
H	Adjustment Factor Number of Measures	Utilities	1	Reduced to less than one if average # of causal measures per household was less than one.

  - ESA Washers Replaced per Home: The number of washing machines installed per home was included as 0.018 from utility inputs. It was calculated by dividing the total number of washing machines installed by the total number of participants.

    - Washing Machines per Household = $\frac{\sum(\#\ of\ Measures)}{Total\ \#\ of\ Participants} = \frac{426}{23{,}518} = 0.018$

  - Value of Reduced Detergent: The value of the reduced detergent per household per year was $43.96 based on the 2001 LIEE Impact study.
    - LIEE 2001 Impact Study: The LIEE Impact Study cited in the 2019 spreadsheet did not include any mention of detergent. The source of this value is not known.

[172] Equipoise, "LIEE Program Evaluation", California 2001, pg. 4-2.

This value may not be applicable in 2020 even after adjusting for inflation because it assumes that new washing machines in 2020 save the same total amount of detergent relative to those they replace as new machines in 2001.

- Cost of Special Detergent: The additional cost of special detergent needed in newer machines was $7.50, based on a web search. The details of this search were not included in the 2019 spreadsheet tool.

  The 2019 spreadsheet tool updated this value for inflation twice but did not state why.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for participant NEBs (18%) was less than one. This is the same calculation as in Section A-C3 for Fewer Fires. No adjustment was made.

  Table A-26B displays the measures included in the calculation of weighted measure life.

Table A-26B
Measures Included in Operations & Maintenance Cost Changes

Measure Name	Measure Lifetime	# of Measures	Lifetime * # Measures
High Efficiency Clothes Washer (with electric water heating)	11	21	231
High Efficiency Clothes Washer (with gas water heating)	11	405	4,455
Total	22	426	4,686
Average Measure Life = 11.0 Years			

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one.

  Factor = minimum of 1 or average number of causal measures

  - Total Number of Measures = 426
  - Total Number of Participants = 23,518
  - Average Number of Causal Measures = $\frac{\sum(\#\ of\ Measures)}{Total\ \#\ of\ Participants}$ = 0.019

  This adjustment factor was turned off in the sensitivity options.

- Assumptions: Key assumptions that were made.
  - Detergent cost reduction of $43.96, equal to the finding from the 2001 LIEE Impact study.

- Higher quality detergent cost of $7.50, equal to that found by a web search and then adjusted for inflation twice.

- Calculation: The following calculation was made to compute the annual benefit. The cost of higher quality detergent was updated for inflation twice, which may have been an error.

	A	*	(B	-	(C	*	D))	*	E	*	G	*	H	=	
Year	ESA Washer Replace Rate		Reduced Detergent		Higher Quality Detergent		Inflation (since 2018)		Inflation (since 2001)		Adjust Prog. Horizon		Adjust # Measures		Annual Participant Impact
2020	0.018		$43.96		$7.50		1.05		1.49		1		1		$0.97
2021	0.018		$43.96		$7.50		1.07		1.53		1		1		$0.99
2022	0.018		$43.96		$7.50		1.10		1.56		1		1		$1.01
2023	0.018		$43.96		$7.50		1.13		1.60		1		1		$1.03
2024	0.018		$43.96		$7.50		1.15		1.64		1		1		$1.05

- Limitations
  - Use of $43.96 as reduced cost of detergent.
  - Use of $7.50 as cost of higher quality detergent.

- Applicability
  - The reduction in the need for detergent based upon a replacement machine in 2001 likely does not apply to 2020.
  - While the reduced cost of detergent was adjusted for inflation, it likely does not apply to 2020.

- Duplication: This NEB did not duplicate another benefit calculated in this NEB analysis or other benefits that were already accounted for in the ESA cost-benefit analysis.

15. Improved Equipment Features/ Performance

Features included on new equipment can make the equipment easier and faster to operate. The 2019 report noted that several studies in the early 2000s valued this NEB at about $20.

This NEB was excluded because basic models supplied by energy efficiency programs primarily improve efficiency rather than providing additional features. It was not included in the 2019 model.

- ESA Impact: The 2019 study stated that the installation of new equipment through the ESA program improved the experience of participants. It estimated a $2.25 average annual benefit per participant every year from 2020 to 2024.

The 2019 report stated that the value of NEBs like the value of improved equipment features were difficult to calculate directly and instead applied a multiplier to participant energy savings. This multiplier was estimated from survey findings.

- Data: The following data were used as inputs in the research.

Table A-27A
Improved Equipment Features / Performance Data Inputs

	Input	Source	Value	Notes
A	Average Bill Savings	Utilities	$30.42	
B	Inflation Factor	Bureau of Labor Statistics	1.00	Assumed current
C	NEB Value Multiplier	Skumatz MD 2014[173]	0.139	
D	Weighted Measure Life (Years)	Utilities	13	Sum (Measure Lifetime * # of Measure)/Total # of Measures
E	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
F	Adjustment Factor Number of Measures	Utilities	0.53	Reduced to less than one if average # of causal measures per household was less than one.

  - Average Bill Savings: Program attributable savings was calculated as $30.42 per participant per year using utility data (as shown in the Thermal Comfort NEB review).

    Table II-10B displays the kWh and therm savings for each measure included in this calculation. Because the NEB value multiplier was applied to total bill savings, all measures were included in this calculation instead of the relevant subset that was used to calculate weighted measure life later in this section.

  - NEB Value Multiplier: The equipment performance multiplier value per dollar saved was calculated as 0.139 based on the findings reported in the Skumatz 2014 MD literature review.
    - Skumatz 2014 MD Literature Review: This review stated that estimates for this multiplier ranged from 0.069 to 0.260 with a midpoint of 0.139. The literature review stated that it considered the following studies in addition to other, unnamed studies, but did not state which were used in calculating the midpoint of 0.139. An additional note in the appendix stated that "many studies" were used in this calculation.
      - Skumatz et al. 2010
      - Skumatz et al. 2009
      - Oppenheim 2012
      - ORNL

[173] Skumatz, MD, 2014, http://energyefficiencyforall.org/resources/non-energy-benefitsnon-energy-impacts-nebsneis-and-their-role-values-cost-effectiveness

- Skumatz et al. 2004
- NMR/TetraTech 2011

The following information was not available to address the reliability of the research and applicability of the estimate to the CA ESA.

- All applicable studies: The 2019 spreadsheet report did not list all studies included in the literature review and did not state which studies were used in defining the midpoint for each NEB. Without knowing which reports were used and how the NEB multiplier was calculated in those reports, a full understanding of this estimate was not possible.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for participant NEBs (18%) was less than one. This is the same calculation as in Section A-C3 for Fewer Fires. No adjustment was made.

  Table A-27B displays the measures included in the calculation of weighted measure life.

Table A-27B
Measures Included in Improved Equipment Features/Performance Calculation

Measure Name	Measure Lifetime	# of Measures	Lifetime * # Measures
High Efficiency Clothes Washer (with electric water heating)	11	21	231
High Efficiency Clothes Washer (with gas water heating)	11	405	4,455
Refrigerator	14	1,002	14,028
Gas Furnace Clean and Tune	5	3,634	18,170
Gas Furnace Pilot Light Conversion	13	18	234
Gas Furnace Repair/Replace	20	4,933	98,660
PCT (with CAC and gas heat)	11	875	9,625
PCT (with gas heat and no CAC)	11	1,625	17,875
Total	96	12,513	163,278
Average Measure Life = 13.0 Years			

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one.

  Factor = minimum of 1 or average number of causal measures

  - Total Number of Measures = 12,513
  - Total Number of Participants = 23,518
  - Average Number of Causal Measures = $\frac{\sum(\#\ of\ Measures)}{Total\ \#\ of\ Participants}$ = 0.532

This adjustment factor can be turned on or off by utilities in the sensitivity options.

- Assumptions: Key assumptions that were made.
  - NEB value multiplier of 0.139, equal to the finding from the Skumatz MD 2014 literature review.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	E	*	F	=	
Year	Bill Savings		Inflation		Value Multiplier		Adjust Prog. Horizon		Adjust # Measures		Annual Participant Impact
2020	$30.42		1.00		0.139		1		0.53		$2.25
2021	$30.42		1.00		0.139		1		0.53		$2.25
2022	$30.42		1.00		0.139		1		0.53		$2.25
2023	$30.42		1.00		0.139		1		0.53		$2.25
2024	$30.42		1.00		0.139		1		0.53		$2.25

- Limitations
  - Use of 0.139 as NEB value multiplier.

- Applicability
  - Equipment performance multiplier may not apply to ESA.

- Duplication: This NEB may have duplicated the impact of other NEBs.
  - The 2019 spreadsheet tool stated that the value multiplier used in this calculation might overlap with others but did not state which ones. Without knowing which estimates were used in the Skumatz 2014 literature review, the potential for overlap could not be assessed.

16. Aesthetics / Appearance of Home

New equipment can improve the home appearance. The 2019 report noted that several studies in the early to mid-2000s valued this NEB at about $20.

This NEB was excluded because measures provided by energy efficiency programs do not improve the home's appearance.

- ESA Impact: The 2019 study stated that the installation of new equipment through the ESA program improved the appearance and aesthetics of the home. They estimated a $2.68 average annual benefit per participant every year from 2020 to 2024.

  The 2019 report stated that the value of NEBs like improved home appearance are difficult to calculate directly and instead applied a multiplier to participant energy savings. This multiplier was estimated from survey findings.

- Data: The following data were used as inputs in the research.

Table A-28A
Aesthetics / Appearance of Home Data Inputs

	Input	Source	Value	Notes
A	Average Bill Savings	Utilities	$30.42	
B	Inflation Factor	Bureau of Labor Statistics	1.00	Assumed current.
C	NEB Value Multiplier	Skumatz MD 2014[174]	0.088	
D	Weighted Measure Life (Years)	Utilities	15.8	Sum (Measure Lifetime * # of Measure)/Total # of Measures
E	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
F	Adjustment Factor Number of Measures	Utilities	1	Reduced to less than one if average # of causal measures per household was less than one.

- Average Bill Savings: Program attributable savings was calculated as $30.42 per participant per year using utility data (as shown in the Thermal Comfort NEB review).

  Table II-10B displays the kWh and therm savings for each measure included in this calculation. Because the NEB value multiplier was applied to total bill savings, all measures were included in this calculation instead of the relevant subset that was used to calculate weighted measure life later in this section.

- NEB Value Multiplier: The equipment performance multiplier value per dollar saved was calculated as 0.088 based on the finding from the Skumatz 2014 MD literature review.
  - Skumatz 2014 MD Literature Review: See the discussion in Section A-C15: Improved Equipment Features/Performance for full details regarding this literature review. This review stated that estimates for this multiplier ranged from 0.060 to 0.184 with a midpoint of 0.088. The review did not state which other studies were used to obtain this midpoint.

[174] Skumatz, MD, 2014, http://energyefficiencyforall.org/resources/non-energy-benefitsnon-energy-impacts-nebsneis-and-their-role-values-cost-effectiveness

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for participant NEBs (18%) was less than one.

  Factor = minimum of 1 or
  pmt(discount rate, yr horizon, PV(discount rate, measure life, 1))

  - Discount Rate = 18% (utility data)
  - Year Horizon = 10 years (utility data)
  - Weighted Measure Life = $\frac{\sum(Measure\ Lifetime * \#\ of\ Measures)}{Total\ \#\ of\ Measures}$ = 15.8
  - pmt(discount rate, yr horizon, PV(discount rate, measure life, 1)) = 1.15
    If the weighted measure life was less than the program horizon, this function would determine the amount by which the NEB should have been reduced.

  Table A-28B displays the measures included in the calculation of weighted measure life.

Table A-28B
Measures Included in Improved Equipment Features/Performance Calculation

Measure Name	Measure Lifetime	# of Measures	Lifetime * # Measures
High Efficiency Clothes Washer (with electric water heating)	11	21	231
High Efficiency Clothes Washer (with gas water heating)	11	405	4,455
Gas Furnace Clean and Tune	5	3,634	18,170
Gas furnace pilot light conversion	13	18	234
Gas Furnace Repair/Replace	20	4,933	98,660
PCT (with CAC and gas heat)	11	875	9,625
PCT (with gas heat and no CAC)	11	1,625	17,875
Room AC Replacement	9	203	1,827
Exterior Hard wired LED fixtures	16	2,734	43,744
Interior Hard wired LED fixtures	16	8,419	134,704
LED diffuse bulb	16	148,722	2,379,552
LED reflector bulb	16	8,045	128,720
LED Torchiere	16	14,817	237,072
Total	171	194,451	3,074,869
Average Measure Life = 15.8 Years			

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one.

  Factor = minimum of 1 or average number of causal measures

  - Total Number of Measures = 194,451
  - Total Number of Participants = 23,518
  - Average Number of Causal Measures = $\frac{\sum(\#\ of\ Measures)}{Total\ \#\ of\ Participants}$ = 8.311

  This adjustment factor can be turned on or off by utilities in the sensitivity options.

- Assumptions: Key assumptions that were made.
  - Value multiplier of 0.088, equal to the finding from Skumatz MD 2014 literature review.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	E	*	F	=	
Year	Bill Savings		Inflation		Value Multiplier		Adjust Prog. Horizon		Adjust # Measures		Annual Participant Impact
2020	$30.42		1.00		0.088		1		1		$2.68
2021	$30.42		1.00		0.088		1		1		$2.68
2022	$30.42		1.00		0.088		1		1		$2.68
2023	$30.42		1.00		0.088		1		1		$2.68
2024	$30.42		1.00		0.088		1		1		$2.68

- Limitations
  - Use of 0.088 as NEB value multiplier.

- Applicability
  - Equipment performance multiplier may not apply to ESA.

- Duplication: This NEB did not duplicate another benefit calculated in this NEB analysis or other benefits that were already accounted for in the ESA cost-benefit analysis.

17. Hardship Benefits

High energy bills can result in hardship and stress for low-income households. The 2019 report noted that over a dozen studies from the early 2000s to 2018 valued this NEB at about $60.

This NEB was excluded because there is no recent literature to support the NEB. It was not included in the 2019 model.

- ESA Impact: The 2019 study stated that the installation of ESA measures reduced energy bills and thus the stress and hardship that could result from higher bills. They estimated a $0 average annual benefit per participant every year from 2020 to 2024 because no strong estimate of the value was available.

  The 2019 report stated that the value of NEBs like the value of reduced hardship were difficult to calculate directly and instead should apply a multiplier to participant energy savings, based on survey findings. In this case, no reliable estimate could be found, so it was assumed to be 0.

- Data: The following data were used as inputs in the research.

Table A-29A
Hardship Benefits Data Inputs

	Input	Source	Value	Notes
A	Average Bill Savings	Utilities	$30.42	
B	Inflation Factor	Bureau of Labor Statistics	1.00	Assumed current.
C	NEB Value Multiplier	No literature	0.00	
D	Weighted Measure Life (Years)	Utilities	14.4	Sum (Measure Lifetime * # of Measure)/Total # of Measures
E	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
F	Adjustment Factor Number of Measures	Utilities	1	Reduced to less than one if average # of causal measures per household was less than one.

  - Average Bill Savings: Program attributable savings was calculated as $30.42 per participant per year using utility data (as shown in the Thermal Comfort NEB review).

    Table II-10B displays the kWh and therm savings for each measure included in this calculation. Because the NEB value multiplier was applied to total bill savings, all measures were included in this calculation instead of the relevant subset that was used to calculate weighted measure life later in this section.

  - NEB Value Multiplier: The 2019 spreadsheet tool stated that no good estimate was available, so it was assumed to be 0.

  - Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for participant NEBs (18%) was less than one. This is the same calculation as in the Fewer Shutoffs NEB review. No adjustment was made.

  - Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one. This is the same

calculation as in the Reduced Arrearage Carrying Costs NEB review. No adjustment was made.

- Assumptions: Key assumptions that were made.
  - Value multiplier was 0 because no previous literature was available.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	E	*	F	=	
Year	Bill Savings		Inflation		Value Multiplier		Adjust Prog. Horizon		Adjust # Measures		Annual Participant Impact
2020	$30.42		1.00		0		1		1		$0.00
2021	$30.42		1.00		0		1		1		$0.00
2022	$30.42		1.00		0		1		1		$0.00
2023	$30.42		1.00		0		1		1		$0.00
2024	$30.42		1.00		0		1		1		$0.00

- Limitations
  - Use of zero as the NEB value multiplier.

- Applicability
  - NEB multiplier may not apply to ESA.

- Duplication: This NEB did not duplicate another benefit calculated in this NEB analysis or other benefits that were already accounted for in the ESA cost-benefit analysis.

18. Avoided Moves / Household Impacts

High energy bills may result in some customers needing to move, resulting in additional costs. The 2019 report noted that a few studies from the early 2000s to 2018 valued this NEB at about $80.

This NEB was excluded because there is no literature to support it. The referenced study does not provide an estimate of this impact. It was not included in the 2019 model.

- ESA Impact: The 2019 study stated that the installation of ESA measures reduced energy bills and thus reduced the number of participants who were forced to move. It estimated a $2.09 benefit per participant in 2020 and adjusted that for inflation every year until 2024.

- Data: The following data were used as inputs in the research.

Table A-30A
Avoided Moves / Household Impacts Data Inputs

	Input	Source	Value	Notes
A	Moves Avoided	2014 Tonn WAP[175]	2.7%	
B	Average Moving Costs	Oppenheim and Macgregor AK 2002[176]	$500	
C	Inflation Factor	Bureau of Labor Statistics	1.47-1.62	
D	Reduced Earning Power and Education	Oppenheim and Macgregor AK 2002	$26.06	
E	Lifetime (years) of Avoided Move Benefit	Oppenheim and Macgregor AK 2002	10	
F	Weighted Measure Life (Years)	Utilities	14.4	Sum (Measure Lifetime * # of Measure)/Total # of Measures
G	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
H	Adjustment Factor Number of Measures	Utilities	1	Reduced to less than one if average # of causal measures per household was less than one.

  - Moves Avoided: The number of moves avoided was 2.7 percent based on the Tonn 2014 WAP Evaluation. This value was presented in the 2019 spreadsheet tool as a percentage, but included in the calculation as the total number of moves avoided per household.
    - Tonn 2014 WAP Evaluation: See discussion in the Fewer Collections Notices NEB review for full details regarding this study. The 2019 spreadsheet tool did not specifically state where in the study the value was found, but the study reported that 2.7 percent of the treatment group had their mortgage foreclosed on as a result of high energy bills prior to WAP treatments.[177] The results are displayed in Table A-30B.

Table A-30B
ORNL Foreclosure Impact Results

	Pre	Post	Percentage Point Change
Treatment Group	2.7%	2.0%	-0.7%
Comparison Group	2.2%	1.9%	-0.3%
Net Change			-0.4%

[175] ORNL, Tonn et al., "Weatherization Works - Summary of Findings from the Retrospective Evaluation of the U.S. Department of Energy's Weatherization Assistance Program," September 2014, Reference ORNL/TM-2014/338.
[176] Oppenheim Arkansas 2002 (pg. 11) http://www.apscservices.info/EEInfo/Econ_of_Low_Inc_Eff.pdf
[177] The 2019 spreadsheet tool stated that the value could be found on page xvii of the report, but no page in the report was numbered that way.

If this was the value used in the analysis, it assumed the following.

- All moves resulting from high energy bills were the result of foreclosure. This is unlikely since elsewhere in the 2019 spreadsheet tool it stated that 75 percent of participants were renters and not homeowners. It also did not include the participants that may have moved prior to foreclosure due to high energy bills.

- All foreclosures resulting from high energy bills were avoided through the ESA program.

- Average Moving Costs: The average moving costs were $500 based on the Oppenheim and Macgregor 2002 AK study.
  - Oppenheim and Macgregor 2002 AK Study: This study stated that it assumed an avoided moving cost of $500. It claimed that this was a conservative estimate given a 1999 Riggert et al. study that found a $50 annual benefit. The Riggert et al. study could not be located.

- Reduced Earning Power and Education: The reduction in earning power and education that resulted from a move was monetized as $26.06.
  - Oppenheim and Macgregor 2002 AK Study: This study stated that $26.06 was the midpoint between two estimates reviewed in a 1999 conference presentation by Skumatz and Dickerson, but this presentation could not be located.

- Moving Benefits – Lifetime (years): The lifetime of the benefits from avoiding a move was included as ten years. The 2019 spreadsheet stated that this value was implied in the Oppenheim and Macgregor 2002 AK study because the authors assumed a $500 avoided moving cost shortly after citing the 1999 study by Riggert et al. that found a $50 annual benefit. A clear discussion of these assumptions was not provided, and the original Riggert et al. study could not be located.

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for participant NEBs (18%) was less than one. This is the same calculation as in the Fewer Shutoffs NEB review. No adjustment was made.

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one. This is the same calculation as in the Reduced Arrearage Carrying Cost NEB review. No adjustment was made.

- Assumptions: Key assumptions that are made.
  - Number of avoided moves per participant of 2.7%, equal to the finding from the Tonn 2014 WAP evaluation.
  - Average moving costs of $500, equal to the assumption used in the 2002 AK Oppenheim study.
  - Reduction in earning power and education of $26.06, equal to the finding from the 1999 Riggert et al. study.
  - Ten-year lifetime for moving-related benefits, equal to the implied assumption in the 2002 AK Oppenheim study.

- Calculation: The following calculation was made to compute the annual benefit.

	(A	*	(B	+	C)	*	D)	/	(E)	*	G	*	H	=	
Year	Moves Avoided		Moving Costs		Reduced Earnings		Inflation		Benefit Lifetime		Adjust Prog. Horizon		Adjust # Measures		Annual Participant Impact
2020	2.7%		$500		$26.06		1.47		10		1		1		$2.09
2021	2.7%		$500		$26.06		1.51		10		1		1		$2.14
2022	2.7%		$500		$26.06		1.54		10		1		1		$2.19
2023	2.7%		$500		$26.06		1.58		10		1		1		$2.25
2024	2.7%		$500		$26.06		1.62		10		1		1		$2.30

- Limitations
  - Use of 2.7% as the percentage of moves avoided.
  - Use of $500 as the average cost of a move.
  - Use of $26.06 as the reduction in earning power and education.
  - Use of ten years as the lifetime of this benefit.

- Applicability
  - Average number of moves avoided may not apply to ESA participants.
  - Moving costs may not apply to California in 2020.
  - Reduced earnings and education may not apply to ESA participants in 2020.
  - Ten-year benefit lifetime may not apply to ESA participants.

- Duplication: This NEB did not duplicate another benefit calculated in this NEB analysis or other benefits that were already accounted for in the ESA cost-benefit analysis.

19. Knowledge / Ability to Control Bill

High energy costs may cause households to feel that they do not have the ability to control their energy bills. The 2019 report noted one study that valued this NEB at about $35.

This NEB was excluded because there is no literature to support it. It was not included in the 2019 model.

- ESA Impact: The 2019 study stated that the installation of ESA measures improved the participant's control over their energy bills. They estimated a $2.81 average annual benefit per participant every year from 2020 to 2024.

  The 2019 report stated that the value of NEBs like control over energy bills was difficult to calculate directly and instead applied a multiplier to participant energy savings. This multiplier was estimated from survey findings.

- Data: The following data were used as inputs in the research.

Table A-31A
Knowledge of / Ability to Control Bill Data Inputs

	Input	Source	Value	Notes
A	Average Bill Savings	Utilities	$30.42	
B	Inflation Factor	Bureau of Labor Statistics	1.00	Assumed current.
C	NEB Value Multiplier	Skumatz Xcel 2010[178]	0.093	
D	Weighted Measure Life (Years)	Utilities	12	Sum (Measure Lifetime * # of Measure)/Total # of Measures
E	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
F	Adjustment Factor Number of Measures	Utilities	0.96	Reduced to less than one if average # of causal measures per household was less than one.

  - Average Bill Savings: Program attributable savings was calculated as $30.42 per participant per year using utility data (as shown in the Thermal Comfort NEB review).

    Table II-10B displays the kWh and therm savings for each measure included in this calculation. Because the NEB value multiplier was applied to total bill savings, all measures were included in this calculation instead of the relevant subset that was used to calculate weighted measure life later in this section.

  - NEB Value Multiplier: The multiplier value per dollar saved for the participant's ability to control the energy bill was calculated as .093 based on the midpoint of two findings from the Skumatz 2010 Xcel study.
    - Skumatz 2010 Xcel Study: See the discussion in II-D4: Thermal Comfort for full details regarding this study's analysis of the Xcel Single Family Weatherization Program. The study stated that the percentage of the total NEBs in that program that were related to bill control was 7.4 percent.

[178] Skumatz, L., "NEBs Analysis for Xcel Energy's Low Income Energy Efficiency Programs", Prepared for Xcel Energy, Denver CO, May 2010

The percentage in the Nonprofit Weatherization Program was 8.9 percent. This program was evaluated separately in the study. It provides funding for energy efficient improvements to nonprofits, such as shelters, safe houses, and residential treatment centers for those that might be homeless. All eleven nonprofits that received funds in the previous year were contacted via phone and given a similar survey to the one mailed to participants in the Single-Family Weatherization Program. The results for both programs are shown in Table A-31B. The study reported separate electric and gas results for the Nonprofit program, but the total NEB value multiplier and benefit percentages were the same for both energy types.

Table A-31B
2010 Xcel Thermal Comfort Multiplier Results for
Single-Family and Nonprofit Weatherization Programs

	Single-Family Weatherization Program			Nonprofit Weatherization Program
	All	**Electric**	**Gas**	**All, Electric, Gas**
Total Participants	1,950			11
Respondents	149	125	106	11
Total NEB Value Multiplier	1.156	1.171	1.148	1
Bill Savings	$238.30	$67.56	$170.74	$2,655.40
Comfort	7.50%	7.50%	7.40%	8.80%
Water	7.40%	7.50%	7.30%	6.30%
Light	7.30%	7.20%	7.20%	7.80%
Noise	8.10%	8.10%	8.10%	6.90%
Safety	8.20%	8.20%	8.20%	6.30%
Health	7.80%	7.70%	8.00%	6.30%
Health – other	0.00%	0.00%	0.00%	6.30%
Maintenance	7.20%	7.20%	7.20%	7.00%
Resale	7.80%	7.70%	7.90%	6.50%
Bill Control	8.20%	8.20%	8.30%	7.20%
Environmental Contribution	7.90%	7.90%	7.80%	8.90%
Bill Knowledge	7.40%	7.40%	7.40%	8.90%
Productivity	0.00%	0.00%	0.00%	6.50%
Collections	7.20%	7.20%	6.90%	0.00%
Other	8.20%	8.10%	8.30%	6.30%
Percentage Total	100%	100%	100%	100.00%

The 2019 spreadsheet used the midpoint between the two programs of 8.15. It did not state why the Nonprofit Weatherization Program was included in this

analysis when it was not included in any other NEB that used this study. This value was then multiplied by the total value multiplier for the Single-Family Weatherization Program of 1.15 to calculate the final value of .093. Table A-31C displays the calculation using this value.

Table A-31C
2010 Xcel Indoor Ability to Control Bill Reduction Multiplier Results

	Number of Respondents	Multiplier
Percent of NEB Attributed to Ability to Control Bill – Single Family	149	0.074
Percent of NEB Attributed to Ability to Control Bill – Non-Profit	11	0.089
Subtotal: Percent of NEB Attributed to Ability to Control Bill – Average	-	0.082
Total NEB Value Multiplier – Single Family	149	1.150
2019 Spreadsheet Tool Multiplier for Ability to Control Bill		0.093

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for participant NEBs (18%) was less than one. This is the same calculation as in the Fewer Shutoffs NEB review. No adjustment was made.

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one.

  Factor = minimum of 1 or average number of causal measures

  - Total Number of Measures = 22,577
  - Total Number of Participants = 23,518
  - Average Number of Causal Measures = $\frac{\sum(\#\ of\ Measures)}{Total\ \#\ of\ Participants}$ = 0.960

  This adjustment factor can be turned on or off by utilities in the sensitivity options.

- Assumptions: Key assumptions that were made.
  - Value multiplier of 0.093, equal to the midpoint between two findings from the Skumatz Xcel 2010 study.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	E	*	F	=	Annual
Year	Bill Savings		Inflation		Value Multiplier		Adjust Prog. Horizon		Adjust # Measures		Participant Impact
2020	$30.42		1.00		0.093		1		0.96		$2.70
2021	$30.42		1.00		0.093		1		0.96		$2.70
2022	$30.42		1.00		0.093		1		0.96		$2.70
2023	$30.42		1.00		0.093		1		0.96		$2.70

2024	$30.42		1.00		0.093		1		0.96	$2.70

- Limitations
  - Use of 0.093 as NEB multiplier.

- Applicability
  - Bill control multiplier may not apply to the ESA program given that the 2010 Xcel participants saved $238 on average compared to the $30 program attributable bill savings for the ESA program.

- Duplication: This NEB did not duplicate another benefit calculated in this NEB analysis or other benefits that were already accounted for in the ESA cost-benefit analysis.

20. Contributing to Environmental Good

Low-income households do not have the financial resources to invest in energy-efficient equipment that will have positive environmental impacts. The ESA program makes these investments and may make participants feel good about having a positive impact on the environment. The 2019 report noted several studies from the mid-2010s that valued this NEB at about $30.

This NEB was excluded because there is no literature to support it. It was not included in the 2019 model.

- ESA Impact: The 2019 study stated that the installation of ESA measures made participants feel that they were contributing to the environmental good because they had a more efficient home. They estimated a $0.82 average annual benefit per participant every year from 2020 to 2024.

  The 2019 report stated that the value of NEBs like contributing to the environmental good was difficult to calculate directly and instead applied a multiplier to participant energy savings. This multiplier was estimated from survey findings.

- Data: The following data were used as inputs in the research.

Table A-32A
Contributing to the Environmental Good Data Inputs

	Input	Source	Value	Notes
A	Average Bill Savings	Utilities	$30.42	
B	Inflation Factor	Bureau of Labor Statistics	1.00	Assumed current.

	Input	Source	Value	Notes
C	NEB Value Multiplier	Skumatz 2005 WI[179]	0.027	
D	Weighted Measure Life (Years)	Utilities	15.8	Sum (Measure Lifetime * # of Measure)/Total # of Measures
E	Adjustment Factor Program Horizon	Utilities	1	Reduced to less than one if discounted remaining weighted measure life was less than one.
F	Adjustment Factor Number of Measures	Utilities	1	Reduced to less than one if average # of causal measures per household was less than one.

- Average Bill Savings: Program attributable savings was calculated as $30.42 per participant per year using utility data (as shown in the Thermal Comfort NEB review).

  Table II-10B displays the kWh and therm savings for each measure included in this calculation. Because the NEB value multiplier was applied to total bill savings, all measures were included in this calculation instead of the relevant subset that was used to calculate weighted measure life later in this section.

- NEB Value Multiplier: The multiplier value per dollar saved for the participant's perception of contributing to the environmental good was calculated as 0.027 based on the finding from the Skumatz 2005 WI study.
  - Skumatz 2005 WI Study: See the discussion in A-C12: Quantity/Quality of Lighting for full details regarding this study.

    Table A-32B displays the calculation of the 0.027 multiplier value used in the 2019 spreadsheet. The average total NEB value multiplier of 1.32 was multiplied by the share of the NEB benefits attributed to the perception of doing environmental good of 0.020.

Table A-32B
Skumatz 2005 WI Perception of Doing Environmental Good Results

	Number of Participant Respondents	Value of Multiplier
Total NEB Value Multiplier	362	1.132
Share of NEB Benefits Attributed to Environmental Good	362	0.020
2019 Spreadsheet Tool Multiplier for Perception of Doing Environmental Good		0.027

[179] Skumatz, L., "NEBs Analysis for Xcel Energy's Low Income Energy Efficiency Programs", Prepared for Xcel Energy, Denver CO, May 2010

The total NEB value multiplier of 1.32 was higher than the value of 1.156 used in other NEB calculations from the Skumatz 2010 Xcel study (See the Thermal Comfort NEB review for full details).

- Adjustment Factor – Program Horizon: Reduced to less than one if the remaining weighted measure life adjusted with the discount rate for participant NEBs (18%) was less than one. This is the same calculation as in Section A-C12 for Quality of Lighting. No adjustment was made.

  Table A-32C displays the measures included in the calculation of weighted measure life.

Table A-32C
Measures Included in Perception of Doing Environmental Good Calculation

Measure Name	Measure Lifetime	# of Measures	Lifetime * # Measures
Gas Furnace Clean and Tune	5	3,634	18,170
Gas furnace pilot light conversion	13	18	234
Gas Furnace Repair/Replace	20	4,933	98,660
PCT (with CAC and gas heat)	11	875	9,625
PCT (with gas heat and no CAC)	11	1,625	17,875
Exterior Hard wired LED fixtures	16	2,734	43,744
LED diffuse bulb	16	148,722	2,379,552
LED reflector bulb	16	8,045	128,720
Total	108	170,586	2,696,580
Average Measure Life = 15.8 Years			

- Adjustment Factor – Number of Measures: Reduced to less than one if the average number of causal measures per household was less than one.

  Factor = minimum of 1 or average number of causal measures

  - Total Number of Measures = 170,586
  - Total Number of Participants = 23,518
  - Average Number of Causal Measures = $\frac{\sum(\#\ of\ Measures)}{Total\ \#\ of\ Participants}$ = 7.253

  This adjustment factor can be turned on or off by utilities in the sensitivity options.

- Assumptions: Key assumptions that were made.
  - Value multiplier was 0.027, equal to the finding from Skumatz WI 2005.

- Calculation: The following calculation was made to compute the annual benefit.

	A	*	B	*	C	*	E	*	F	=	Annual
Year	Bill Savings		Inflation		Value Multiplier		Adjust Prog. Horizon		Adjust # Measures		Participant Impact
2020	$30.42		1.00		0.027		1		1		$0.82
2021	$30.42		1.00		0.027		1		1		$0.82
2022	$30.42		1.00		0.027		1		1		$0.82
2023	$30.42		1.00		0.027		1		1		$0.82
2024	$30.42		1.00		0.027		1		1		$0.82

- Limitations
  - Use of 0.027 NEB as value multiplier.

- Applicability
  - Environmental good multiplier may not apply to the ESA program given that the 2010 Xcel participants saved $220 on average compared to the $30 program attributable bill savings for the ESA program.

- Duplication: This NEB did not duplicate another benefit calculated in this NEB analysis or other benefits that were already accounted for in the ESA cost-benefit analysis.