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September 12, 2024

Via E-Filing

Ms. Lisa Felice
Executive Secretary
Michigan Public Service Commission
7109 West Saginaw Highway
Lansing, MI 48917

RE: MPSC Case No. U-21534

Dear Ms. Felice:

Please find enclosed the Official Exhibits DAO-201 to DAO-213 sponsored by Yunus Kinkhabwala (Part 5 of 10) on Behalf of Soulardarity and We Want Green, Too, along with proof of service for electronic filing in the above-referenced matter. Please do not hesitate to contact me with any questions or comments.

Sincerely,

Mark N. Templeton, *pro hac vice*
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Chicago, IL 60637
Phone: (773) 702-9611
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xc: Parties to Case No. U-21534

YUNUS A. KINKHABWALA, PhD

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EDUCATION

Cornell University *September 2015 – October 2021 – Ithaca, NY* MS, PhD, Applied Physics

Region XIII Teacher Certification *April 2009 – May 2010 – Austin, TX* Math/Physics
Teacher Certification

University of Illinois at Urbana-Champaign *September 2003 – May 2006 – Urbana, IL* BS,
Physics

WORK AND RESEARCH EXPERIENCE

Senior Data Scientist, PSE Healthy Energy *October 2021 – Present Oakland, CA*

- Generated first household-scale estimates of residential energy usage and bills to develop policies aimed at reducing energy bills through investments in home improvements
- Developed capacity expansion model incorporating public health damages and distributed resilience targets to optimize retirement of single peaker power plant in disadvantaged Wilmington neighborhood
- Designed and implemented geospatial optimization models of the allocation of energy resilience at community centers to prioritize vulnerable populations in the case of an outage

Research Assistance, Cornell University, Itai Cohen lab *August 2015 – October 2021 Ithaca, NY*

- Developed data-driven predictive models of complex systems based on statistical physics principles
- Implemented simulations of segregation and predator prey dynamics
- Generated accurate neighborhood scale predictions of changes in demographic compositions

Math/Science Teacher, International School of Dakar *September 2011 – June 2015 Dakar, Senegal*

- Co-founded Green Team of students and teachers aimed at improving environmental impacts in Senegal

Math/Physics Teacher, Eastside Memorial High School *September 2009 – June 2011 Austin, TX*

- Taught first cohort to meet minimum Texas standards in math and science in five years

Schools/Community Resource Volunteer, US Peace Corps *September 2006 – November 2008*

Magogeni, Mpumalanga Province, South Africa

- Organized HIV testing drives and outreach in rural South African village
- Led teacher training in modern curriculum at three public schools
- Initiated first library in village in a school classroom

SELECTED PUBLICATIONS AND REPORTS

1. Arjun Makhijani, PhD, **Yunus Kinkhabwala, PhD**, Jessie Jaeger, MPH, MCP, Kelsey Bilsback, PhD, Lee Ann Hill, MPH, Laurel Peltier, MBA, Boris Lukanov, PhD, Elena Krieger, PhD. Energy Affordability in Maryland. PSE Healthy Energy. 2023
2. **Yunus Kinkhabwala, PhD**, Jessie Jaeger, MS, Energy Cost Burdened: A Case for Utility Disconnection Protections in Virginia. PSE Healthy Energy. 2023
3. **Dr. Yunus Kinkhabwala** and Rory McIlmoil. Direct Testimony of Duke Energy Progress, LLC, and Duke Energy Carolinas, LLC. Biennial Integrated Resource Plans. State of North Carolina Utilities Commission. DOCKET NO. E-100, SUB 179. 2022.
4. Boris Lukanov, PhD, Arjun Makhijani, PhD, Karan Shetty, M.ESM, **Yunus Kinkhabwala, PhD**, Audrey Smith, MPH, Elena Krieger, PhD. Pathways to Energy Affordability in Colorado. *PSE Health Energy*. 2022.
5. **Yunus A. Kinkhabwala**, Boris Barron, Matthew Hall, Tomas A. Arias, Itai Cohen. 2021. Forecasting racial dynamics at the neighborhood scale using Density-functional Fluctuation Theory, arXiv:2108.04084 (under review).
6. Yuchao Chen, **Yunus A. Kinkhabwala**, Boris Barron, Matthew Hall, Tomas A. Arias, Itai Cohen. 2020. "Forecasting the dynamics of segregated population distributions at the neighborhood scale using Density-Functional Fluctuation Theory", arXiv:2008.09663 (under review).
7. J. Felipe Méndez-Valderrama, **Yunus A. Kinkhabwala**, Jeffrey Silver, Itai Cohen & T. A. Arias. 2018. Density-functional fluctuation theory of crowds. Nat Commun 9, 3538 (2018).

HOME ENERGY AFFORDABILITY GAP

Fisher
Sheehan
& Colton
Public Finance &
General Economics



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Introduction

The objective was to quantify the gap between "affordable" home energy bills and "actual" home energy bills. We were successful.

In 2003, Fisher, Sheehan & Colton (FSC) introduced a model that calculated the dollar amount by which "actual" home energy bills exceeded "affordable" home energy bills on a county-by-county basis for the entire country. This is the "home energy affordability gap." Updated every year since then, the model has become an invaluable tool for research, legislative analysis, program-planning and advocacy. The analyses are used by individuals and organizations across the country. The 2012 Home Energy Affordability Gap, published in May 2013, introduces the 2nd Series of FSC's annual Affordability Gap analysis. While remaining fundamentally the same, several improvements have been introduced in both data and methodology in the Affordability Gap (2nd Series). Explore our site to learn more.

For Example

Connecticut's 5th Congressional District

The aggregate 2012 Home Energy Affordability Gap for all households **at or below 200%** of

For Example

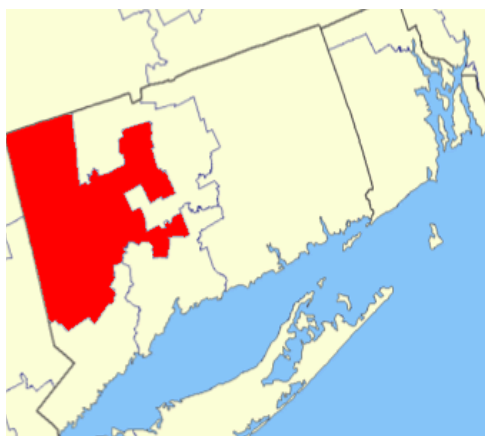
Marion County Oregon

The 2013 Home Energy Affordability Gap for each household **at or below 50%** of

For Example

The Commonwealth of Pennsylvania

The aggregate 2012 Home Energy Affordability Gap for all households **at or below 200%** of



the Federal Poverty Level in Connecticut's 5th Congressional District was \$131,743,402. The gross 2012 LIHEAP allocation for the entire state was \$79,532,000.



the Federal Poverty Level was \$1,206. That was a home energy burden (bill as a percentage of income) of 22.9%. Housing analysts consider an energy burden of more than six percent (6%) to be unaffordable.

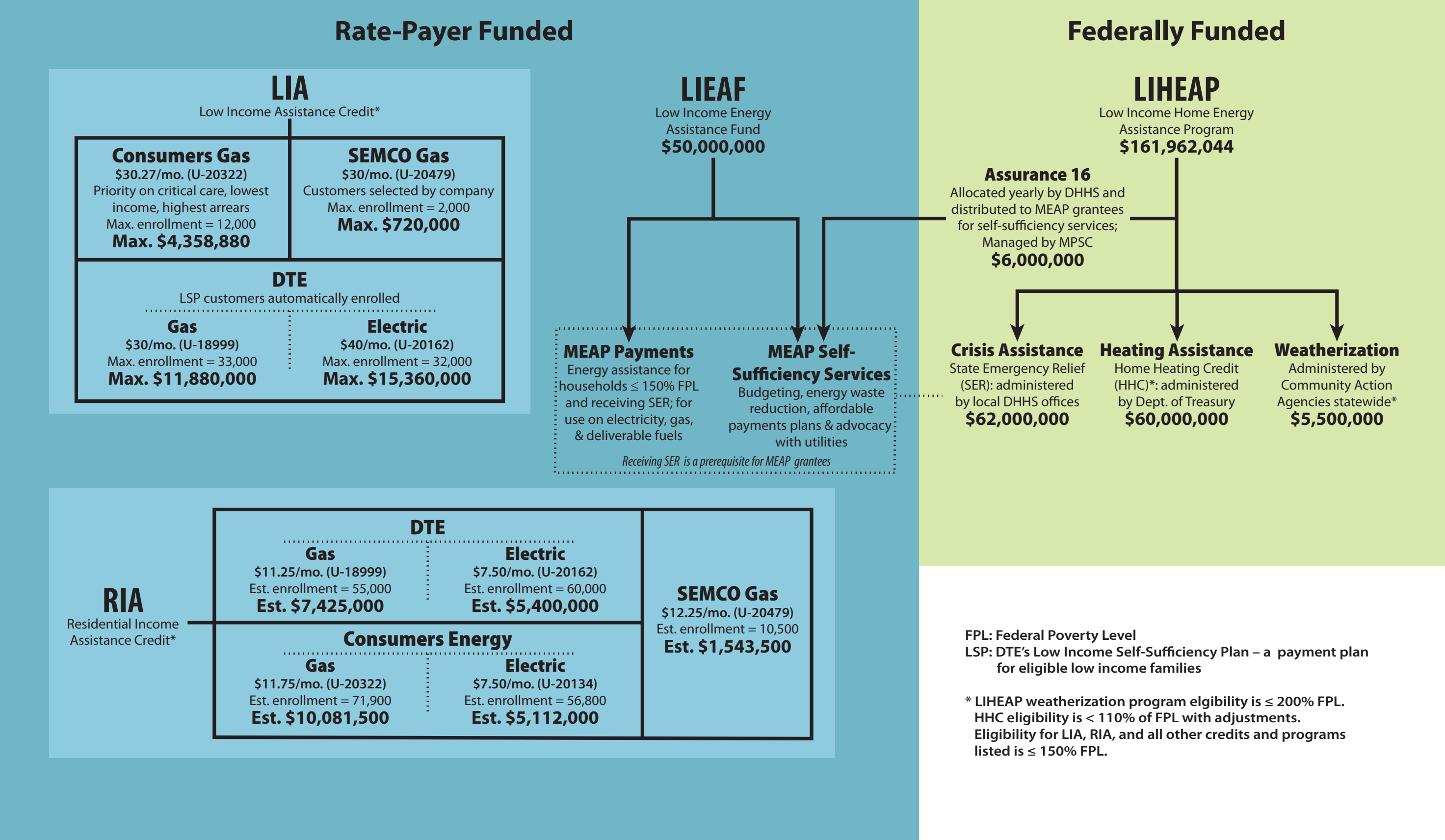


the Federal Poverty Level in Pennsylvania was \$1,840,924,328. The 2012 "Gap" for each household was \$1,252 or \$104/month.

Fisher, Sheehan & Colton
Public Finance and General Economics

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FY20 ENERGY ASSISTANCE FUNDING & LOW INCOME CREDITS



A High-Resolution Statistical Model of Residential Energy End Use Characteristics for the United States

Jihoon Min, Zeke Hausfather, and Qi Feng Lin

Keywords:

electricity
energy efficiency
energy modeling
geographic information systems
industrial ecology
information and communication
technology (ICT)



Supporting information is available
on the JIE Web site

Summary

The absence of detailed information on residential energy end use characteristics for the United States has in the past presented an impediment to the effective development and targeting of residential energy efficiency programs. This article presents a framework for modeling space heating, cooling, water heating, and appliance energy end uses, fuels used, and carbon emissions at a zip code-level resolution for the entire United States. It combines a regression-based statistical model derived from Residential Energy Consumption Survey data with U.S. census 2000 five-digit zip code level information, climate division-level temperature data, and other sources. The results show large variations in energy use characteristics both between and within different regions of the country, with particularly notable differences in the magnitude of and distribution by fuel of residential energy use in urban and rural areas. The results are validated against residential energy sales data and have useful implications for both residential energy efficiency planning and further study of variations in use patterns.

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RESEARCH AND ANALYSIS

Introduction

To understand and model opportunities for households to reduce energy use and carbon emissions, it is useful to have reasonably accurate estimates of how households use energy and how they can best reduce their use. While this is often best accomplished by in-home audits and bottom-up engineering models of how a specific home functions, those approaches are often prohibitively expensive to scale and require large amounts of household-specific data (Swan and Ugursal 2009). This article develops a high-resolution zip code–level estimate of the average residential energy use by fuel and end use category for the entire United States via an econometric model. In the absence of detailed home information, a spatially explicit model of residential energy use can serve as a first pass estimate of home energy end use characteristics and as a tool for targeting energy efficiency recommendations. It can also help identify spatial patterns in specific residential energy end uses and fuel consumption, and can be used to address questions of the effects of urban form and other factors on energy use.

Energy consumption in the residential sector represents approximately 22% of total U.S. energy consumption and 21% of total carbon emissions (EIA 2009a, 2009b). There is a paucity of detailed information about residential energy use vis-à-vis commercial, industrial, and transportation energy use due to the wide variation in house characteristics, temperatures, and behavioral patterns in the nearly 128 million housing units in the United States (Swan and Ugursal 2009). Additionally, detailed information on the breakdown of residential energy use into different end use categories—space heating, water heating, cooling, and appliances—is limited by the prohibitive cost of submetering specific devices (Swan and Ugursal 2009).

The various modeling techniques for residential energy use can be classified into two approaches: top-down and bottom-up. The terminology refers to the hierarchical position of data inputs with respect to the housing sector. Top-down models attempt to attribute aggregate energy consumption data to different characteristics of the housing sector and economy, with the primary purpose of identifying long-term

trends in energy consumption. Variables that are commonly used by top-down models include macroeconomic indicators (employment rates, price indices), climatic conditions, and housing construction and demolition rates (e.g., Hirst 1978).

Strengths of the top-down approach include the need for only aggregate data that are widely available, the ability to detect trends over time when historical data are used, and the ability to compare across countries. Due to the macroscopic approach, information on local and regional variation in residential energy use is almost impossible to obtain from top-down models. Top-down models also have no inherent capability to directly model changes that are not reflected in economic or demographic variables, such as improvements in technology or behavioral changes (Swan and Ugursal 2009). Bottom-up models are models that use input data more granular than the housing sector as a whole. The input data can take the form of individual end uses or a sample of houses. The resulting models are then extrapolated to represent the geographic area of interest. Two classes of models can be identified within bottom-up models: engineering models and statistical models (Swan and Ugursal 2009). Engineering models estimate the energy consumption of various end uses by taking into account energy ratings and usage of equipment. They provide detailed profiles of individual houses, or of a housing stock with relatively uniform archetypes, but the intensive data requirements of engineering-based approaches and their limitations in capturing variations due to demographic and socioeconomic-driven behavioral characteristics somewhat restrict their usefulness in large-scale high-resolution analysis (Larsen and Nesbakken 2004). For example, Heiple and Sailor (2008) developed an engineering model using Residential Energy Consumption Survey (RECS)-based census region factors combined with county tax assessment parcel data and weather records for specific urban areas. The Lawrence Berkeley National Laboratory's Home Energy Saver (HES) model has long been a standard for bottom-up estimates of home energy use, though it requires a fairly extensive set of home-specific inputs to produce detailed results. In the absence of specific inputs, the HES defaults to

broad census-division average home characteristics obtained via the RECS (Mills et al. 2008).

Statistical models are regression models that establish a relationship between household energy consumption and various end uses while controlling for exogenous variables such as climatic conditions and household occupancy. Statistical models require careful attention with respect to model selection and validation. Douthitt (1989) constructed a regression model of space-heating fuel use by regressing heating fuel consumption on fuel price, price of alternative fuel, total fuel consumption, and various household characteristics that explained the majority of variation in space-heating requirements. Similarly, Ewing and Rong (2008) studied the relationship between urban form and residential energy use. Using Ewing and colleagues' (2003) county sprawl index as a measure of urban form, they found that compact development is associated with lower residential energy consumption as compared with sprawling counties. Brown and Logan (2008) estimated the residential energy and carbon footprints of the 100 largest metropolitan areas in the United States. Using proprietary utility sales data that allowed for analysis at the zip code level, they found that residential energy consumption per capita is significantly lower in metropolitan areas than for the entire United States.

The Vulcan project (Gurney et al. 2009) took a novel approach using data and models developed for conventional air pollutants to produce a high-resolution estimate of carbon emission sources, though their model shows carbon production as opposed to consumption. This distinction is important for electricity at a residential level, because the actual carbon emissions occur at power plants rather than via in-home fuel consumption. Vulcan has been adapted to model energy use by urban form (Parshall et al. 2010), though it does not differentiate by building sector (e.g., commercial, industrial, residential) and cannot easily model electricity consumption at the point of use.

The detailed data input of bottom-up modeling allows for the estimation of energy consumption of different end use and the effect of technology change. However, detailed data, especially broken down by energy end use, is difficult and expensive to acquire on a large scale.

The only nationwide data source that provides energy end use breakdowns for a representative sample of houses in the United States is the Department of Energy's RECS, conducted roughly every four years. Unfortunately, the RECS is not particularly useful for analyzing spatial energy use patterns, as it explicitly excludes any spatial characteristics other than census regions and specifically inoculates small errors in certain datasets to avoid geographic identification by temperature or fuel price. The RECS can be used, however, to analyze how home characteristics, appliance ownership, demographics, and other factors influence the distribution of residential energy use into different end use categories (EIA 2008).

Many of the factors that the RECS identifies as significant in determining energy end uses can be found in the U.S. 2000 census five-digit zip code level data (U.S. Bureau of the Census 2000). Applying the relationships derived via the RECS to the high-resolution data from the U.S. census, climate division temperature data from the National Climate Data Center (NCDC 2009), and emission factors and generation efficiencies from the U.S. Environmental Protection Agency's (EPA) eGRID (EPA 2009), we can construct a bottom-up statistical model of residential energy end use characteristics at a zip code resolution for the United States.

Model Methodology

Specifying Regression Models for Each Energy End Use

Our regression analysis consists of four major residential energy end use categories: space heating, water heating, cooling, and appliance. We constructed a statistical regression model for each category with the microdata files from the RECS of 2005 released by the EIA (2008). The RECS collected data from 4,382 households randomly sampled through a multistage, area probability design method to represent 111.1 million U.S. households, the U.S. Census Bureau's statistical estimate for all occupied housing units in 2005 (EIA 2008). Each sampling weight value from the RECS data was used as a weighting factor for the weighted regression analysis.

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The ordinary least square (OLS) method was used with predictor variables including energy price, household characteristics, housing unit characteristics, regional fixed effects, and heating/cooling degree-days (see figure 1 for a sample of specific variables used). Dependent variables of the four regressions were natural log values of per-household final energy use for heating, water heating, appliance, and cooling. Appliance energy here includes energy consumption from all types of household lighting and appliances such as those used for cooking, refrigeration, audio/video, computer, dish/clothes washer, dryer, pool heating and pumps, and so on.

The model can be formulated as

$$\ln E_j = \beta_{j0} + \sum_i \beta_{ij} \cdot X_{i,RECS} + \varepsilon_j, \quad (1)$$

where j indicates the four categories of heating, water heating, cooling, or appliance, E_j is total annual energy consumption for each end use, and $X_{i,RECS}$ means predictor variable X_i whose value is from the RECS dataset. This RECS notation is used because we want to differentiate the RECS data used for model creation and the census data used for prediction. The dependent variables E_j are an aggregation of annual energy use per end use, which the EIA estimated from the total fuel uses per household. Each E_j means

$$\begin{cases} E_{water} = E_{water, NG} + E_{water, EL} + E_{water, FO} + E_{water, LP} \\ E_{heating} = E_{heating, NG} + E_{heating, EL} + E_{heating, FO} + E_{heating, LP} \\ E_{appliance} = E_{appliance, NG} + E_{appliance, EL} \\ E_{cooling} = E_{cooling, EL} \end{cases} \quad (2)$$

where NG means natural gas, EL electricity, FO fuel oil, and LP propane. The regression results for selected major variables are shown in figure 1, and the comprehensive results are included in supporting information available on the Journal's Web site. The space-heating, cooling, water-heating, and appliance regression models use 18, 15, 16, and 12 significant variables, respectively, including regional fixed effects (via census division) and squared terms. We converted some explanatory variables into log forms to have better information criteria values.

Utilizing Census Data to Achieve High Geographical Resolution

Since the goal of this research is to estimate per-household energy use in a geographical resolution as granular as possible, the resolution in the RECS dataset, which is the U.S. census division level, was not appropriate. Instead, we made use of the U.S. 2000 census dataset (U.S. Bureau of the Census 2000) containing five-digit zip code-level information for independent variables used in our regression models, including race of householder, mean household income, mean age of householder, mean number of people per household, mean number of rooms, number of housing units by type, number of housing units built at different year ranges, number of housing units using each home-heating fuel type, number of housing units in urban and rural areas, and number of housing units where the head of household works at home. For variables in the unit of number of housing units, we standardize them to determine the ratio of households in each zip code with the associated characteristic, which then become comparable with the binary variables in the RECS data set. For temperature data, we use climate division daily average temperatures from the NCDC (2009), averaging heating and cooling degree-days relative to 65 degrees over the preceding five years to better reflect average annual climatic conditions. We used geographic

information systems (GIS) to map specific zip codes to climate divisions using shape files provided by the NCDC, assigning zip codes to the climate division containing the majority of their land area in the case of overlap. Fuel price data for 2005 were obtained from state-level average residential prices provided by the EIA (2009d), and was fixed at 2005 values to correspond with the year of the RECS survey and avoid implicitly assuming any short-term price elasticity.

Once we created regression models for four end uses as above, we plug the census and the weather data $X_{i, census}$ into equation (1) to predict

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Sample of Model Inputs Appliance (sample value) Coeff/t-value	Heating Coeff/t-value	Cooling Coeff/t-value	Water Coeff/t-value
Elec price (\$/kbtu) -14.683*** (0.04) (-10.77)		-19.342*** (-13.72)	
Elec price ^2 35.148*** (0.0016) (3.71)	-117.562* (-2.02)		
Heat deg. day (65 base) (6000)	0.001*** (34.80)		0.000*** (5.48)
Heat deg. day ^2 (3.6*10^7)	-0.000*** (-21.16)		-0.000*** (-5.18)
Log of cool deg day (7.6)		1.216*** (52.81)	
Log of Household Size 0.325*** (1.1) (23.03)		0.284*** (12.26)	0.443*** (22.21)
Household income 0.000*** (75000) (11.44)	0.000*** (3.63)	0.000*** (8.49)	0.000*** (7.24)
Age of householder (54)	0.003*** (4.79)	-0.002** (-2.77)	
Large apartment -0.366*** (0.7) (-14.84)	-0.242*** (-8.12)	-0.078* (-2.31)	
Urbanity index (0-1) -0.064*** (0.9) (-3.98)		-0.087*** (-3.91)	
West South Central Div 0.065** (0 or 1) (3.04)		0.161*** (4.59)	0.203*** (3.96)
Fuel oil furnace (0.4)	0.352*** (11.03)		
Electric furnace (0.1)	-1.188*** (-24.70)		
Number of rooms 0.091*** (7) (18.24)	0.050*** (8.44)	0.092*** (12.97)	0.067*** (9.27)
Built before 1940 (0.2)	0.254*** (8.19)		
Race:White (0.6)		0.062* (2.36)	
Race:Asian -0.141*** (0.2) (-3.53)		-0.162* (-2.07)	
Adj. R-Sq 0.518	0.825	0.703	0.343
Number of Samples 4380	4211	3492	4327
Number of Sig. Var. 12	18	15	16

t-values in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Figure 1 Sample of major variables and residential energy use for different end uses. *Note:* t-values are in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; Elec = electricity; deg = degree; Div = division; Adj. R^2 = adjusted R^2 , which is a measure of the goodness of fit of the line; Number of Sig. Var. = number of significant variables; Coeff = coefficient. This is a limited sample of variables with particularly large t-values. Full regression models are available in the supporting information on the Journal's Web site. Not all variables are used in each regression, and blank spaces in columns indicate cases where the variable in question is not significant for the specific regression.

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zip code level energy estimates $\hat{E}_j$:

$$\hat{\ln E}_j = \hat{\beta}_{j0} + \sum_{i \in A} \hat{\beta}_{ij} \cdot X_{i, \text{census}} \quad (3)$$

Modeling Energy Use by Fuel Type

From the estimated energy use per end use, we can estimate residential energy consumption by fuel type for both prediction and validation purpose. To do so, we first need to disaggregate each specific energy end use category estimate into component fuel types. First, we assume all cooling energy is from electricity, such that all $\hat{E}_{cooling}$ is added to electricity use. Second, water-heating and space-heating energy, $\hat{E}_{water}$ and $\hat{E}_{heating}$, are divided into four different fuel types depending on the coefficients of the regressions and the percentage of households using each fuel in the zip code area. Since our model is log-linear, each coefficient β of a dichotomous variable can mean, when β is close to zero, $100 \cdot \beta\%$ change in the dependent variable (since, $e^\beta \approx 1 + \beta$ when β is small). For example, according to figure 1, the fuel oil furnace variable has the coefficient 0.352, which means households using fuel oil heating equipment use about 42% more heating energy than others with everything else being equal. From this consideration, we can disaggregate each end use energy for a representative household to obtain energy use per each fuel type by the following equation. For a particular zip code area j , heating energy from gas for the representative household is:

$$E_{j, \text{heating, gas}} = E_{j, \text{heating}} \frac{r_{j, \text{gas}} \beta_{\text{gas}}}{\sum_{\text{all fuel } i} (r_{j,i} e^{\beta_i})}, \quad (4)$$

Here $r_{j,i}$ means the percentage of households using fuel i as the main heating fuel in the area with zip code j . The same approach is applicable to all other fuel types used for space heating. To disaggregate water-heating energy into different fuel types, it requires additional steps, because census data we are using do not keep track of water-heating fuel types per zip code area. For this case, we built a multinomial logistic regression model with water-heating fuel type from RECS data set as dependent variable and other independent variables for which both the RECS and census have data. Once this model is created, we

can plug zip code-level information for the independent variables from the census into the model to estimate a zip code-level ratio of different fuel types for water heating. With the estimated ratio, we can apply the same approach used to disaggregate space-heating energy and get estimates for water-heating energy use per fuel type per zip code area.

Third, since the nature of appliance energy consumption is not as homogeneous as heating energy consumption, we cannot divide it as simply as through the method above. Lighting and refrigerators, for example, use only electricity, while energy use for stoves, ovens, pools, spas, dryers, or grills may come from either gas or electricity. Since some households (54% according to the RECS data) use only electricity while others use multiple energy sources for appliance energy, we cannot treat all the households in the same way when modeling fuel usage for appliances. Instead, first we built a regression model only with household samples using multiple fuel sources for appliances to estimate the ratio $\hat{r}_e$ of electricity to total appliance energy. Second, we estimate probability p_j that each representative household may use only electricity for appliance energy. For this, we ran a logistic regression with a dependent variable of whether each household uses 100% electricity for appliances or not. Independent variables in this regression include ownership and fuel types for appliances such as stove, oven, spa, and clothes dryer. With this probability $\hat{r}_e$ we can calculate the expected ratio $E[r_e]$ of electricity use for appliance in the region:

$$E[r_e] = p_j \cdot 1 + (1 - p_j) \cdot \hat{r}_e \quad (5)$$

The estimation methods of fuel type disaggregation for water-heating and appliance energy will certainly introduce additional uncertainties to the consumption estimate per energy source. However, this method will still provide the unbiased mean estimates because of the characteristics of the OLS method. In order to specify the size of uncertainty of a random variable that is a product of other random variables, we have to have correlation coefficients between those original variables (e.g., between water-heating energy use and types of water-heating fuel) for each zip code area (Simon 2006). But practically, we do

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Table 1 Comparison of Linear and Log-Linear Models

	Model	Heating	Water	Cooling	Appliance
Adj. R ²	Linear	0.594	0.295	0.490	0.409
	Log-linear	0.825	0.343	0.703	0.518
Prediction interval (kBtu)	Linear	4981.1	3766.7	1355.8	2168.7
	Log-linear	4567.2	2135.0	822.6	2121.6

Note: kBtu = kilo British thermal units; Adj. R² = adjusted R², which is a measure of the goodness of fit of the line.

not have the information in the census dataset, so we cannot specify the uncertainty size for them.

Model Specification and Uncertainty

In terms of model specification, we chose log-linear models over linear ones for three main reasons:

- 1) Log models gave us higher adjusted R² values for given combinations of predictor variables.
- 2) We compared the average sizes of prediction intervals at 95% confidence level, and it shows that log-linear models consistently have smaller intervals for the

given combinations of predictor variables (table 1).

- 3) Normality probability plots drawn from prediction residuals show more linear curves for log-linear models (figure 2).

Prediction intervals here are calculated at the mean points for the explanatory variables for each zip code area. To do this, we executed mean-centered regressions for the four models and observed the 95% confidence intervals around the intercepts.

Detecting Multicollinearity

One of the major problems facing statistical models of residential energy use characteristics

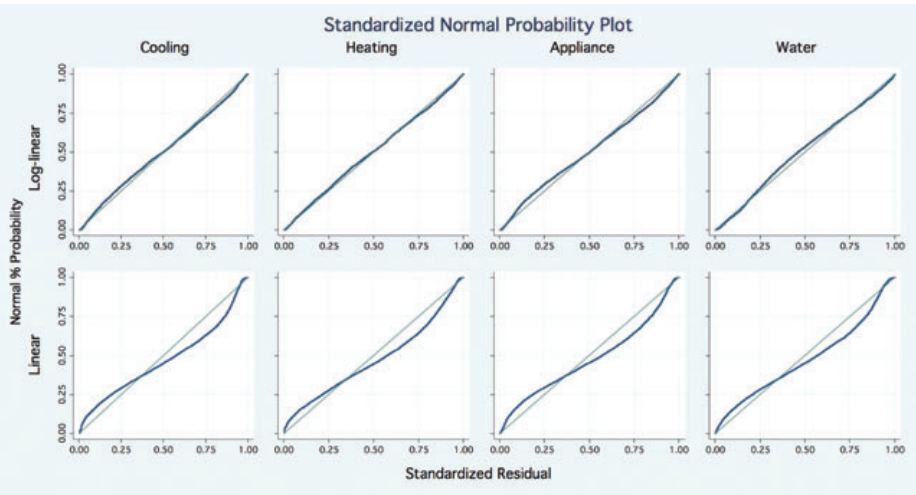


Figure 2 Standardized normal probability plots comparing log-linear and linear models. These graphs show that for the same combination of independent variables, log-linear models are the better specification compared with linear models.

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Table 2 Variance Inflation Factor (VIF) and F Values for Each Regression Model

Model	Heating	Water	Cooling	Appliance
VIF	3.1	3.95	1.35	1.72
F	.	120.6	549.3	320.23

is multicollinearity, often resulting in poor predictions of certain end uses (Swan and Ugursal 2009). Multicollinearity commonly arises when dealing with variables that tend to be correlated, such as household income and square footage of the house. However, except for the square terms (e.g., $hd65sq$) that we intentionally added in the model to see the marginal impact change of the factor, correlation between any two variables does not exceed 0.5. Moreover, variance inflation factors for the four regressions range from 1.35 to 3.95 (table 2). Considering that the rule of thumb value for detecting collinearity is 5 or 10 (Hair 1995; Menard 2002), we can say our models do not indicate a noticeable presence of multicollinearity. From the F values of the models,¹ we can find the sample size of 4,382 is large enough to make our models significant.

Dealing with Endogeneity

Three out of the four model equations include the estimated 2005 residential electricity price as a variable, based on EIA statewide average residential electricity price data (EIA 2009d). This electricity price has a possibility of endogeneity because of the simultaneity with the dependent variable, energy consumption. In order to detect endogeneity between those two, we ran Hausman-Wu tests comparing instrumental variable estimates to OLS estimates and found that electricity price and energy use are not endogenous at the 95% confidence level (table 3).

Potential Errors in the RECS Dataset

As shown in figure 1, the coefficient for electric space heaters is quite substantial. This means that, all things being equal, households with electric space heating as their primary fuel type use only 30.5% ($= e^{-1.188}$) of heating energy used by those with natural gas space heaters. These num-

Table 3 Hausman-Wu Test Results for Each Regression Model

Model	Heating	Water	Cooling	Appliance
p-value	0.621	.	0.200	0.355

bers are strongly at odds with other published data, which indicate efficiency differences more in the 60% to 70% range (Energy Efficiency and Renewable Energy [EERE] 2010).

This problem appears in the published RECS data tables. For example, the RECS reports that in the New England Census Division, an average household with fuel oil as the primary heating fuel uses 102,500 kBtu for heating, while an average household with electric primary heating uses a mere 8,300 kBtu for heating despite large sample sizes for both fuel types, which is very unlikely in reality. We approached the office at the EIA administering the RECS, and they confirmed that they would look into the issue. This may be attributable to incorrect sampling or erroneous approach taken by the EIA to disaggregate electric bills into end use categories. Because we rely on the relationships in the RECS to determine end uses, we have no simple way to circumvent this problem. Error inoculation introduced by the RECS into degree-day and price data to prevent location of individual respondents will result in additional uncertainty for model projections (EIA 1996).

Results and Validation

The model provides residential energy estimates by end use and fuel type for all zip codes in the United States included in the 2000 census. We can also calculate final energy use, secondary energy use, primary energy use, and carbon emissions, both direct and indirect, for each zip code using associated North American Electricity Reliability Corporation (NERC) subregion emission factors and thermal efficiency (in the case of primary energy) from the EPA's eGRID (EPA 2009). The EPA provided the specific mapping of zip code to NERC subregion, and we assigned each zip code to the NERC subregion that contains the most land area of the zip code in the case of overlap. State-level transmission loss data

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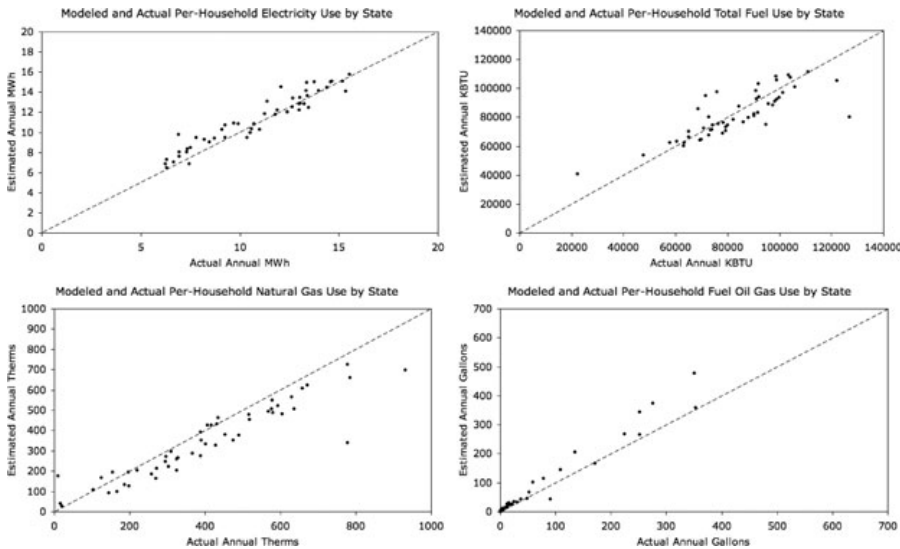


Figure 3 Modeled and actual residential electricity, natural gas, fuel oil, and total energy use by state. Residential use data from the Energy Information Administration are divided by the number of occupied housing units in each state in 2008 to obtain the average per-household residential energy use characteristics by state. The dotted line represents the expected value if the estimated energy use and the actual energy use were equal.

for electricity are taken from the EIA (2009c). Indirect emissions associated with the fuel cycle, plant construction, and plant decommissioning of natural gas, nuclear, oil, coal, solar, wind, biomass, geothermal, and hydro power are based on the dissertation by Meier (2002) and differentiated for cases in which fuels are being combusted within the residence and for electricity generation elsewhere. These indirect emissions increase the emission intensity of coal, oil, and natural gas by 2%, 5%, and 18%, respectively (note that the work by Meier [2002] did not assess the indirect fuel cycle emissions of propane, and for the purposes of the model it is assumed that it is similar in magnitude to that of natural gas).

Model Validation

It is difficult to validate the accuracy of model outputs given the relative paucity of high-resolution data on residential energy use characteristics. However, the U.S. Department of En-

ergy publishes reliable data on the state level for residential electricity, natural gas, and fuel oil use, which we can compare to our model outputs (EIA 2009d, 2009e, 2009f). Figure 3 shows how, for state-level 2008 residential fuel use, our model mirrors the variation in per-household residential energy use characteristics between states, with estimated use being within 10% of actual use in most cases, though there are a few notable outliers.

Estimated and actual use vary considerably in a few cases. We overestimate electricity use in the District of Columbia, though this may be due in part to the small number of households in the district relative to the states. We also tend to overestimate per-household electricity use by Utah by 15%, which may be due in part to limitations of degree-days based on daily average temperatures as a proxy for cooling requirements in places with high diurnal variability (Baumert and Selman 2003). Many of the states in New England also use somewhat less electricity (5%–15%) than our model predicts.

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For natural gas, both Alaska and Hawaii are major outliers, with the model underestimating Alaska's average per-household natural gas use by 50% and overestimating Hawaii's use almost 13-fold. In Hawaii's case, this is due to a unique characteristic of natural gas use in the state, namely that there is almost no natural gas available. While we model nearly no natural gas use for space heating and water heating in Hawaii, we overestimate the amount used for appliances. Natural gas estimates are also a bit high for Maine.

The model is quite good at estimating which states do and do not use fuel oil, but it tends to systemically overestimate fuel oil use in states where the per-household usage is negligible. In most cases, however, the overestimate is still a negligible portion of total per-household energy use. The model notably underestimates fuel oil use in both Alaska and the District of Columbia.

For total energy use, the two major outliers are, unsurprisingly, Alaska and Hawaii. In the past, the RECS dataset did not sample houses in either state (EIA 1996), and while that has changed in recent years, characteristics of the survey coverage of those states may be at least partially responsible for the anomalous model results.

Changes in residential energy characteristics between 2000 and 2008 are major potential drivers of differences between estimated and observed energy use on a state level. The model uses 2000 U.S. census data for most of the zip code-specific energy use characteristics (the major exceptions being fuel prices, for which we use 2005 numbers to be in line with the RECS and avoid assuming any price elasticity of demand, and weather data, which we obtain for 2008), and many characteristics of the housing stock may have changed in the interim. However, validating the model against 2000 energy sales data would pose its own complications, given that the RECS survey underlying the modeled relationships between energy use characteristics and end use magnitudes was conducted in 2005. The release of the 2009 RECS study (in 2012) and the 2010 U.S. census will provide a good opportunity to update and further validate the model using reasonably concurrent data sources.

Additional uncertainties arise from the fact that the model is tuned toward providing the best

estimates of end use energy based on the values in the RECS survey, but those values are themselves estimates based on household bills and home characteristics. There is little true empirical data on residential energy by end use outside of small-scale spatially limited studies, due in part to the prohibitively high costs associated with submetering (Swan and Ugursal 2009). As discussed previously, we have reason to believe that the RECS dataset significantly underestimates electricity used as the primary space-heating and water-heating fuel. As RECS end use distributions are limited by the magnitude of household bills, any errors in the distribution may end up assigning too much electricity use to appliances vis-à-vis other end uses and too little to space and water heating, which could lead to our model underestimating the magnitude of space-heating and water-heating energy demands, especially in areas with more extreme temperatures.

Finally, the zip code-level U.S. census data has a non-negligible sampling error for very small geographic areas, which may make calculations for certain zip codes less accurate, though the net effect on state-level aggregations should be minimal (U.S. Bureau of the Census 2007). The U.S. census does not provide any zip code-level data on water-heating fuel type or the gas versus electric composition of home appliances, and the secondary regressions used to derive these two factors (shown in the online supporting informations) adds additional uncertainty, though they are necessary to calculate a distribution of end uses by specific fuel type.

We have also compared our model outputs for specific zip codes with electricity bills for 2008 from 3,662,839 individual households in 523 zip codes in Illinois aggregated at the zip code level from Commonwealth Edison (ComEd). This was pared down to 413 zip codes for use in model validation by eliminating 92 with exceptionally small population sizes (with less than 150 households) and an additional 18 zip codes that were missing one or more necessary piece of U.S. census data (likely due to the zip code changing or being created subsequent to the 2000 census). We also identified one obviously anomalous zip code and confirmed with ComEd that it was due to a large individually metered RV (recreational vehicle—sometimes called camper) park that had an order

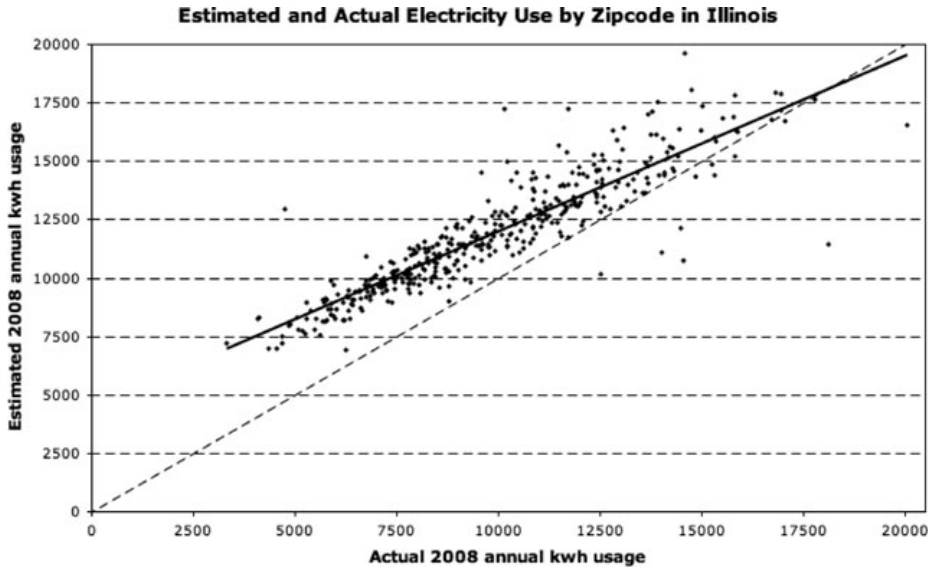


Figure 4 Expected and actual 2008 electricity use by zip code for the ComEd service territory. Based on zip code-level average daily energy use data for single houses without electric heating, single houses with electric heating, multiunit buildings without electric heating, and multiunit buildings with electric heating obtained from ComEd and weighted by the population of each group to create a composite average for each zip code.

of magnitude more units than the actual zip code housing stock. Finally, we identified a shortcoming of our model due to the income categorization in the RECS, namely that the highest income category specified in the RECS is \$120,000+. This means that our appliance model does not correctly account for diminishing returns to appliance use as income increases, and tends to produce unrealistically high appliance energy use values for the rare zip codes where the median household income is greater than \$200,000. To correct for this, we removed the five anomalous zip codes that exceed this income threshold, and were left with 407.

Figure 4 shows the modeled annual electricity use and the actual electricity use for 2008 for 407 zip codes in the ComEd service territory. Our model accounts for more than 80% of the variability in energy use between these zip codes ($R^2 = 0.814$), though the modeled electricity use values tend to be consistently high. This may be due in part to changes in housing stock and characteristics since the 2000 census and is in line with our Illinois statewide estimates for residen-

tial electricity use for 2008 that are about 12% higher than actual residential sales data from the EIA. As we continue to work with utility programs, we will have future opportunities to compare our model to actual billing data, particularly after we update the model with upcoming 2010 U.S. census microdata.

Model Outputs

We can use GIS software to spatially map the end use and fuel-specific outputs of our model for each individual zip code, as shown in figures 4, 5, and 6. Note that these reflect the mean house in every zip code and are not weighted by the population of the zip code. The mean house has a probabilistic assignment of factors such as appliance ownership and space heating and water heating fuel types that do not reflect any specific physical house but rather the average of all houses in the zip code. This accounts for the fact that, in a hypothetical zip code, 50% of houses may use natural gas for space heating, 40% may use fuel oil, and 10% electricity.

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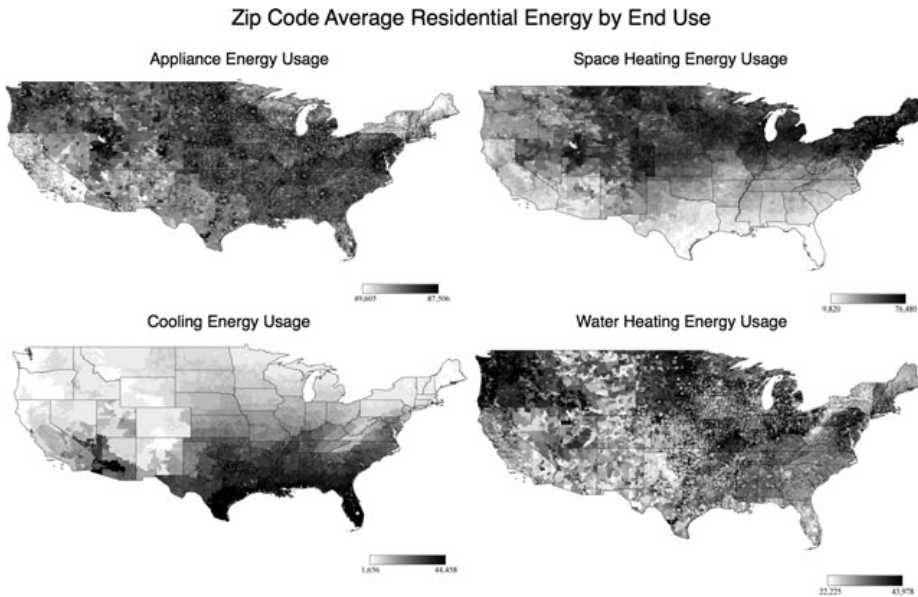


Figure 5 Spatial maps of average per-household residential energy by end use. The maps display model outputs in kBtus for each zip code for appliance energy in the upper left, heating energy in the upper right, cooling energy in the lower left, and water heating energy in the lower right. The legend represents the number of kBtus used by the average house over the course of 2008 in zip codes illustrated by the corresponding density of shading. See the supporting online informations for high-resolution color versions of these maps.

Displaying average residential per-household energy by end use presents an interesting problem due to differences in end use efficiencies by fuel (National Academy of Science–National Research Council 2008). Specifically, electric devices tend to be significantly more efficient at converting secondary energy into useful energy than devices using primary energy fuels like natural gas (EIA 2008), and a map of point-of-use energy that did not account for the fact that electric energy tends to be more useful when analyzing aggregate energy values would largely reflect differences in fuel type rather than differences in demand for hot water, cooling, heating, or appliance services. A map of energy use that takes into account full fuel cycle factors for electricity would result in the opposite problem, namely that differences in generation efficiencies between grid regions would swamp differences in actual end use magnitudes, at least for appliances and water heating (cooling and heating remain dominated

by temperature differences for both point-of-use and full fuel cycle energy metrics). As a compromise and in order to best reflect difference in end use demand across the entire country, we calculate a point-of-use primary energy value using a constant generation efficiency for electricity similar to the methods that Brown and colleagues (2008) and others have used to conduct total end use comparisons spanning different regions of the country. The constant generation efficiency (approximately 41.9%) was chosen to reflect the mean thermal generation efficiency of all kilowatt-hours used by residences in our model based on data from eGRID (EPA 2009). In an effort to reflect differences in use rather than exogenous factors, we do not include any spatially explicit transmission losses in the energy end use maps, though these full fuel cycle factors and transmission losses are included in the estimated residential carbon emissions map.

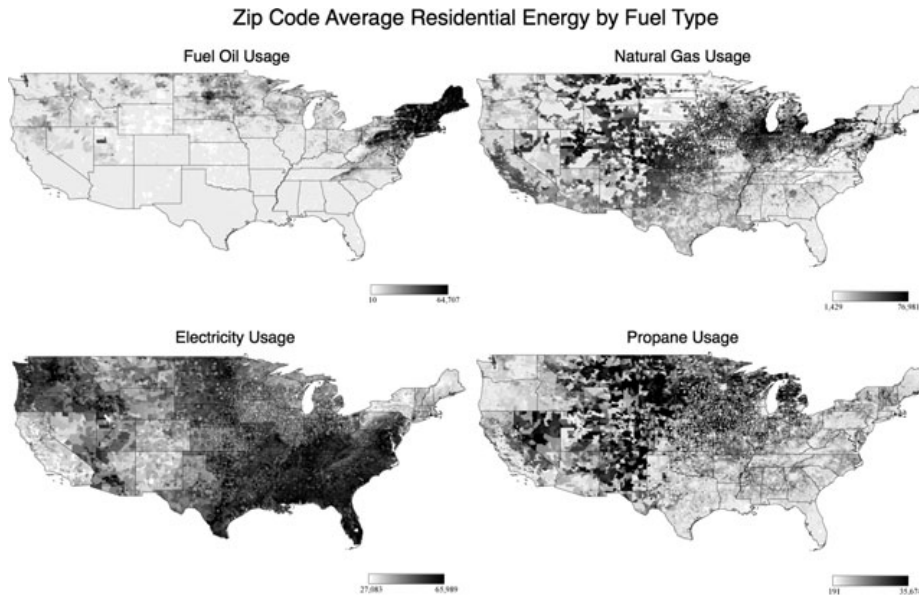


Figure 6 Spatial maps of average per-household residential energy by fuel type. The maps display model outputs for each zip code for fuel oil in the upper left, natural gas in the upper right, electricity in the lower left, and propane in the lower right. The legend represents the number of kBtus used by the average house over the course of 2008 in zip codes illustrated by the corresponding density of shading. See the supporting online information for high-resolution color versions of these maps.

This first set of maps in figure 5 shows residential energy by end use in kBtus for all 31,467 zip codes for which we have all needed data available, covering roughly 99.5% of the U.S. population. For uninhabited areas (e.g., geographical features like mountain ranges) and areas where data is missing, we in-filled values based on the average of surrounding zip codes using GIS. Lakes and rivers were left uncolored. We chose to use primary energy with a constant generation efficiency for electricity to provide a more meaningful comparison between electricity and other fuels.

The residential appliance energy use map displays an interesting “halo” effect around urban areas in many cases: the urban area itself tends to have lower appliance energy use than both the surrounding suburban or rural areas. However, surrounding the urban area is a bright red ring of suburbs with relatively high appliance energy use, fading into more rural areas with lower appliance energy use. This is due to the strong role played by income, house size, and house type in determining appliance energy use. For example,

in the 1,713 zip codes with a population density of over 5,000 people per square mile, appliance electricity use is 28% lower than the U.S. average. Similarly, the 6,320 zip codes with a population density of over 1,000 use 12% less appliance energy than average. Water-heating energy use tends to show an influence of urban form similar, though somewhat less pronounced, to that of the appliance energy use map.

Residential heating energy use and cooling energy use follow an expected pattern dictated by temperature, with warmer areas requiring less heating and more cooling energy than colder areas. However, heating equipment, fuel, house size, house age, thermostat settings, and other factors also play a large role and are more clearly visible in higher-resolution regional views that avoid being swamped by temperature-induced variations.

The particularly high heating use in the Northeast is somewhat of an artifact of the inefficiency of fuel oil heating vis-à-vis other heating types rather than any systemic difference

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in heating demand, and heating requirements are similar to those of the Midwest when efficiencies are standardized. The relatively low heating energy use in Montana and northern Minnesota may be due to the inclusion of the squared degree day term in the regression function, which can produce somewhat unrealistic results in areas of extreme cold.

The maps of residential energy use by fuel type in figure 6 reflect the division of space heating, water heating, and appliances into specific fuel uses and the aggregation of resulting values together by fuel type. It is useful to note that propane and fuel oil are modeled here as only pertaining to space heating and water heating, as data on propane usage rates for appliances was not available via RECS and appliance fuel oil use is virtually nonexistent. Similarly, all cooling energy use is assigned to electricity. The model can produce maps of fuel use by specific energy end use category, though they are not included herein.

Residential fuel oil use is largely limited to the northeastern United States, with some minor use in North Carolina and Virginia, as well as scattered parts of the Midwest and Northwest. Cities in those regions tend to use less fuel oil than

more rural areas. Residential electricity use is influenced by all four end use categories and reflects a number of different factors, especially cooling energy use. Electricity use is particularly high in the southeastern United States and relatively low in California and the Northeast.

Cities and suburban areas tend to have fairly high residential natural gas use relative to more rural areas. However, there are also a number of noticeable areas of natural gas use in lower population areas corresponding to the location of natural gas pipelines (e.g., in upstate New York). Even in states with relatively low natural gas usage, such as Georgia, there is still a noticeable increase in use surrounding urban areas (e.g., Atlanta).

Propane use for heating and water heating is almost an inverted image of the natural gas use map, with urban and suburban areas using virtually no propane, and with high use in many rural areas, particularly in the Midwest. Other fuel use (e.g., wood, solar, coal, etc.) is not shown here, but tends to be clustered in the Appalachian region and in the Pacific Northwest.

The final two maps in figure 7 show average household carbon emissions and total primary energy use for each zip code. The carbon emissions

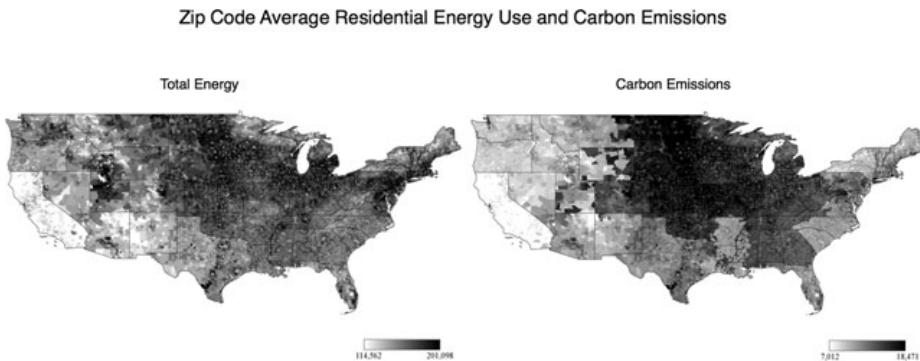


Figure 7 Spatial maps of average per-household carbon emissions and total energy use. The maps display model outputs for each zip code for total primary use (in kBtus) on the left and carbon emissions (in kg) on the right. For the total energy map, the legend represents the number of kBtus used by the average house over the course of 2005 in zip codes illustrated by the corresponding density of shading. For the carbon emissions map, the legend represents the number of kilograms (kg) of carbon dioxide that the average house was responsible for emitting over the course of 2008 in zip codes illustrated by the corresponding density of shading (1 kilogram $\approx$ 2.2 pounds). See the supporting information on the Web for high-resolution color versions of these maps.

map follows NERC subregion lines, though there is still strong differentiation within subregions that is difficult to see on the aggregate national map, particularly between urban, suburban, and rural areas. Average home carbon emissions vary by a factor of 2.5 between regions, ranging from 7,012 kilograms (kg) in the lowest 5% of zip codes to 18,471 kg in the highest 5%. More rural areas in the Midwest tend to have the highest average household carbon emissions, due in a large part to the high percentage of their electricity coming from coal-based generation. California has the lowest average household carbon emissions, followed by the Northwest and Northeast (though some wealthy communities and Connecticut and Long Island have sizable average household carbon emissions).

Total final energy use tends to be dominated by heating (as it represents the single largest energy end use for the residential sector as a whole), but still reveals some interesting patterns. California stands out as having particularly low total energy use, while rural areas in the Midwest and suburban areas in the Northeast show particularly high total energy use. The 100 largest cities in the United States have an average household total energy use of 86,700 kBtus, quite similar to the 88,400 kBtus found by Brown and Logan (2008). This compares to a national average household energy use of 101,800 kBtus for the country as a whole.

Conclusions

This model presents a novel approach to modeling residential energy by both end use and fuel type for the entire United States at a resolution higher than that of any previous model. It provides an in-depth look at how energy is used by residences in different parts of the country, and the variances between home energy use characteristics both within and across different regions. There are numerous possible research applications for this data, both in examining factors like rural/urban divides in residential energy use in different parts of the country and patterns in residential fuel use. Additionally, the model can be combined with fuel-specific price data to estimate

end use costs for residences. The model can also be used to examine the impact of various end use reduction actions on different zip codes or regions based on the average characteristics of homes therein. For example, a priori estimates of average annual heating and cooling use by zip code could help assess potential HVAC programs and home retrofits, and help target efficiency programs to those regions for which they would be most effective.

We currently utilize a version of the model in the Personal Energy Advisor online home energy audit tool to estimate home energy use characteristics in the absence of both an in-home audit and the guaranteed availability of specific user inputs for all home characteristics. It is supplemented by home-specific data on year built, square footage, room number, and home type from county tax assessment offices based on the home addresses of users. A variant of the model is also used to disaggregate individual monthly electricity and natural gas bills into component end uses, and can combine top-down estimates using available fuel bills with bottom-up model estimates for fuels without available bills (e.g., in cases where electric bills are available but natural gas and fuel oil bills are not). The model opens up the possibility of sub zip code-level analysis when combined with specific housing unit data from county tax assessment offices and billing data from utility companies.

The model developed in this article could be further tested by examining energy billing data from a representative sample of households in different zip codes, and by comparing the mean energy use values with those predicted. Additionally, the model's annual results could be expanded to estimate monthly energy use characteristics, particularly for heating and cooling, based on temperature data. The major limitation to statistical modeling of residential energy use at a subannual timescale is the absence of a national dataset analogous to RECS that tracks monthly energy end uses. Finally, the model can be used to more deeply explore relationships between urban form, population density, fuel availability, energy use, and carbon emissions in different regions of the country.

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Acknowledgements

This work was made possible by the help and support of our employer, Efficiency 2.0. We also want to thank Chip Berry who manages the RECS survey at EIA for assistance with data access and interpretation, Mark Armstrong at the National Climate Data Center for help with degree day data, Arnulf Grübler for indirectly inspiring the project, and three anonymous reviewers for a wealth of constructive comments.

Note

1. F is the ratio of the Model Mean Square to the Error Mean Square which tells whether the model can make statistically significant predictions.

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- Corrections made after online publication [12 Oct 2010]: “(1 kilogram $\approx$ 2.2 kilograms)” changed to “(1 kilogram $\approx$ 2.2 pounds)” in the caption of figure 7.

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Supporting Information

Additional supporting information may be found in the online version of this article:

Supporting Information S1. This supplement contains two sections. The first section details Residential Energy Consumption Survey–based regression functions for the four major energy end use subcategories. The second section includes high-resolution model GIS map outputs.

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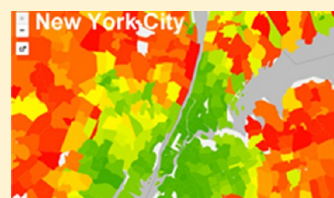
Spatial Distribution of U.S. Household Carbon Footprints Reveals Suburbanization Undermines Greenhouse Gas Benefits of Urban Population Density

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S Supporting Information

ABSTRACT: Which municipalities and locations within the United States contribute the most to household greenhouse gas emissions, and what is the effect of population density and suburbanization on emissions? Using national household surveys, we developed econometric models of demand for energy, transportation, food, goods, and services that were used to derive average household carbon footprints (HCF) for U.S. zip codes, cities, counties, and metropolitan areas. We find consistently lower HCF in urban core cities (~40 tCO₂e) and higher carbon footprints in outlying suburbs (~50 tCO₂e), with a range from ~25 to >80 tCO₂e in the 50 largest metropolitan areas. Population density exhibits a weak but positive correlation with HCF until a density threshold is met, after which range, mean, and standard deviation of HCF decline. While population density contributes to relatively low HCF in the central cities of large metropolitan areas, the more extensive suburbanization in these regions contributes to an overall net increase in HCF compared to smaller metropolitan areas. Suburbs alone account for ~50% of total U.S. HCF. Differences in the size, composition, and location of household carbon footprints suggest the need for tailoring of greenhouse gas mitigation efforts to different populations.



BACKGROUND

Demand for energy, transportation, food, goods and services drives global anthropogenic emissions of greenhouse gases (GHGs). Households in the United States alone are directly or indirectly responsible for about 20% of annual global GHG emissions,^{1,2} yet represent only 4.3% of total global population. In the absence of comprehensive national climate policy, U.S. states and over 1000 U.S. mayors have committed to GHG reductions.³ In response, a new protocol exists for managing community-scale GHG emissions that emphasizes contributions from households.⁴ For compliance and voluntary policies to be effective, information is needed on the size and composition of household carbon footprints for all regions, at metropolitan, county, city, and even neighborhood scales. As global urbanization accelerates, increasing by 2.7 billion people by 2050,⁵ the lessons from the data-rich U.S. experience may have increasing importance for planning efforts in urban areas of the world's expanding list of mega-cities.

Previous research using a diverse set of methods focused largely on large metropolitan regions or cities has shown that household carbon footprints (HCFs) vary considerably, with energy, transportation, or consumption comprising a larger share of the total and with households in some locations contributing far more emissions than others.^{6–9} For example, motor vehicles in California account for 30% of HCF, compared to 6% for household electricity, while electricity is frequently the largest single source of emissions in locations with predominantly coal-fired electricity.¹⁰ Income, household size, and social factors have been shown to affect total HCF, while a large number of factors have been shown to contribute

to household energy and transportation-related emissions.^{1,8,11,12}

A number of studies suggest that geographic differences in emissions are in part explained by population density. Population-dense municipalities tend to be urban centers with employment, housing, and services closely colocated, reducing travel distances, increasing demand for public transit, and with less space for larger homes. Early research by Newman and Kenworthy,¹³ using data on 32 global cities, suggested a strong negative log-linear correlation between vehicle fuels and density (Figure S-1 in Supporting Information). More recent work using data from domestic and global cities has also seemed to confirm this relationship, although with more variance than previously thought.¹⁴ One thread of research suggests that urban form (colocation of housing, employment and services) to be a more important factor.¹⁵ Other studies suggest that neither density nor urban form result in large CO₂ benefits, and these may be outweighed by other social costs, such as crowding and higher rents.¹⁶

These earlier studies have been limited to analyzing a small set of case studies, and the resulting conclusions are difficult to generalize beyond those included in the studies themselves. A large, nationwide data set of all locations at fine geographic resolution holds potential to reassess the urban form hypothesis to more accurately describe the relationship between

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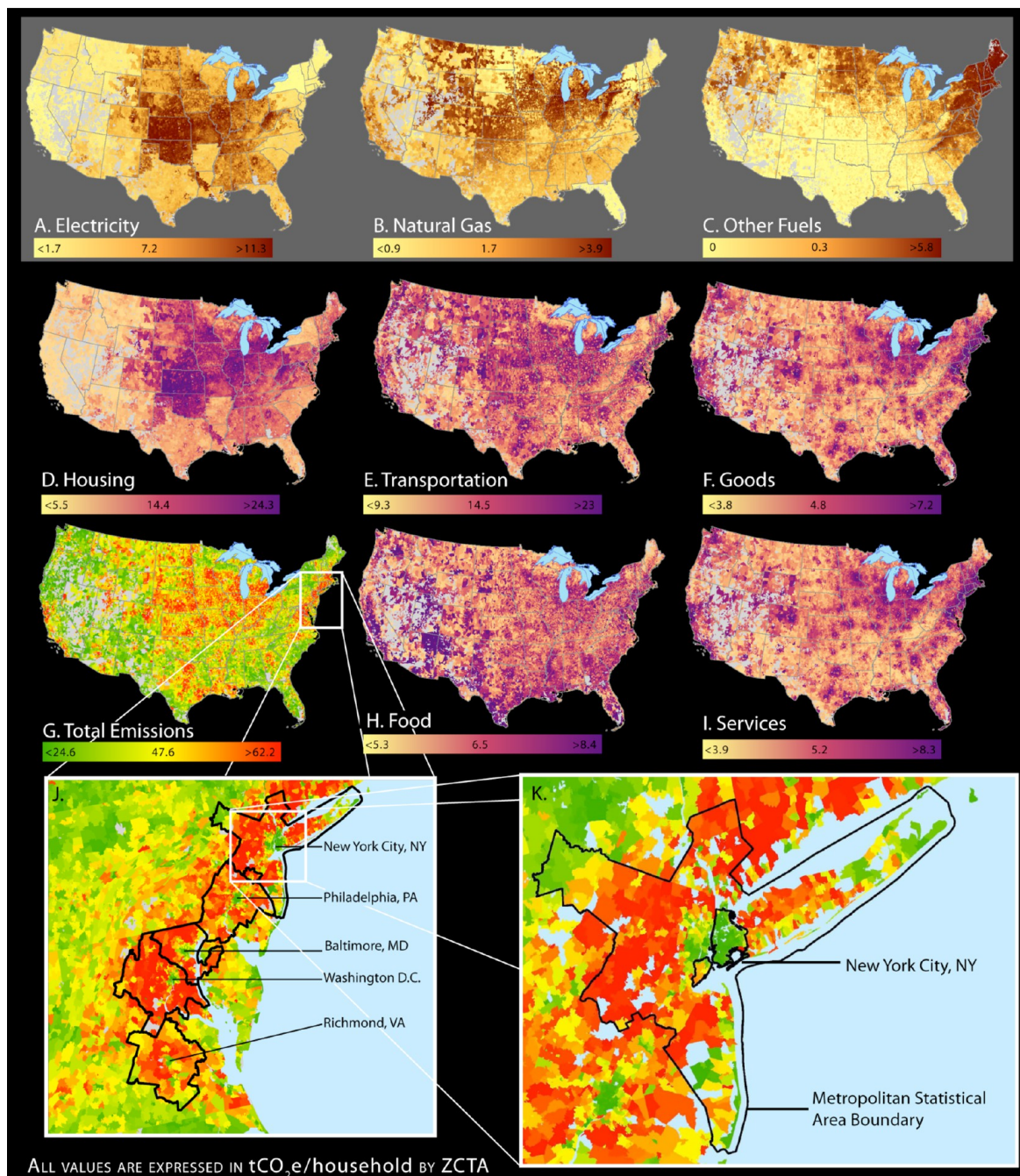


Figure 1. HCF from (A) electricity, (B) natural gas, (C) fuel oil and other fuels, (D) housing = A + B + C + water, waste, and home construction, (E) transportation, (F) goods, (H) food, (I) services, and (G) total = D + E + F + H + I. Transportation includes motor vehicle fuel, lifecycle emissions from fuel, motor vehicle manufacturing, air travel direct and indirect emissions, and public transit. Scales below each map show gradients of 30 colors, with labels for upper value of lowest of quantile, median value and lowest value of highest quantile, in metric tons CO₂e per household, for zip code tabulation areas (ZCTAs). East Coast metropolitan statistical areas (J), with a larger map of New York metropolitan area (K, outer line) and New York City (K, inner line) highlight the consistent pattern of relatively low GHG urban core cities and high GHG suburbs.

population, policy, urban form, and emissions. Our primary research questions are (1) how much variability exists in the size and composition of household carbon footprints across all U.S. locations and (2) how much of this variability can be explained by population density, income, home size, and other

factors contributing to carbon footprints in urban, suburban, and rural areas?

In this work, we developed econometric models to estimate household energy, transportation, consumption of goods and services, and total household carbon footprints at fine geographic resolution. Min et al.¹⁷ used national energy survey

data to develop econometric models that could be applied at zip code tabulation areas to reasonably estimate household energy consumption. Other work in the U.K. has used demographic and lifestyle data to estimate more comprehensive household carbon footprints of 434 municipalities.^{12,18}

We present a model that characterizes the size and composition of household carbon footprints for essentially every U.S. zip code, city, county, and U.S. state. Household carbon footprints are the greenhouse gas emissions required to produce, distribute and dispose of all household consumption for one year, including emissions resulting from the purchase and use of motor vehicles, public transit, air travel, household energy, housing, food, water, consumer goods, and services. We use this information to develop high geospatial resolution household carbon profiles of each location and to analyze the effect of population density and level of urbanization on full life cycle GHG emissions.

METHODS AND MATERIALS

The total household carbon footprint, HCF, of any individual or population can be expressed simply as the product of consumption, C , in dollars or physical units, and emissions per unit of consumption, E , summed over each emissions activity (i) included in the model

$$\text{HCF} = \sum C_i E_i \quad (1)$$

We use existing national household survey data to develop econometric models of demand, C in eq. 1, for transportation, residential energy, food, goods, and services. Independent variables used to predict household electricity, natural gas and other household heating fuels in the Residential Energy Consumption Survey¹⁹ ($n = 4363$) include energy prices, heating fuel type, heating and cooling degree days, structure of homes (number of rooms, percent single-detached, year home-built), demographic information (income, number of household members, age of householder, race), home ownership, percentage rural or urban, Census divisions, and U.S. state. Predictive variables for motor vehicles miles traveled (VMT) in the National Household Travel Survey²⁰ ($n = 11\,744$) include number of vehicles owned, fuel prices, average time to work, percentage of commuters who drive to work, demographic information (income, number of household members, race), number of food and recreation establishments in the zip code, population density, Census region, and U.S. state. Independent variables for 13 categories of goods and 11 categories of services in the Consumer Expenditures Survey²¹ ($n = 6965$) include household size and income. The total number of independent variables used in all models is 37, all of which were also compiled for zip codes for prediction purposes. Regression coefficients, t -statistics, and p -values for each independent variable, in addition to model summary statistics (adjusted r^2), various tests of model validation and description of uncertainty are provided in the Supporting Information.

The model regression coefficients were then applied to data known at the level of U.S. zip code tabulation areas (ZCTAs, or zip codes) to estimate demand for typical households of each category of consumption for >31k ZCTAs. Information on the demographic characteristics of population, the physical infrastructure of homes, travel patterns, and economic activity are from the U.S. Census.²² Energy and fuel prices are from the Energy Information Administration (EIA)²³ at the level of U.S. states. Heating and cooling degree-days were interpolated for

each zip code from 5500 NOAA weather stations²⁴ using Geographic Information Systems software. Diets for 15 categories of food for adults (first two household members) and children (remaining members) are from the USDA nutrition database.²⁵

Demand was then multiplied by GHG emission factors, in carbon dioxide equivalents²⁶ for electricity,²⁷ fuels,²⁸ and upstream emissions from fuels.²⁹ Indirect life cycle emission factors for goods and services are from the CEDA economic input-output model.³⁰ Input-output life cycle assessment is widely used to approximate emissions from average goods per dollar of expenditures in the consumption literature.³¹ Emissions from water, waste and home construction are from previous work³² and assumed to be the same for all households due to lack of regionally-specific data. We then created population weighted averages for each city, county, and U.S. state. Zip codes were further classified into urban core, urban, urban fringe, suburban, rural fringe, or rural to evaluate the effect of urban development on emissions using U.S. Census data.³³

To be clear, the models do not measure consumption, but rather estimate demand for goods and services for average households in zip codes using econometric models of national household survey data. As such, the results should be considered benchmarks by which measurements may be compared. We are limited to only variables available for zip codes and have left out potentially important variables, such as fuel economy of vehicles and local energy policies. Local energy policies are reflected in the model only to a certain degree, by inclusion of some states as dummy variables.

The primary purpose of these models is prediction and not explanation or inference. Because of multicollinearity between independent variables, correlation coefficients should not be compared. To infer causation and explain the relative influence of independent variables, we conducted a separate analysis of results for which we do explore the influence of multicollinearity (see discussion of Table 3 in Results and Table S-7 in Supporting Information for a coefficient correlation matrix).

Herein we present results highlighting regional differences and explore the impact of population density and suburbanization. The data set could also support a range of other potential results not included in this paper, including rankings, composition comparisons, mitigation analysis, efficiency ratings based on reported energy usage, quantitative spatial analysis, and comparison with source emissions. Interested readers are encouraged to visit the project Web site³⁴ to view detailed maps and results for almost any zip code, city, county, or U.S. state.

RESULTS

The broad regional patterns of household carbon footprints across the contiguous United States are shown in Figure 1 in aggregate, and for the home energy, transportation, goods, services, and food components. It is important to note that this map allocates all emissions to households at the point of residence (a consumption perspective), and not where emissions physically enter the atmosphere (a production perspective). All data are presented on a per household basis, but show similar spatial patterns when viewed on a per capita basis. The Midwest, noncoastal East, and much of the South have relatively high GHG emissions from electricity (1a), while the entire West and Northeast regions of the country show relatively low electricity emissions, due primarily to low carbon-intensity of electricity production. Natural gas (1b) and other

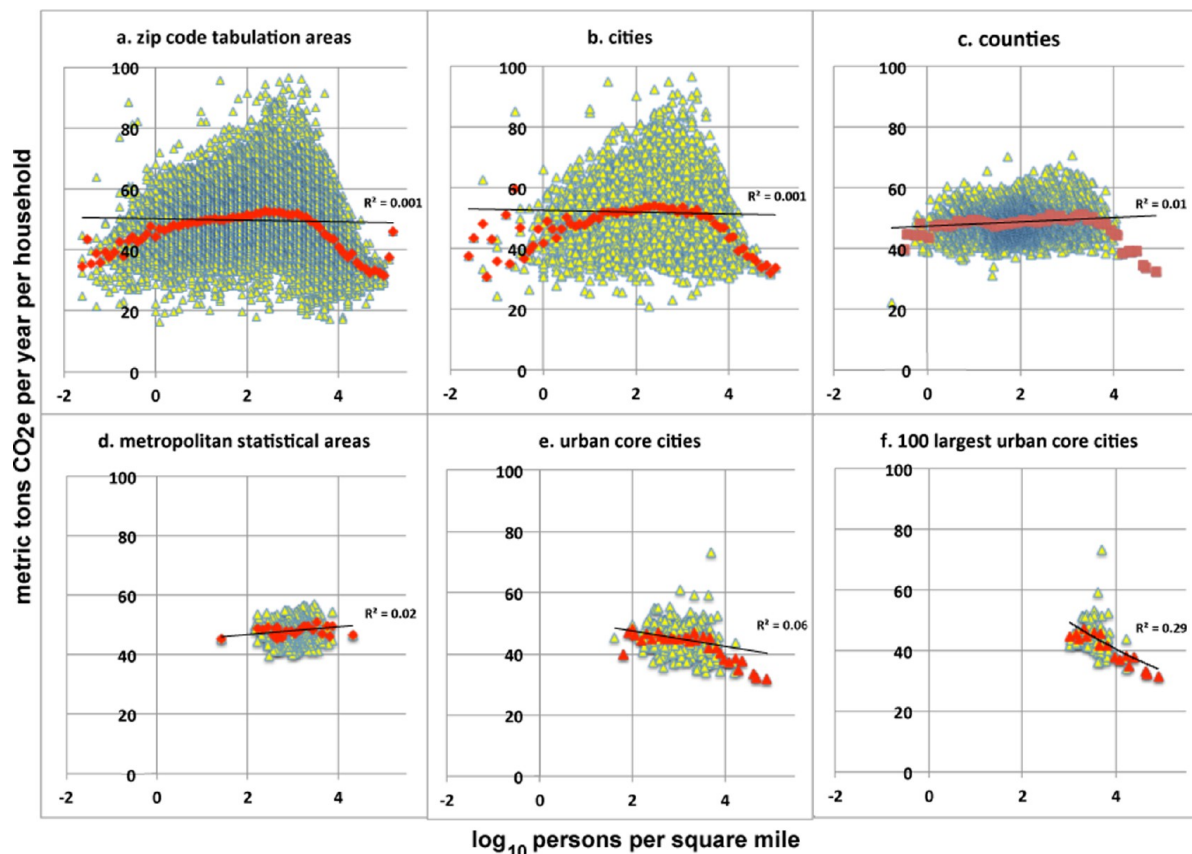


Figure 2. Average household carbon footprints (HCF) in (a) 31 531 zip code tabulation areas, (b) 10 093 U.S. Census cities and towns, (c) 3124 counties, (d) 276 metropolitan statistical areas, (e) 376 urban core cities, and (f) 100 largest urban core cities, by $\log_{10}$ of population per square mile (log of population density). The red line in each figure is the mean of all HCF for that population density, binned at increments of 0.1 on the x -axis. Linear goodness of fit trend lines show no correlation between population density and HCF, with the exception of the 100 largest urban core cities, $R^2 = 0.29$. Mean HCF decreases only after ~ 3000 persons per square mile (or 3.5 on the x axis).

heating fuels (1c) are concentrated in colder regions of the country, including the Midwest, Northeast and parts of the Pacific. Combining all energy emissions along with the life cycle emissions of fuels, water, waste, and home construction into a single metric, “housing,” (1d) presents a more comprehensive view of the contribution of homes to HCF than when considering energy components independently. Viewed through this lens, the Midwest and much of the South have relatively high emissions, so do parts of the Pacific and much of the Northeast. HCF from transportation (1e), goods (1f), food (1h), services (1i), and in total (1g) are widely distributed across the United States with no distinct broad regional patterns; however, the largest concentrations of HCF are surrounding metropolitan regions. When viewing HCF maps at regional spatial scales it is evident that GHG hotspots surrounding metropolitan regions have low carbon footprint cores, with rural areas exhibiting average to low carbon footprints. Figure 1j demonstrates this effect for East Coast metropolitan statistical areas. This pattern holds across the United States, with larger cities exhibiting the strongest urban/suburban differences, for example, the New York metropolitan statistical area (1k).

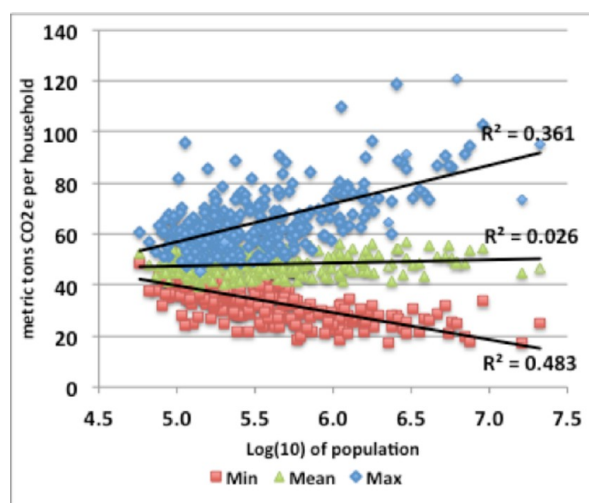
A number of factors account for differences between household carbon footprints in urban cores and suburbs. Supporting Information Figure S-2 shows transportation,

energy, goods and total household carbon footprints for zip codes in the Atlanta metropolitan area. Atlanta was chosen as the example for this figure because it is the most populous landlocked MSA. All other large MSAs show very similar patterns. The zip codes with the highest energy-related emissions are concentrated in a tight band of suburbs between 15 and 45 miles from the city center. Despite having the same weather, energy prices and carbon-intensity of electricity production, suburbs still exhibit noticeably higher energy-related emissions. Geographic differences are most pronounced for transportation-related emissions, which range from <10 tCO₂e per household in the urban core to >25 tCO₂e in the most distant suburbs. Income and household size contribute to larger consumption-related carbon footprints in suburbs. The combined result is distinct carbon footprint rings surrounding urban cores, with suburbs exhibiting noticeably higher HCF.

This large data set allows for a more complete understanding of the effect of population density on communities than previous work limited to a number of cities. In Figure 2, total household carbon footprints are plotted against $\log_{10}$ of population density for all zip codes (a), cities (b), counties (c), metropolitan statistical areas (d), urban core cities (e) and the 100 most populous urban core cities (f). Carbon footprints in 10 093 cities (and also zip codes) are widely dispersed, with standard deviation of 9.2 and mean 52.0 tCO₂e. In contrast,

carbon footprints of entire metropolitan statistical areas are quite similar, 48 tCO₂, SD 3.8. The red line in each figure is the mean of all HCF for that population density, binned at increments of 0.1 on the *x*-axis. Mean HCF, standard deviation and range increase moderately until a threshold of about 3,000 persons per square mile is reached (3.5 on the *x*-axis), after which mean HCF decreases logarithmically by about 10 tCO₂e for each 10-fold increase in population density. Linear trend lines plotted for each chart reveal virtually no correlation between population density and household carbon footprints ($r^2 = 0.001$ for zip codes and cities, 0.01 for counties and 0.02 for metropolitan areas), with the exception of the 100 largest cities ($r^2 = 0.29$). Other possible trend lines produce similar results, with or without a log *x*-axis. If plotting only the mean carbon footprints of highly dense cities, it is possible to find strong correlations between population density and transportation emissions or total HCF; however, this correlation almost completely disappears when considering all cities or metropolitan regions.

In agreement with population density hypotheses, large, dense metropolitan areas do contain locations in city cores with very low HCF compared to smaller, less dense cities, but they also contain suburbs with relatively high HCF, more than offsetting the benefit of low carbon areas in city centers. Figure 3 shows the min, mean, and max household carbon footprints of zip codes within each metropolitan statistical area



	Min	Mean	Max	Max/Min
10 smallest	40.3	46.7	58.8	1.5
50 smallest	41.5	47.9	61.4	1.5
100 smallest	39.8	47.7	59.7	1.5
All MSAs	34.1	48.1	65.0	1.9
100 largest	27.8	48.6	72.5	2.6
50 largest	26.1	49.5	79.9	3.1
25 largest	25.2	50.1	85.5	3.4
10 largest	24.6	50.6	92.9	3.8

Figure 3. Min, mean and max carbon footprints of zip codes within 276 metropolitan statistical areas (y-axis) by log₁₀ of total population (x-axis).

(Supporting Information Figure S-4 is the same plot with population density on the *x*-axis instead of population). There is a strong negative correlation between population and min values ($r^2 = 0.483$) but also a strong positive correlation between population and max values ($r^2 = 0.361$). As metropolitan size increases the range between the lowest and highest HCF locations also increases, growing from a factor of 1.5 difference in small metropolitan areas to a factor of 4 difference in the largest. While the 25 most populous MSAs contain locations with 50% lower HCF than average, there is a small but noticeable trend of higher overall household carbon footprints in larger metropolitan areas because of the influence of outlying suburbs. The two largest metropolises, New York and Los Angeles, break this trend by demonstrating lower than average HCF.

Analysis of all urban cores (also called principal cities), suburbs, and rural areas is presented in Tables 1 and 2. Large,

Table 1. Summary of Household Carbon Footprints (HCF) of Urban Core Cities, Suburban Cities, Suburban Towns, and Rural Areas for Sample of Zip Codes Categorized by NCHS^{33a}

	trans	total	st. dev.	pop. (M)	pop. density
city, large	11.3	41.8	8.2	20.3	9953
city, midsize	13.9	45.1	9.5	7.3	3583
city, small	14.6	46.6	7.3	13.4	2117
rural, remote	16.0	47.6	5.6	4.4	15
town, distant territory	16.1	48.7	5.1	15.0	160
suburb, small territory	16.8	50.0	6.1	3.3	494
suburb, midsize	17.3	51.0	7.0	5.0	902
rural, distant	18.0	51.3	6.1	9.0	74
suburb, large	16.9	53.1	8.9	43.9	2706
town, fringe	18.2	53.2	14.7	3.8	251
town, remote territory	18.4	54.5	18.8	1.3	93
rural, fringe	19.1	55.8	7.8	12.9	254

^aSee Supporting Information for definitions of location types. Table includes HCF for transportation, total HCF, standard deviation of total HCF, total population in the sample (in millions of residents), and population density (persons per square mile).

population-dense cities, which are defined as urbanized areas inside a principal city,³³ have lower HCF than smaller principal cities; however, the opposite is true with large, relatively population dense suburbs, which have higher HCF than smaller suburbs (Table 1). We find no evidence that increased

Table 2. Household Carbon Footprints in Metropolitan Statistical Area Principal Cities, Suburbs, and Rural and Micropolitan Areas (MSAs)^a

	pop. (M)	tCO ₂ /cap	tCO ₂ /hh	MtCO ₂	percentage
metropolitan areas	241	18.4	49	4442	80%
principal cities	98	17.2	44	1695	30%
suburban	143	19.3	53	2747	49%
rural and micropolitan	59	19.5	50	1145	20%
total	300	18.6	49	5588	100%

^aTable includes almost all populated zip codes in the U.S. and per capital and per household HCF for model year 2007. All locations not in principal cities, as classified by Census, but within metropolitan statistical areas are considered "suburbs".

population density correlates directly with lower household carbon footprints in suburbs or rural areas; in fact, the opposite appears to be true. Transportation carbon footprints are about 50% higher in large suburbs compared to large principal cities, while total carbon footprints are about 25% higher, or 10 tCO₂e.

Table 2 summarizes results from all U.S. zip codes, including 300 M people, or over 99.6% of total U.S. population in the model year of 2007. Metropolitan statistical areas account for about 80% of the U.S. population and household carbon footprints. Principal cities, as defined by the U.S. Census, account for about 30% of U.S. carbon footprints, while locations outside of principal cities but still within metropolitan areas (suburbs), account for about 50% of total U.S. household contributions to climate change.

Total HCF for all U.S. locations is nearly 6 billion metric tons of CO₂ equivalent, or about 80% of total U.S. GHG emissions, but would likely be equivalent to nearly 100% of total U.S. GHG emissions if the carbon intensity of imports were considered.¹ Our estimate aligns very closely with other national HCF studies of the United States,^{1,10,35} all of which estimate average U.S. HCF at about 50 tCO₂e. Future versions of this work would benefit from inclusion of a multiregional input-output model to account for the carbon intensity of international supply chains.^{1,36}

To develop the best explanatory model of the results we regressed total HCF against all independent variables used in our econometric models (vehicle ownership, household size, energy prices, etc.) for each zip code in the data set. Of the 37 independent variables included in the regression models, 6 variables explain 92.5% of the variability for all zip codes, 96.2% in principal core cities and 94.6% in suburbs, as measured by adjusted r^2 . In order of their influence on HCF, controlling for all variables entered previously (or stepwise) these are: number of vehicles per household, annual household income, carbon intensity of electricity, number of rooms (a proxy for home size, which is not available for zip codes), natural log of persons in household and log of population density (model 1 in Table 3). The next most significant variables (not shown) are average time to work, fuel prices for gasoline and natural gas, heating degree days and average year homes built; inclusion of these variables improves adjusted r^2 from 0.925 to 0.935.

Overall, income is the single largest contributing factor to household carbon footprints (controlling for all other variables), but the combined effect of other model variables, controlling for income, has far greater influence on the model goodness of fit. Income is positively correlated with population density for all locations ($R^2 = 0.339$), but slightly negatively correlated when considering just principal cities ($R^2 = 0.078$).

Models 2–4 in Table 3 emphasize the role of population density on household carbon footprints. Consistent with Figure 3, model 2 confirms there is virtually no direct correlation between population density and HCF for all zip codes ($\beta = 0.037$, $R^2 = 0.001$) yet there is a reasonably strong correlation when considering only principal cities ($\beta = 0.484$, $R^2 = 0.234$). Population density also becomes strongly significant when controlling for income and household size ($\beta = -0.3$) for all locations (model 3). When controlling for rooms and number of vehicles, population density is no longer significant due to multicollinearity between population density and these variables (see Supporting Information for a correlation matrix). Thus, population density appears to affect the size of homes and vehicle ownership and these variables in turn affect HCF,

Table 3. Summary Statistics for All Zip Codes in the Data Set (All), Principal Cities (Cores), and Suburbs^a

		all	cores	suburbs
1	no. vehicles	0.338	0.183	0.310
	annual hh income	0.499	0.476	0.500
	g CO ₂ /kWh	0.271	0.255	0.288
	no. rooms	0.202	0.242	0.221
	ln persons per hh	0.179	0.255	0.154
	log pop. density	-0.126	-0.084	-0.123
	adj. R^2	0.925	0.962	0.946
	2 log pop. density	0.037	-0.484	-0.076
	adj. R^2	0.001	0.234	0.006
3	annual hh income	0.754	0.683	0.780
	ln persons per hh	0.314	0.371	0.266
	log pop. density	-0.302	-0.320	-0.301
	year home built	-0.116	-0.060	-0.022
	adj. R^2	0.653	0.812	0.691
	no. rooms	0.448	0.486	0.526
4	no. vehicles	0.515	0.472	0.471
	ln persons per hh	0.008	-0.015*	-0.014**
	adj. R^2	0.747	0.808	0.788
	N	31447	3646	11011

^aStandardized beta coefficients. $p < 0.001$ for all variables, except * $p < 0.1$, ** $p < .01$. VIF < 2.1 for all variables.

along with income, the carbon intensity of electricity, household size, and other factors to a lesser degree.

The diverse composition of household carbon footprints between locations (see Supporting Information Figure S-3) is also of significance. Emissions from travel are 3 times larger than energy in some locations, while in other locations energy-related emissions are considerably higher than travel. Household energy comprises between 15% and 33% of total household carbon footprints for about 90% of locations, while transportation comprises between 26% and 42%. The carbon footprint of food ranges from 12% to 20% of total HCF and is in some cases larger than either transportation or energy carbon footprints. Previous research^{9,10} has further shown that the size and composition of carbon footprints varies even more noticeably for households of different demographic characteristics within locations.

These results should be understood in the context of uncertainty and the methods used to derive the estimates. We have used national survey data to predict consumption at fine geographic scales and have used average GHG emission factors to estimate emissions. This approach hides important regional differences. For example, while we estimated vehicle miles traveled for almost every zip code in the U.S. using locally available data, we have assumed average vehicle fuel economy for all locations. We have also assumed similar diets, housing construction, water, and waste-related emissions because of a lack of regionally specific data. Some of the model variables may indicate multiple conflicting aspects of urban form. For example, increased travel time may simultaneously indicate increased traffic, higher use of public transit, and longer travel distances. Also, population density does not account for mixed use, such as commercial and industrial zones colocated in populated areas. Additionally, as noted under model validation in the Supporting Information, the model tends to underestimate emissions for locations with relatively high consumption.

DISCUSSION

In this study, we characterize average household carbon footprints of essentially all populated U.S. locations and reveal a more nuanced relationship between population density and household carbon footprints. Previous research using much smaller data sets has suggested a negative correlation between population density and emissions; as population density increases, emissions decrease. In contrast, we find that the mean, standard deviation and range of emissions actually increase until a population density of about 3000 persons per square mile is reached, after which mean HCF declines logarithmically, leveling out at a lower limit of about 30 tCO₂ per household (35% below average) at densities over 50 000 persons per square mile. The net effect of this inverted-U relationship is no overall correlation between population density and HCF when considering all U.S. zip codes ($r^2 < 0.001$, Figure 2a) and cities ($r^2 < 0.001$, Figure 2b); however there is a strong negative log-linear correlation between population density and HCF if only considering the most populous cities ($r^2 = 0.3$, Figure 2f), consistent with previous studies.

When considering entire metropolitan statistical areas the inverted-U relationship disappears and the correlation appears to be slightly positive (Figures 2d and 3 and Supporting Information Figure S-4), similar to the left side of the inverted-U relationship for zip codes and cities. More populous metropolitan areas tend to have somewhat higher net HCF due to the influence of more extensive suburbs, which are on average 25% higher than urban cores (Figure 3). The two largest metropolitan areas, New York and Los Angeles, are exceptions with somewhat lower net carbon footprints, suggesting the inverted-U relationship may hold when including extremely population-dense metropolitan areas, or megacities. Similar comprehensive studies in other countries are needed to compare the effects of population density and suburbanization to see if lessons in the U.S. are transferable.

Higher emissions in suburbs, and at moderate population densities, are due to a number of factors. First, urbanized areas are wealthier than rural areas, with higher consumption and emissions; however, at population densities above a threshold of about 3000 persons per square mile, household carbon footprints tend to be lower, primarily, due to smaller homes, shorter driving distances, and also somewhat lower incomes.

As a policy measure to reduce GHG emissions, increasing population density appears to have severe limitations and unexpected trade-offs. In suburbs, we find more population-dense suburbs actually have noticeably higher HCF, largely because of income effects. Population density does correlate with lower HCF when controlling for income and household size; however, in practice population density measures may have little control over income of residents. Increasing rents would also likely further contribute to pressures to suburbanize the suburbs, leading to a possible net increase in emissions. As a policy measure for urban cores, any such strategy should consider the larger impact on surrounding areas, not just the residents of population dense communities themselves. The relationship is also log-linear, with a 10-fold increase in population density yielding only a 25% decrease in HCF. Generally, we find no evidence for net GHG benefits of population density in urban cores or suburbs when considering effects on entire metropolitan areas.

Given these limitations of urban planning our data suggest that an entirely new approach of highly tailored, community-scale carbon management is urgently needed. Regions with high energy-related emissions, such as the Midwest, the South, and parts of the Northeast, should focus more on reducing household energy consumption than regions with relatively clean sources of energy, such as California. However, if household energy were the sole focus of residential GHG mitigation programs, then between two-thirds and 85% of household carbon footprints would be left unaddressed in most locations; the full carbon footprint of households should be considered in community GHG inventories and management plans. Suburbs, which account for 50% of total U.S. HCF, tend to have high motor vehicle emissions, large homes, and high incomes. These locations are ideal candidates for a combination of energy efficient technologies, including whole home energy upgrades and solar photovoltaic systems combined with electric vehicles. Food tends to be a much larger share of emissions in urban cores, where transportation and energy emissions tend to be lower, and in rural areas, where household size tends to be higher and consumption relatively low.

Several recent studies for California^{37,38} conclude that 80% GHG reductions are possible only with near technical potential efficiencies in transportation, buildings, industry, and agriculture. To the extent that these efficiencies are not met, highly tailored behavior-based programs must make up the difference to decrease demand for energy, transportation, goods, and services that drives emissions.

ASSOCIATED CONTENT

Supporting Information

Detailed methods for the carbon footprint model, including regression coefficients, *t*-values, and *p*-values for each independent variable, model summary statistics (r^2), various tests of model validation, and description of uncertainty. This material is available free of charge via the Internet at <http://pubs.acs.org>. Carbon footprint profiles of almost all U.S. zip codes, cities, counties and states are available on the project Web site, <http://coolclimate.berkeley.edu/carboncalculator>, and an interactive mapping Web site, <http://coolclimate.berkeley.edu/maps>.

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Notes

The authors declare no competing financial interest.

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General Assistance

Low-Income Programs

Low-Income Self-Sufficiency Plan

Payment Agreement

Customer Resource Fairs

Energy Assistance Agencies

Help Others

Shutoff Protection Plan

Low-Income Programs

We understand the importance of energy in your life, and our goal is to keep your services turned on. Throughout the year, we work with government agencies and community organizations to offer payment assistance to income-qualified residents.

If you are behind on your energy bill, we will work with you to discuss payment plan options or direct you to [energy assistance agencies](#) in your area. For more information, contact us at [\(800\) 477-4747](#).

How to Apply

This video describes which documents and information you will need to provide when applying for energy assistance.

Federal Poverty Guidelines

To receive specific types of energy assistance, we allow your income to be at or above a certain percentage of the **Federal Poverty Guidelines**.

Number of Household Members	2023-2024 Federal Poverty Guidelines
1	\$14,580
2	\$19,720
3	\$24,860
4	\$30,000
5	\$35,140
6	\$40,280
7	\$45,420
8	\$50,560
Add \$5,140 for each additional household member.	

Source: 

https://www.acf.hhs.gov/sites/default/files/documents/ocs/COMM_LIHEAP_FY24FPGUpdateIM_F

FY2024.pdf

Income Eligibility

Based on your income, you could qualify for energy assistance or a payment plan to help pay your past-due balance or current bill.

Within the table below, determine the number of members in your household and then your monthly or yearly income. Then decide if you might qualify for a specific type of energy assistance or payment plan.

Type of Energy Assistance	Home Heating Credit	SER ¹ LSP ² THAW ³ MCA ⁴ Salvation Army RIA Credit	Shutoff Protection Plan
Number of Household Members	Annual Income	Monthly Income	Monthly Income
1	\$16,038	\$1,823	\$2,430
2	\$21,692	\$2,465	\$3,287
3	\$27,346	\$3,108	\$4,143
4	\$33,000	\$3,750	\$5,000
5	\$38,654	\$4,393	\$5,857
6	\$44,308	\$5,035	\$6,713

7	\$49,962	\$5,678	\$7,570
8	\$55,616	\$6,320	\$8,427
For each additional person add	\$5,654	\$643	\$857

¹State Emergency Relief

²Low-Income Self-Sufficiency Plan

³The Heat and Warmth Fund

⁴Michigan Community Action

Some non-profit agencies may provide assistance to households with a higher income level than listed above. Contact the specific agency for details.

You can also call United Way of Southeastern Michigan at 211 or (844) 211-4994 or United Way of Jackson County at (517) 741-0202.

⌵ Affordable Connectivity Program (ACP)

⌵ Earned Income Credit

⌵ Energy Efficiency Assistance Program

⌵ Federal – Earned Income Tax Credit

⌵ The Heat and Warmth Fund

⌵ Home Heating Credit

⌵ Lifeline

⌵ Michigan 2-1-1

⌵ Michigan Community Action

⌵ Michigan Homeowner Assistance Fund (MIHAF)

⌵ Michigan Veterans Trust Fund Emergency Grant Program

⌵ Residential Income Assistance Credit

⌵ The Salvation Army

⌵ State Emergency Relief Program

⌵ Wayne County – Foreclosure Prevention

Utility Characteristics									RESIDENTIAL		
									Revenues	Sales	Customers
Data Year	Utility Number	Utility Name	Part	Service Type	Data Type O = Observed I = Imputed	State	Ownership	BA Code	Thousand Dollars	Megawatthours	Count
2022	5109	DTE Electric Company	A	Bundled	O	MI	Investor Owned	MISO	2,910,745.9	15,844,478	2,047,944
2022	5109	DTE Electric Company	C	Delivery	O	MI	Investor Owned	MISO	24.1	305	16

COMMERCIAL			INDUSTRIAL			TRANSPORTATION			TOTAL		
Revenues	Sales	Customers	Revenues	Sales	Customers	Revenues	Sales	Customers	Revenues	Sales	Customers
Thousand Dollars	Megawatthours	Count	Thousand Dollars	Megawatthours	Count	Thousand Dollars	Megawatthours	Count	Thousand Dollars	Megawatthours	Count
2,019,207.0	16,500,656	208,758	658,926.5	8,548,188	711	533.7	4,320	2	5,589,413.1	40,897,642	2,257,415
71,743.6	2,811,992	4,347	13,888.6	1,673,198	124	.	.	.	85,656.3	4,485,495	4,487

Utility Characteristics									RESIDENTIAL			
									Revenues	Sales	Customers	Revenues
Data Year	Utility Number	Utility Name	Part	Service Type	Data Type O = Observed I = Imputed	State	Ownership	BA Code	Thousand Dollars	Megawatthours	Count	Thousand Dollars
2022	15497	Puerto Rico Electric Pwr Authority	A	Bundled	O	PR	State	NA	1,823,195.0	6,419,574	1,370,811	2,332,860.0
2022	19879	Virgin Islands Water & Power Authority	A	Bundled	O	VI	State	NA	87,199.4	258,812	45,850	43,788.2
2022	40428	Guam Power Authority	A	Bundled	O	GU	State	NA	167,563.9	555,558	45,271	305,996.8
2022	40429	American Samoa Power Authority	A	Bundled	O	AS	State	NA	25,372.6	56,424	10,893	31,667.8
2022	57105	Commonwealth Utility Corporation	A	Bundled	O	MP	State	NA	25,079.1	94,566	12,770	37,702.1
2022	57313	Tesla Inc.	A	Bundled	O	PR	Behind the Meter	NA	0.0	0	0	201.0
2022	59579	Sunnova	A	Bundled	O	GU	Behind the Meter	NA	5,059.2	18,734	1,413	0.0
2022	59579	Sunnova	A	Bundled	O	PR	Behind the Meter	NA	68,257.0	276,245	33,822	0.0
2022	59647	Sunrun Inc.	A	Bundled	O	PR	Behind the Meter	NA	10,419.2	27,380	3,770	0.0
2022	60981	TerraForm US Energy Services, LLC	A	Bundled	O	PR	Behind the Meter	NA	0.0	0	0	118.0
2022	61098	Longroad Energy	A	Bundled	O	PR	Behind the Meter	NA	.	.	.	17.1
2022	99999	Adjustment 2022	A	Bundled	I	GU		NA	0.0	0	-1,413	0.0
2022	99999	Adjustment 2022	A	Bundled	I	PR		NA	0.0	0	-37,592	1,768.0

To calculate a state or the US total, sum Parts (A,B,C & D) for Revenue, but only Parts (A,B & D) for Sales and Customers.

To avoid double counting of customers, the aggregated customer counts for the states and US do not include the customer count for respondents with ownership code 'Behind the Meter'.

This group consists of Third Party Owners of rooftop solar systems.

COMMERCIAL		INDUSTRIAL			TRANSPORTATION			TOTAL		
Sales	Customers	Revenues	Sales	Customers	Revenues	Sales	Customers	Revenues	Sales	Customers
Megawatthours	Count	Thousand Dollars	Megawatthours	Count	Thousand Dollars	Megawatthours	Count	Thousand Dollars	Megawatthours	Count
7,495,422	127,739	505,081.0	1,768,396	589	0.0	0	0	4,661,136.0	15,683,392	1,499,139
101,485	7,524	95,359.1	261,772	2,292	.	.	.	226,346.7	622,069	55,666
984,602	7,602	.	.	.	.	.	.	473,560.7	1,540,160	52,873
70,418	1,575	10,834.7	24,745	4	.	.	.	67,875.1	151,587	12,472
163,706	4,195	0.0	0	0	0.0	0	0	62,781.2	258,272	16,965
4,834	12	0.0	0	0	0.0	0	0	201.0	4,834	12
0	0	0.0	0	0	0.0	0	0	5,059.2	18,734	1,413
0	0	0.0	0	0	0.0	0	0	68,257.0	276,245	33,822
0	0	0.0	0	0	0.0	0	0	10,419.2	27,380	3,770
731	5	0.0	0	0	0.0	0	0	118.0	731	5
101	2	.	.	.	.	.	.	17.1	101	2
0	0	0.0	0	0	0.0	0	0	0.0	0	-1,413
10,390	-17	0.0	0	0	0.0	0	0	1,768.0	10,390	-37,609

Utility Characteristics						Decoupled				Revenue Adjustment Method			
Data Year	Utility Number	Utility Name	Ownership	State	BA-Code	Residential	Commercial	Industrial	Transportation	Residential	Commercial	Industrial	Transportation
2022	604	City of Andalusia	Municipal	AL	SOCO	Yes	Yes	Yes	Yes	Proceeding	Proceeding	Proceeding	Proceeding
2022	963	Atlantic City Electric Co	Investor Owned	NJ	PJM	Yes	Yes	Yes	No	Proceeding	Proceeding	Proceeding	
2022	1167	Baltimore Gas & Electric Co	Investor Owned	MD	PJM	Yes	Yes	No	No	Automatic	Automatic		
2022	1179	Versant Power	Investor Owned	ME	ISNE	Yes	Yes	Yes		Automatic	Automatic	Automatic	
2022	1179	Versant Power	Investor Owned	ME	NBSO	Yes	Yes	Yes	No	Automatic	Automatic	Automatic	
2022	1764	Black Diamond Power Co	Investor Owned	WV	PJM	Yes	Yes			Automatic	Automatic		
2022	2651	Butler Rural Electric Coop Inc - (OH)	Cooperative	OH	PJM	Yes	Yes	Yes		Automatic	Automatic	Automatic	
2022	2812	City of Calhoun - (GA)	Municipal	GA	SOCO	Yes	Yes	Yes	No	Proceeding	Proceeding	Proceeding	
2022	3240	Central Electric Coop Inc - (OR)	Cooperative	OR	BPAT	Yes	Yes	Yes	No	Proceeding	Proceeding	Proceeding	Proceeding
2022	3249	Central Hudson Gas & Elec Corp	Investor Owned	NY	NYIS	Yes	Yes	Yes		Automatic	Automatic	Automatic	
2022	3542	Duke Energy Ohio Inc	Investor Owned	OH	PJM	Yes	No	No	No	Proceeding			
2022	3989	City of Colorado Springs - (CO)	Municipal	CO	WACM	Yes	Yes	Yes	No	Proceeding	Proceeding	Proceeding	
2022	4003	City of Colton - (CA)	Municipal	CA	CISO	Yes	Yes	Yes		Proceeding	Proceeding	Proceeding	
2022	4110	Commonwealth Edison Co	Investor Owned	IL	PJM	Yes	Yes	Yes	Yes	Proceeding	Proceeding	Proceeding	Proceeding
2022	4176	Connecticut Light & Power Co	Investor Owned	CT	ISNE	Yes	Yes	Yes	Yes	Proceeding	Proceeding	Proceeding	Proceeding
2022	4226	Consolidated Edison Co-NY Inc	Investor Owned	NY	NYIS	Yes	Yes	Yes	Yes	Proceeding	Proceeding	Proceeding	Proceeding
2022	4296	Cookson Hills Elec Coop, Inc	Cooperative	OK	AECI	Yes	Yes	Yes	No	Automatic	Automatic	Automatic	
2022	5027	Delmarva Power	Investor Owned	MD	PJM	Yes	Yes	Yes	No	Proceeding	Proceeding	Proceeding	
2022	5325	City of Douglas	Municipal	GA	SOCO	Yes	Yes			Automatic	Automatic		
2022	5336	City of Dover - (OH)	Municipal	OH	PJM	Yes	Yes	Yes	No	Proceeding	Proceeding	Proceeding	
2022	6374	Fitchburg Gas & Elec Light Co	Investor Owned	MA	ISNE	Yes	Yes	Yes	Yes	Proceeding	Proceeding	Proceeding	Proceeding
2022	7294	City of Glendale - (CA)	Municipal	CA	LDWP	Yes	Yes	Yes		Automatic	Automatic	Automatic	
2022	7563	Grand Valley Power	Cooperative	CO	PSCO	Yes	Yes	Yes	No	Automatic	Automatic	Automatic	
2022	8287	Hawaii Electric Light Co Inc	Investor Owned	HI	NA	Yes	Yes	Yes		Automatic	Automatic	Automatic	
2022	9191	Idaho Power Co	Investor Owned	ID	IPCO	Yes	Yes	No	No	Proceeding	Proceeding		
2022	9246	Indian Electric Coop, Inc	Cooperative	OK	SWPP	Yes	Yes	Yes		Proceeding	Proceeding	Proceeding	
2022	10451	Kotzebue Electric Assn Inc	Cooperative	AK	NA	Yes	Yes			Automatic	Automatic		
2022	10668	Licking Rural Electric Inc	Cooperative	OH	PJM	Yes	Yes	Yes		Proceeding	Proceeding	Proceeding	
2022	10879	Lehi City Corporation	Municipal	UT	PACE	Yes	Yes	Yes	Yes	Automatic	Automatic	Automatic	Automatic
2022	11171	Long Island Power Authority	State	NY	NYIS	Yes	Yes	No	Yes	Automatic	Automatic		Automatic
2022	11200	Lorain-Medina RE C, Inc	Cooperative	OH	PJM	Yes	Yes	Yes	No	Proceeding	Proceeding	Proceeding	
2022	11586	Town of Mansfield - (MA)	Municipal	MA	ISNE	Yes	Yes	Yes	Yes	Proceeding	Proceeding	Proceeding	Proceeding
2022	11804	Massachusetts Electric Co	Investor Owned	MA	ISNE	Yes	Yes	Yes		Proceeding	Proceeding	Proceeding	
2022	11843	Maui Electric Co Ltd	Investor Owned	HI	NA	Yes	Yes	Yes		Automatic	Automatic	Automatic	
2022	12268	Medina Electric Coop, Inc	Cooperative	TX	ERCO	Yes	Yes	Yes	No	Proceeding	Proceeding	Proceeding	
2022	12351	City of Mesa - (AZ)	Municipal	AZ	WALC	Yes	Yes	Yes		Automatic	Automatic		
2022	12515	Midwest Electric, Inc	Cooperative	OH	PJM	Yes	Yes	Yes	No	Proceeding	Proceeding	Proceeding	
2022	12539	Midwest Electric Member Corp	Cooperative	NE	WACM	No	No	Yes	No			Automatic	
2022	13206	Nantucket Electric Co	Investor Owned	MA	ISNE	Yes	Yes	Yes		Proceeding	Proceeding	Proceeding	
2022	13214	The Narragansett Electric Co	Investor Owned	RI	ISNE	Yes	Yes	Yes		Proceeding	Proceeding	Proceeding	
2022	13314	Navajo Tribal Utility Authority	State	AZ	PACE	Yes	Yes	Yes	No	Proceeding	Proceeding	Proceeding	
2022	13314	Navajo Tribal Utility Authority	State	UT	PACE	Yes	Yes	Yes	No	Proceeding	Proceeding	Proceeding	
2022	13314	Navajo Tribal Utility Authority	State	NM	PACE	Yes	Yes	Yes	No	Proceeding	Proceeding	Proceeding	
2022	13511	New York State Elec & Gas Corp	Investor Owned	NY	NYIS	Yes	Yes	Yes	Yes	Proceeding	Proceeding	Proceeding	Proceeding
2022	13573	Niagara Mohawk Power Corp.	Investor Owned	NY	NYIS	Yes	Yes	Yes	No	Proceeding	Proceeding	Proceeding	Proceeding
2022	13640	Northern Virginia Elec Coop	Cooperative	VA	PJM	Yes	Yes	Yes	No	Proceeding	Proceeding	Proceeding	
2022	13679	Town of North Attleborough - (MA)	Municipal	MA	ISNE	Yes	Yes	Yes		Proceeding	Proceeding	Proceeding	
2022	13693	North Central Elec Coop, Inc	Cooperative	OH	PJM	Yes	Yes	Yes	No	Automatic	Automatic	Automatic	
2022	13762	Northern Neck Elec Coop, Inc	Cooperative	VA	PJM	Yes	Yes			Proceeding	Proceeding		
2022	13781	Northern States Power Co - Minnesota	Investor Owned	MN	MISO	Yes	Yes	Yes	Yes	Automatic	Automatic	Automatic	Automatic
2022	14328	Pacific Gas & Electric Co.	Investor Owned	CA	CISO	Yes	Yes	Yes	Yes	Proceeding	Proceeding	Proceeding	Proceeding
2022	14354	PacifiCorp	Investor Owned	WA	PACW	Yes	Yes	Yes	No	Proceeding	Proceeding	Proceeding	
2022	14401	City of Palo Alto - (CA)	Municipal	CA	CISO	Yes	Yes	Yes	Yes	Proceeding	Proceeding	Proceeding	Proceeding
2022	14534	City of Pasadena - (CA)	Municipal	CA	CISO	Yes	Yes	Yes	Yes	Proceeding	Proceeding	Proceeding	Proceeding
2022	14537	Pascoag Utility District	Municipal	RI	ISNE	Yes	Yes	Yes	Yes	Proceeding	Proceeding	Proceeding	Proceeding
2022	14626	Pedernales Electric Coop, Inc	Cooperative	TX	ERCO	Yes	Yes	Yes		Automatic	Automatic	Automatic	
2022	14839	City of Peru - (IN)	Municipal	IN	MISO	Yes	Yes	Yes		Proceeding	Proceeding	Proceeding	
2022	15248	Portland General Electric Co	Investor Owned	OR	PGE	Yes	Yes	No	No	Automatic	Automatic		

Utility Characteristics						Decoupled				Revenue Adjustment Method			
Data Year	Utility Number	Utility Name	Ownership	State	BA-Code	Residential	Commercial	Industrial	Transportation	Residential	Commercial	Industrial	Transportation
2022	15270	Potomac Electric Power Co	Investor Owned	MD	PJM	Yes	Yes	Yes	No	Proceeding	Proceeding	Proceeding	
2022	15270	Potomac Electric Power Co	Investor Owned	DC	PJM	Yes	Yes	Yes	No	Proceeding	Proceeding	Proceeding	
2022	15410	Prince George Electric Coop	Cooperative	VA	PJM	Yes	Yes	Yes	Yes	Automatic	Automatic	Automatic	Automatic
2022	15466	Public Service Co of Colorado	Investor Owned	CO	PSCO	Yes	Yes	Yes	No	Proceeding	Proceeding	Proceeding	
2022	15477	Public Service Elec & Gas Co	Investor Owned	NJ	PJM	Yes	Yes	Yes	Yes	Proceeding	Proceeding	Proceeding	Proceeding
2022	15500	Puget Sound Energy Inc	Investor Owned	WA	PSEI	Yes	Yes	Yes	Yes	Proceeding	Proceeding	Proceeding	Proceeding
2022	16183	Rochester Gas & Electric Corp	Investor Owned	NY	NYIS	Yes	Yes	Yes		Automatic	Automatic	Automatic	
2022	16572	Salt River Project	Political Subdivision	AZ	SRP	Yes	Yes	Yes	Yes	Proceeding	Proceeding	Proceeding	Proceeding
2022	16609	San Diego Gas & Electric Co	Investor Owned	CA	CISO	Yes	Yes	Yes	Yes	Automatic	Automatic	Automatic	Automatic
2022	17609	Southern California Edison Co	Investor Owned	CA	CISO	Yes	Yes	Yes		Automatic	Automatic	Automatic	
2022	17612	Bear Valley Electric Service	Investor Owned	CA	CISO	Yes	Yes	Yes	Yes	Proceeding	Proceeding	Proceeding	Proceeding
2022	17637	Southern Maryland Elec Coop Inc	Cooperative	MD	PJM	Yes	Yes	No	No	Automatic	Automatic		
2022	19497	United Illuminating Co	Investor Owned	CT	ISNE	Yes	Yes	Yes	Yes	Proceeding	Proceeding	Proceeding	Proceeding
2022	19501	Union Rural Electric Coop, Inc	Cooperative	OH	PJM	No	No	Yes	No			Automatic	
2022	19547	Hawaiian Electric Co Inc	Investor Owned	HI	HECO	Yes	Yes	Yes	No	Automatic	Automatic	Automatic	
2022	19603	USBIA-Mission Valley Power	Federal	MT	NWMT	Yes	Yes	Yes	No	Automatic	Automatic	Automatic	
2022	19896	City of Volga - (SD)	Municipal	SD	SWPP	Yes	Yes	Yes		Automatic	Automatic	Automatic	
2022	20169	Avista Corp	Investor Owned	WA	AVA	Yes	Yes	Yes	Yes	Automatic	Automatic	Automatic	Automatic
2022	20169	Avista Corp	Investor Owned	MT	AVA	Yes	Yes	Yes	Yes	Automatic	Automatic	Automatic	Automatic
2022	20169	Avista Corp	Investor Owned	ID	AVA	Yes	Yes	Yes	Yes	Automatic	Automatic	Automatic	Automatic
2022	24590	Unitil Energy Systems	Investor Owned	NH	ISNE	Yes	Yes	Yes	Yes	Proceeding	Proceeding	Proceeding	Proceeding
2022	26510	Liberty Utilities (Granite State Electri	Investor Owned	NH	ISNE	Yes	Yes	Yes	Yes	Proceeding	Proceeding	Proceeding	Proceeding
2022	38084	Great Lakes Energy Coop	Cooperative	MI	MISO	No	Yes	Yes			Automatic	Automatic	
2022	54913	NSTAR Electric Company	Investor Owned	MA	ISNE	Yes	Yes	Yes	Yes	Proceeding	Proceeding	Proceeding	Proceeding
2022	56697	Ameren Illinois Company	Investor Owned	IL	MISO	Yes	Yes	Yes	Yes	Proceeding	Proceeding	Proceeding	Proceeding
2022	57483	Liberty Utilities	Investor Owned	CA	CISO	Yes	Yes	No	No	Proceeding	Proceeding		



Evaluation of the Percentage of Income Payment Plans

FINAL REPORT

October 2020

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Colorado Energy Office

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I Executive Summary

Under contract with the Colorado Energy Office (CEO), ADM Associates, Inc. (ADM) performed an evaluation of the Percentage of Income Payment Plans (PIPP) administered by Black Hills Colorado Electric and Gas, Public Service Company of Colorado Electric and Gas, Colorado Natural Gas, and Atmos Energy Corporation (collectively referred to as “the Utilities”).

Under 4 CCR 723-3-3412(k) and 4 CCR 723-4-4412(k), a triennial evaluation of utility low-income rate assistance (PIPPs) is required. This document summarizes the methods, findings, and resulting recommendations of the evaluation. Under the rules, the evaluation was to:

- Review best practices of utility low-income energy assistance programs in existence in other jurisdictions.
- Identify and recommend modifications that will improve the delivery of benefits to program participants and increase the efficiency and effectiveness of each program.
- Evaluate the operation of each utility’s program for effectiveness in providing optimum support to participants, including energy affordability.

The period of program operations covered by the evaluation is for the triennial period beginning November 1st, 2016 and ending October 31st, 2019.

ADM engaged in several forms of research to complete this evaluation:

- Review of literature on income assistance programs and PIPP program practices in other jurisdictions.
- Interviews with utility representatives and other stakeholders.
- Analysis of U.S. Census Bureau data to characterize the population of PIPP qualified households.
- Surveys and in-depth interviews of program participants and non-participants.
- Analysis of program impacts using data provided by the utilities.
- Analysis of monetized utility and participant benefits.
- Review of filed reports and regulatory rules governing PIPP.

I.1 Key Findings and Conclusions

The following summarizes the key findings and conclusions of the evaluation of the PIPP Programs.

I.1.1 Enrollment and Participation

- **Participant opt-outs were generally low, but varied by utility.** The number of customers that opted out varied by utility. Atmos Energy historically had a large number of opt-outs (773 in PY2016/17 and 250 in PY2017/18), but the number of opt-outs were notably lower for PY2018/201 (85). Black Hills Electric had few opt-outs relative to the number of

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enrolled customers, which may be a function of the application requirement for that program. Colorado Natural Gas stated they did not track opt-outs. Data provided by Public Service did not include information to identify participants who opted-out but staff reported that there were very few.

- **The Black Hills Energy electric program is the only program currently with a wait list.** At the end of the triennial period, there were 1,036 customers on the wait list. ADM estimated that the costs of the benefits of enrolling all of these customers would be approximately \$1,190,647 per year or about \$0.54 per month per residential customer.
- **The majority of qualified customers have not enrolled in PIPP.** Using the U.S. Census Bureau's American Community Survey data, ADM estimated that PIPP enrollments during the triennial period comprised 8% of the PIPP eligible households.¹ The total number of PIPP eligible households was estimated to be approximately 11% of the residential utility customers.
- **Re-enrollment rates varied across the utilities but were low in some cases.** The re-enrollment rates were highest for Colorado Natural Gas and Black Hills Energy, around 70%. Lower re-enrollment rates of around 25% were observed for Atmos and Public Service.
- **Shares of LEAP recipients enrolled in PIPP varied.** ADM found that the share of LEAP recipients enrolled in PIPP varied across the utilities. PIPP enrollment rates were generally low for Atmos (3.5% across the three years of the triennial) and for Black Hills Gas (7.4% across the three years of the triennial). Colorado Natural Gas reported PIPP enrollments approximately equal to the reported LEAP enrollments. Approximately one-third of Public Service customers enrolled in LEAP were enrolled in PIPP across the three years of the triennial period.

Given the automatic enrollment procedures in place for these programs, enrollment rates significantly less than 100% are somewhat surprising. Factors driving the enrollment rates include the \$5,000 to \$7,000 difference in household income requirements between LEAP, a share of customers with bills that do not meet the energy burden requirements, and the practice of applying LEAP credits to offset costs in the calculation of an affordable bill by Atmos.

Black Hills Electric had PIPP enrollments that exceeded LEAP enrollments because many of the customers in the PIPP electric program reportedly have natural gas heating and do not receive LEAP electric benefits.

¹ ADM used U.S. Census American Community Survey data to estimate the total number of PIPP eligible customers. Households were defined as qualifying for the electric PIPP benefit if the household had an 1) an electricity bill, 2) an income at 185% of federal poverty or less, and 3) an electricity bill greater than 6% of their income if they had electric heat, or a utility bill greater than 3% of their income if they heated using a different fuel. Households were defined as qualifying for gas PIPP benefits if the household had 1) a utility gas bill, 2) an income at 185% of federal poverty or less, 3) a natural gas bill greater than 3% of their income.

1.1.2 Program Awareness and Outreach Effectiveness

- **Outreach for PIPP is largely accomplished through LEAP outreach efforts.** Because in most cases, PIPP enrollment is automatic for qualified customers enrolled in LEAP, the focus on LEAP outreach is appropriate. The LEAP office and its nonprofit partners do most of the LEAP outreach. Use of government and community groups to promote and enroll customers in public benefit programs is consistent with best practices. All of the individual utilities described various outreach approaches taken to promote LEAP or their low-income assistance programs, but none characterized these as consistent ongoing outreach efforts. All utilities notify customers of their receipt of the PIPP benefits.
- **LEAP uses multiple channels to advertise the program and has materials in English and Spanish.** LEAP outreach efforts are comprised of media releases, television advertisement, applications provided to non-profits, materials on the program website, and hosting a toll-free telephone number. ADM noted that online materials for LEAP do not refer to the availability of the PIPP benefit.
- **Participants' social networks and the Colorado Department of Human Services website were the primary ways that customers learned of LEAP.** Most participants learned of the LEAP program through their social networks and from the Colorado Department of Human Services website. Social workers were another source of awareness of for LEAP.
- **Many PIPP recipients were unaware that they received the benefit.** Aside from Black Hills participants, approximately one-half of PIPP participants were aware that they received PIPP. Most Black Hills Electric and Gas participants were aware that they received PIPP. This is likely because an application to Black Hills is required to receive the electric benefit and the survey sample, like the population of participants, was largely comprised of those receiving the electric benefit.²
- **LEAP requires annual reapplication to certify customer eligibility.** Reapplication is facilitated by the LEAP office by mailing all enrolled participants a LEAP application for the following year. The annual recertification of eligibility is consistent with common practice for means-tested programs.
- **Utility use of different program names is inconsistent with best practice.** A best practice recommendation is to use consistent program names to help build awareness of the benefit or service. Each utility has its own name for the PIPP assistance.

1.1.3 Barriers to Participation

- **Enrollment in PIPP is consistent with best practices in that it leverages other means-tested programs (i.e., LEAP) and qualified customers are automatically enrolled.** LEAP enrollment drives PIPP enrollment, with LEAP participants being auto-enrolled in utilities' PIPP programs. The one exception to the autoenrollment process is the Black Hills Energy

² 90% of Black Hills survey respondents received electric benefits through PIPP.

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electric program, which requires the submission of an application. Black Hills requires an application because more customers receive LEAP and qualify for the program than funding for PIPP permits. The re-enrollment rates for the Black Hills Energy electric program are relatively high, suggesting that the application requirement is not adversely affecting participation.

- **Except for eight-person households, PIPP qualified customers also qualify for LEAP.** A lower income is required to qualify for PIPP than is required for LEAP for households with one to seven members. For eight-person households, a lower income is required for LEAP than is required for PIPP (LEAP requires an income of \$75,528, PIPP requires an income of \$81,622). Consequently, eight-person households with an income of more than \$75,528 but less than \$81,622 would not qualify for LEAP and therefore could not enroll in PIPP because LEAP enrollment is required for PIPP. While this presents a systematic barrier to PIPP, the impact is likely minimal due to the likely small number of eight-person households that meet the PIPP income threshold but not the LEAP threshold.
- **LEAP requires that a member of the household is a permanent resident or that the household have members that are U.S citizens.** Enrollment in LEAP is a requirement to receive the PIPP benefit and as such non-permanent residents are not able to participate in PIPP.
- **The levelized billing requirement may limit PIPP participation.** Anecdotally, some stakeholders reported that the levelized billing requirement was a component that participants did not like and was a significant factor in customer decisions to opt-out of PIPP. Additionally, interviews with participants found that some did not like the requirement for levelized billing. As such, levelized billing may present a barrier to enrollment and continuation of enrollment.

I.1.4 Eligibility Requirements

- **The income requirements for the program are appropriate.** Compared to other states reviewed, Colorado allows for households with higher incomes to qualify for PIPP. ADM's review of other states found that the most common qualification for the percentage of income payment plans was 150% of the federal poverty level (FPL) in comparison to Colorado's qualification (up to 185% of FPL). Colorado's inclusion of households between 151% and 185% FPL opens the PIPP to a greater number of customers than would be the case if 150% of FPL was used and as such, increases the potential costs of funding PIPP. However, the finding that the energy burden of households between 151% and 185% of FPL was similar to those households between 125% and 150% of FPL suggests that providing the program to the higher income households is appropriate.

I.1.5 Definition of Affordable Bill and Approach to Levelized Billing

- **Colorado's regulatory definition of an affordable bill is generally appropriate.** A review of best practices found that energy costs of 6% of income was an appropriate definition of an affordable bill and that energy costs of 11% of income are considered high. Colorado

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caps electricity costs at 6% of income for households with electric heating and 3% with non-electric heating, and natural gas costs at 3% of income for households with natural gas heating. As such most PIPP qualified households would have energy costs capped at 6% of their income. An exception is households with electric heating but with natural gas service for other loads (such as cooking and domestic hot water). Analysis of U.S. Census Bureau data found that the average share of income paid for natural gas for homes with electric heating and natural gas service exceeded 6% for households at or below the 185% poverty level.

- **All of the utilities comply with the bill caps defined in the regulations, but there is variation in the definition of the affordable bill.** Atmos Energy, Black Hills Energy – Gas, and Colorado Natural Gas use the same tiered cap structure. Under this structure, customer bill caps are either 2%, 2.5%, or 3%, depending on what percent of federal poverty level their income and household size places them in. Public Service – Gas uses a different structure and places a cap of 3% on all qualified customer bills, but also provides discounted rates for qualified customers with bills that are less than 3% of their income. Black Hills-Electric uses a tiered benefit structure whereas Public Service – Electric uses the same approach as described for the gas program.
- **The use of tiered benefits is consistent with best practice.** The review of best practices found that using a tiered benefit structure that provides greater benefits to those of lesser means and that is in place for Atmos, Black Hills, and CNG is a best practice.
- **Levelized billing calculation practices vary.** All the utilities provide levelized billing to customers enrolled in PIPP and enroll them as part of the PIPP. The approach to reconciling the payments made through the levelized billing plans with actual energy costs varied. Atmos Energy uses a rolling 11-month calculation to level monthly bill amounts. Black Hills Energy uses a 12 month estimate of the average bill, but will adjust the monthly bill if energy costs differ from billed costs by 10% or more. The other utilities use a 12-month average to fix the billing amount. Processes to reconcile billed amounts and actual energy costs also differed. Because Atmos takes a rolling approach to calculating bills, costs are reconciled once the account is closed. Black Hills Energy reconciles the bill after 12-months of enrollment and incorporates the difference between paid and actual costs into the next 12-month levelized billing period. Colorado Natural Gas and Public Service reconcile actual and paid costs after a year of enrollment. This latter approach may result in a customer bill for the difference between actual and billed costs.

I.1.6 Coordination with Energy Efficiency Programs

- **The number of homes receiving weatherization annually is considerably smaller than the number of PIPP participants.** During the triennial evaluation period, PIPP enrollments approximately 28,000 households each year. In comparison, the Weatherized Assistance Program provided services to an average of 2,100 homes each year at an average of cost

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of \$7,000 per home. To some extent this would be expected because weatherization is a one-time service whereas PIPP provides annual assistance. That said, the WAP director estimated that there are 500,000 homes in Colorado in need of weatherization services, suggesting that the need for weatherization is considerably larger than what the funding can support.

- **PIPP referral requirements to weatherization partially align with WAP prioritization of homes served.** A requirement of PIPP is that any household with annual consumption greater than 10,000 kWh or 600 therms is to be reported to the WAP for services. WAP prioritizes homes based on energy burden, which leads to a focus on homes with electric and propane heating (i.e., homes with high gas usage are lower priority). It was reported that the high-consumption lists provided by the utilities are not currently being used to prioritize homes for weatherization. Instead WAP uses the consolidated list provided by LEAP.
- **Recalled rates of receipt of information on WAP were relatively high among PIPP recipients.** Approximately two-thirds of PIPP recipients recalled receiving information on weatherization services, primarily from the LEAP program. Additionally, around 25% reported that they received weatherization services.
- **Approximately one-half of survey respondents were aware of utility energy efficiency programs.** Approximately 20% of respondents reported that they had participated in a utility efficiency program. The reported program participation included weatherization programs (which may include the state WAP) and free or discounted LED programs.

1.1.7 Program Impacts

Table 1-1 provides a high-level summary of the direction of program impacts. Although different models were used, the findings are consistent across the utilities for disconnects, disconnect notices, and annual usage.

- **The program resulted in decreased disconnects and disconnect notices across the programs, although some effects were not statistically significant.**
- **Annual energy usage increased for each of the programs.** Electricity usage, with the increase associated with PIPP, was below the average household electricity usage in Colorado. Natural gas usage, with increase associated with PIPP, was below average household consumption for one utility, roughly equal to average household consumption for another, and above average household consumption for the other two utilities.
- **The effect of the program on total amount billed was either negative or positive, depending on the utility.**
- **For the one program that an arrearage analysis could be performed on and for which the result was statistically significant, the program was associated with decreased arrearages.**

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Table 1-1 Summary of Program Impact Directions

Utility PIPP	Disconnects	Disconnect Notices	Arrearages	Total Billed	Annual Usage
Atmos	-	-	ns	-	+
Black Hills - Electric	-	-	-	+	+
Black Hills - Gas	ns	-	ns	-	ns
CNG	-	-	n/a	-	+
Public Service - Electric	ns	-	n/a	+	+
Public Service - Gas	ns	ns	n/a	+	+

- PIPP associated with a decrease in the outcome

+ PIPP associated with an increase in the outcome

ns PIPP was not associated with a statistically significant effect for the outcome

n/a Data limitations prevented the analysis

I.1.8 Program Costs and Benefits

- **A reasonable share of program funding is provided as benefits to customers.** Colorado Natural Gas, Black Hills-Electric, Black Hills-Gas, and Public Service spent between 2% and 8% on administrative costs during PY2018/19. Atmos spent 13% on administration and the administration costs as a percent of the benefit costs for the same year equaled 15%, which is inconsistent with the regulations.

In general, programs with larger enrollments spend a larger share of funding on benefit costs, as is to be expected given that there are certain fixed costs associated with the administration of the programs.

- **Monetized utility benefits were modest.** The total value of utility benefits resulting from reductions in arrearages, disconnections, and disconnect notices was \$23,980. This value is likely an underestimate due to data limitations that limited the estimation of program impacts for Public Service, in particular.
- **Monetized participant benefits were significant.** ADM monetized the benefits of improved comfort, reduced stress, and health for program participants. The estimated value of these benefits was \$5,169,322, or equal to 48% of the amount paid for participant benefits (i.e., bill credits and arrearage forgiveness).

I.1.9 Covid-19 Impacts

- **The economic impacts of Covid-19 will likely increase demand for energy assistance.** Stakeholders noted that at the time of the interviews, a moratorium for disconnections was in place, but that there will likely be greater energy insecurity once the moratorium is lifted. LEAP staff indicated they have observed an approximately 5% increase in applications since the onset of Covid-19. Approximately one-third of survey respondents reported work impacts from Covid-19 including job loss or reduced pay.

I.2 Recommendations

ADM offers the following recommendations.

I.2.1 Participation Qualifications

- **ADM recommends maintaining the current income requirements for PIPP.** Analysis of census data and review of other program practices support keeping the income requirement at 185% of federal poverty level.
- **Modify the heating fuel requirements for PIPP qualification.** Currently customers with electric heating do not qualify for a natural gas cost cap. ADM recommends capping natural gas costs for these customers to prevent total fuel costs increasing much past 6% of income.

I.2.2 Awareness

- **Use consistent program naming to facilitate increased awareness of the PIPP benefit.** A best practice in providing these types of programs is to use consistent naming across utilities. This helps promote recognition and would facilitate state-wide awareness efforts of the benefit. Colorado Energy Assistance Program is one suggestion for a common name.
- **Incorporate PIPP benefits into LEAP program marketing materials.** Providing information that there is an additional benefit to receiving LEAP in the form of the PIPP credits may help improve increase interest in applying for LEAP and generally improve awareness of the PIPP. Materials should note that PIPP is only available to customers of the investor owned utilities.

I.2.3 Funding

- **Consider increasing the funding limit to serve more qualifying PIPP customers.** The coming year will likely see increased demand for PIPP as a result of Covid-19 and currently the Black Hills Electric program is oversubscribed. ADM estimated that serving all of the waitlisted Black Hills customers would require increasing the \$0.31 per month charge to \$0.54 per month. Increasing charges to nonresidential customers may be another means to increase funding. ADM recognizes that a decision to increase PIPP funding requires balancing multiple stakeholder priorities.
- **Explore the use of federal health funding to support weatherization improvements.** The American Council for an Energy-Efficient Economy (ACEEE) has identified multiple federal funding sources that could be used to support home energy efficiency improvements that are summarized in Section 4.1.2.2.

I.2.4 Retention

- **Explore opportunities for re-enrollment of customers to boost retention rates.** The re-enrollment rates were low for some utilities. Although means tested programs tend to use annual recertification of qualifications, enrolling participants for multiple years would

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increase retention and increase overall enrollments. One tactic to consider is to automatically re-enroll customers in PIPP who did not submit a LEAP application for one additional year. It should be noted that the impact on enrollments would likely result in additional funding needs.

- **Allow for individuals to opt-out of levelized budget billing component.** The benefit of the levelized billing is that it allows for more predictable monthly energy costs. Survey and participant interview responses that some customers do perceive this as a benefit. However, despite these potential benefits, there may be some negative impacts of it. Utility staff reported that some customers dislike the levelized budget billing component and some interviewed participants echoed this sentiment. Additionally, some research indicates that levelized budget billing plans increase overall consumption of energy. For these reasons, we recommend auto-enrolling customers in the levelized budget billing component and communicating to customers the benefits of levelized budget billing and that they may opt-out of this component of the PIPP.

I.2.5 Reporting

- **Clarify definitions of metrics in annual reports submitted.** ADM found differences in the enrollment statistics reported across the utilities in the Annual report for Low Income Program for Colorado Utilities per 3412(I) and 4412(I). For example, CNG applicants enrolled and participating (line 16) equaled the sum of the monthly enrollments reported in line 22 and appear to be new enrollments for each month. In contrast, the other utilities appeared to report current enrollments for the month.
- **Consider modifying annual reporting to include benefits and participation by primary heating fuel type for electric program participants.** Currently the annual reports present information by utility fuel type but do not contain information on participation and benefits by primary heating fuel type. Including this information will provide additional clarity on who is participating and the level of benefit they are receiving.
- **Consider removing the requirement that utilities report homes with high gas or electricity usage to the Weatherization Assistance Programs.** WAP is not currently using these separate utility lists to prioritize homes, but instead uses consolidated data provided by LEAP. Additionally, WAP prioritizes homes based on energy costs rather than usage, which makes homes heated by lower cost natural gas relatively lower priority compared to homes heated by electricity or propane.

I.2.6 Implementation

- **Develop a consistent means of amortizing differences between amounts paid through levelized budget billing and total energy costs.** Not all the utilities' levelized budget billing plans amortize the difference between paid energy costs and the total cost of energy used during the levelized period. ADM recommends either using a rolling calculation to smooth out monthly costs or amortizing the difference between fixed paid

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amounts and owed costs to prevent customers receiving a potentially large additional charge to reconcile payments and costs.

- **Consider adding enrollment in a behavioral program as a component of receiving PIPP benefits.** A behavioral program may help to provide customers with information and tips to reduce their energy costs. The evaluation found that enrollment in PIPP is associated with increased consumption of energy relative to the control group that did not receive PIPP during period impacts were assessed. The increased consumption may be the result of reduced costs to the customer for energy used, as well as increased ambiguity in the relationship between energy-use behaviors and energy use costs resulting from the bill credits and levelized budget billing. Home energy report type programs can provide information to customers to help them understand how they can impact their energy use.

I.2.7 Future Evaluations

ADM recommends the following for future evaluations of PIPP.

- **Provide greater clarity in data requested for the impact analysis.** Differences in data provided by the utilities suggest that the data request provided by ADM could have been improved in terms of clarity. Specifically, we suggest that future data requests define specific table structures and definitions of variables requested. While utility data systems may not align to provide the exact type and format of data requested, this approach will improve communication about desired data and identify specific challenges in providing the data needed for the evaluation. It would also be of value if the request could be developed in advance of the onset of evaluation activities to allow for utilities to configure reporting systems and allow for the provision of timely data.
- **Consider performing a low-income energy needs assessment as a significant component of the next evaluation.** Completing a needs assessment through the surveying of the low-income population could provide additional information on barriers to participation in LEAP and PIPP. A survey that targeted the general population of low-income customers could provide additional insight that could not be obtained through a survey of customers who had been enrolled in PIPP at one point, as was done for this evaluation. For example, barriers such as lack of awareness, interest in, or logistical constraints may prevent some Coloradans from seeking or receiving LEAP or PIPP assistance. A needs assessment could also provide an understanding of the energy insecurity that a broader range of customers experience.

2 Introduction

Under contract with the Colorado Energy Office (CEO), ADM Associates, Inc. (ADM) evaluated the Percentage of Income Payment Plans (PIPP) administered by Black Hills Colorado Electric and Gas, Public Service Company of Colorado Electric and Gas, Colorado Natural Gas, and Atmos Energy Corporation (collectively referred to as “the Utilities”).

The period of program operations covered by the evaluation is the triennial period beginning November 1st, 2016 and ending October 31st, 2019.

2.1 Program Description

Rule 3412 of the Commission’s Rules Regulating Electric Utilities, 4 Code of Colorado Regulations (CCR) 723-3 (Electric Rules), and Rule 4412 of the Commission’s Rules Regulating Gas Utilities and Pipeline Operators, 4 CCR 723-4 (Gas Rules) outlines the requirements for the PIPPs. Under 4 CCR 723-3-3412(e) and 4 CCR 723-4-4412(e), electric and gas utilities are required to offer payment plans such that the cost of gas and electricity does not exceed an affordable percentage of participants income.

Table 2-1 summarizes the applicable percentages that define affordable electricity and natural gas service under the rules.

Table 2-1 Percentage of Income Payments

Utility Service	Heating Type	Percentage of Income	Cap for Minimum Monthly Charge Allowed for Participants with Household Income of \$0
Electricity	Electric	3-6% of household income	\$20
Electricity	Non-electric	2-3% of household income	\$10
Natural Gas	Natural Gas	2-3% of household income	\$10

The rules require each utility to:

- Enroll participants in its levelized budget billing program; and
- Apply credits to pre-existing arrearages such that when combined with participant copayment, the arrearages are reduced to \$0.00 within 24 months;
- Apply Low-income Energy Assistance Program (LEAP) grants to the dollar value of the credits granted to program participants and to apply any amount of assistance greater than the annual bill to arrearages or as a benefit to the participant; and
- Provide information on existing energy efficiency programs offered by the utility and other entities, and existing weatherization programs offered by the state.

Participation in the program is limited to those with a household income at or below 185% of the current federal poverty level.

2.2 Organization of the Report

The evaluation report is organized into the following chapters:

- Chapter 3 discusses the methods used in the evaluation.
- Chapter 4 discusses the Colorado PIPP, compares the programs operated by the utilities, and provides findings from a review of the literature and program best practices.
- Chapter 5 summarizes findings from utility and stakeholder interviews on their perspectives of the PIPP and the state's efforts to meet the energy needs of low-income residents.
- Chapter 6 presents findings from the surveys of participating customers and nonparticipating customers, as well as the in-depth interviews with a sample of participants.
- Chapter 7 presents the findings of program impacts on energy consumption, arrearages, disconnect notices, and disconnect rates.
- Chapter 8 presents the results of the analysis of program costs and benefits.
- Chapters 9 - 15 contain the report appendices that present data collection instruments and other supporting information used in the evaluation.

3 Methodology

The evaluation of the PIPP was based on collection and analysis of primary and secondary data. Table 3-1 summarizes the primary data collection completed for the evaluation. Additional details on these data collection efforts as well as the other research and analysis activities are summarized in subsections 3.1 through 3.6

Table 3-1 Summary of Primary Data Collection

Activity	Sample Size	Time Frame	Research Goals
Participant Interviews	22	July – August 2020	Gain insights into customer satisfaction, feedback, and perspectives. Acquire demographic data.
Participant Survey	392	July – August 2020	
Non-participant Survey	207	July – August 2020	
Colorado Energy Office Interview	2	June 2020	Solicit feedback and gain an understanding of program history, stakeholder engagement, and low-income customer needs.
Utility Interviews		June 2020	Solicit feedback and gain an understanding of program history, program processes, perspectives on the states effort to meeting energy needs, and lessons learned.
Atmos Energy	1		
Black Hills Colorado Electric and Gas	1		
Colorado Natural Gas	1		
Public Service Company of Colorado Electric and Gas	1		
Partner Organization Interviews		June 2020	Understand efforts to coordinate various low-income programs, program oversight, perspectives on the effectiveness of PIPP and the state's ability to meet low income customer energy needs.
Low Income Energy Assistance Program (LEAP)	1		
Weatherization Assistance Program (WAP)	1		
Energy Outreach Colorado (EOC)	1		
Office of Consumer Counsel (OCC)	1		
Public Utilities Commission (PUC)	1		

3.1 Review of Other Low-income Programs and Best Practice Review

ADM performed a benchmark review of PIPP programs in other states and best practices and provide utility specific recommendations for program improvements. ADM performed an internet search of applicable reports and program websites for this activity. The works reviewed are cited in the bibliography in Appendix B in Chapter 10.

3.2 Utility and Stakeholder Interviews

ADM completed interviews with utility staff for each of the four participating utilities. The utility interviews addressed the following topics:

- The historical context of the PIPP programs, prior to the beginning of the 2016-19 Triennial and subsequently;
- Processes for identifying and recruiting customers into the PIPP programs;
- Processes for qualifying customers for the program and maintaining certification of the qualifying status;
- Data management and tracking issues;
- Other programs directed towards low income customers and efforts to connect PIPP participants to these other programs;
- Issues or challenges that staff face in delivering the PIPP program; and
- Planned or desired changes in program administration in the future.

ADM completed stakeholder interviews with a staff person at:

- Energy Outreach Colorado;
- Colorado Low Income Energy Assistance Program (LEAP);
- State Weatherization Assistance Program (WAP);
- Public Utilities Commission; and
- Colorado Office of Consumer Counsel.

ADM spoke with each utility program staff to better understand their role and responsibility for the PIPPs (see Table 3-2).

Table 3-2 Utility Program Staff Roles and Responsibilities

Utility	Title of Interviewed Staff	Role
Public Service	Energy Assistance Programs Supervisor	Create and implement programs. Ensure the disbursement of funds are correct.
Black Hills Energy	Regulatory and Finance Analyst	Works with low income programs.
Atmos Energy	Customer Advocate (consultant) Manager of Customer Advocacy Energy Efficient Specialist	Managing the advocacy department; manage customer donor program; and work with LEAP to assist working poor households.
Colorado Natural Gas	Regulatory Affairs Specialist	Manages the PIPP program and payment distribution; runs calculations and data tracking.

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In general, the purpose of these interviews was to understand stakeholder perspectives on program goals, customer needs, program performance in meeting customer needs, and other feedback that they have on the program delivery and process.

Additionally, the interviews with WAP and LEAP staff covered specific aspects where coordination is required between parties, for example, coordination between LEAP and PIPP in providing data on enrollees (e.g., primary heating fuel type).

Each of the interviews lasted approximately one hour.

3.3 Qualified Households and Demographic Characteristics

This section outlines the methodology and data sources used to develop estimates of the Colorado population of customers eligible for PIPP.

3.3.1 Data Sources

Multiple data sources used in this analysis are summarized below in Table 3-3.

Table 3-3 Data Sources used in Population Estimates

Data Source	Data Used
U.S. Census Bureau 2018 American Community Survey (ACS) Five Year Estimates Public Use Microdata Sample (PUMS).	The PUMS data are records of individual survey respondents used to develop population estimates of utility customers including counts of customers and housing and demographic characteristics.
Data on utility service territory provided by the utilities	Data on zip codes served for use in segmenting the PUMS data by utility service territory. Black Hills Energy provided shape files, from which ADM extracted zip codes served. Public Service data did not distinguish between gas and electric service areas. ADM referenced an information sheet on communities served on the Public Service website to segment the zip codes into gas and electric service areas.
U.S. Electric Energy Information Administration Electric Sales, Revenue, and Average Price Data. U.S. Electric Energy Information Administration Natural Gas Annual Respondent Query System	2018 data on residential electricity and natural gas customer counts.
Missouri Census Data Center Geocorr 2018: Geographic Correspondence Engine	Used to map ACS Public Use Microdata Areas (PUMAs) to zip codes.

3.3.2 Analysis Steps

The following summarizes the series of steps taken to develop the population estimates.

- **Recode ACS data to develop variables of interest.** An initial step of the analysis was to code the ACS data to develop variables of interest. ADM used ACS data on household size, income, and other relevant variables to develop a series of variables for the analysis. For example, ADM used data on heating type, income, and utility cost to develop flags indicating if the customer qualified for the natural gas and the electricity PIPP programs. The following conditions were applied to code households as qualified for PIPP:
 - *Electric PIPP Qualified:* Households with 1) an electricity bill, 2) an income at 185% of federal poverty or less, 3) with an electricity bill greater than 6% of their income if they had electric heat, or a utility bill greater than 3% of their income if they heated using a different fuel.
 - *Gas PIPP Qualified:* Households with 1) a utility gas bill, 2) an income at 185% of federal poverty or less, 3) a natural gas bill greater than 3% of their income.
- **Summarize ACS data at the PUMA-level.** In this step ADM summarized the individual survey responses to develop PUMA-level estimates of the variables of interest. The summary was developed by applying the population weight included in the data set and involved summarizing household characteristics based on the individual responses to get totals for the PUMA.
- **Map the ACS PUMA data to zip codes.** The census bureau performs sampling and data collection using a geography known as a Public Use Microdata Areas (PUMAs). ADM used the Missouri Census Data Center's correspondence engine to map the PUMAs to the zip code tabulation areas (ZCTAs).
- **Summarize data at the ZCTA level.** There is a "many-to-many" relationship between PUMAs and ZCTAs such that more than one ZCTA can map to a PUMA and a single ZCTA can map to more than one PUMA. The correspondence engine provides an allocation factor that functions as a weighting variable in the data set. The allocation factor represents a proportion of the source area (PUMA in this case) to the target area (ZCTA in this case). ADM summarized the PUMA data by applying the allocation factor as a weight to develop the ZCTA-level summaries.
- **Map the ZCTAs to the utility service area zip codes.** The next step of the analysis was to map the ZCTAs to the utility service area zip codes. This was accomplished by referencing the zip codes provided by the utilities. Summary statistics were then calculated by referencing the zip codes served by each of the utilities.

The process described above used data collected for the PUMA geographies to develop estimates that correspond to a different geography, that of the utility service territory. An issue with this process is that utility service areas do not conform to ZCTA boundaries. That is, a utility may serve an entire zip code or a small portion of it, and multiple utilities may provide service to the same zip code. As such, the estimates based on zip codes served, or any other geography for that

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matter, contain some degree of error resulting from this imperfect correspondence between the geographies of interest.

To improve the estimates of counts of customers, we used data reported to the U.S. Electric Energy Information Administration (EIA) to “true-up” the estimates developed using the ACS data. Specifically, we developed an adjustment factor using the EIA data on customers served in relation to the estimated number of customers based on the ACS data. The ACS estimate of customers served was developed by summing the ACS count of households that received either electricity or natural gas service, as applicable, for a zip code that was served by a given utility. The adjustment factor was equal to:

$$\text{Adjustment Factor} = \text{EIA reported customer count} / \text{ACS household count}$$

It should be noted this method assumes that inaccuracies of estimates resulting from the process of mapping ACS survey data to utility customers by using zip codes are unrelated to the characteristics of the ACS survey respondents. This may be a limitation affecting the estimates of customer counts but it is not possible to assess the degree of impact on the estimates.

The utility estimates and adjustment factors are summarized in Table 3-4. In general, the number of households served by the utility using ACS data were higher than the counts reported to the EIA. This is likely because the ACS estimates were based on counting all households in a zip code served by the utility as a utility customer, when in fact, utilities provide service to a subset of residents in some zip codes. The exception is for Public Service gas. It may be the case that the zip codes served by the utility provided did not include all zip codes.

Table 3-4 Summary of Adjustment Factors

Utility	ACS Estimate of Households Served by the Utility	EIA Count of Residential Customers	Adjustment Factor
Atmos	109,359	108,634	0.993
Black Hills Electric	110,980	84,990	0.766
Black Hills Gas	251,724	165,953	0.659
CNG	123,670	21,013	0.170
Public Service Electric	1,533,894	1,262,866	0.823
Public Service Gas	830,060	1,293,327	1.558

3.4 Participant and Non-Participant Surveys and Interviews

3.4.1 Participant and Non-Participant Surveys

ADM completed surveys of PIPP participants and those participants who had opted-out or discontinued their enrollment (referred to as non-participants) to assess overall program performance, customer satisfaction, health impacts, program experiences, and customer

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perceptions of affordability, program impacts, and barriers to participation. The topics covered by the survey were as follows:

- How participants became aware of the PIPP;
- The enrollment process;
- Perceived affordability of utilities with and without the PIPP;
- Health and other impacts resulting from reduced utility costs;
- Knowledge of efficiency programs and if they received information about these programs when they enrolled in PIPP;
- Home characteristics including primary heating fuel type;
- Impacts of Covid-19 on employment; and
- Demographics including income and household size.

Appendix B: Participant and Nonparticipant Survey Instrument contains a copy of the survey instrument.

ADM used records provided by each of the utilities to develop lists of customers who were enrolled in PIPP. The participant customers were identified as those enrolled in the most recent year of the triennial period (PY2018/19).

In addition, we surveyed non-participants to compare-and-contrast their demographics, energy burden, and perceptions of affordability. Table 3-5 discusses four different approaches to defining who is a non-participant and the strength and weaknesses of the approach.

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Table 3-5 Strength and Weaknesses of Different Approaches to Defining Non-participants

Non-participant Definition	Strength	Weakness
Opt-outs	The sample frame can be defined from utility lists and contact information. May be able to provide insight into barriers to participation because they withdrew.	Cannot provide information on level of program awareness amongst qualifying population. Not all utilities maintain lists or have many explicit opt-outs.
Discontinued enrollment	The sample frame can be defined from utility lists and contact information. May be able to provide insight into barriers to participation because they stopped participating.	Cannot provide information on level of program awareness amongst qualifying population. Not all utilities maintain lists or have many explicit opt-outs.
Waitlists	The sample frame defined from utility lists and contact information.	Cannot provide information on level of program awareness amongst qualifying population. Only one utility has a wait list (Black Hills electric)
Residents of low-income geographies	Can inform an understanding of levels of program awareness among qualifying customers.	May be prohibitively costly if 1) email addresses are not available for significant shares of customers, and 2) customers are screened out at a high rate for not qualifying for a PIPP through the administration of the survey.

In consultation with CEO and PUC Staff, ADM defined non-participating utility customers as opt-outs but also included customers who discontinued their enrollment. Customers who discontinued their enrollment were added because opt-outs were not tracked or identified in the datasets provided or because there were few of them. Discontinued enrollments were identified as customers who were enrolled in PY2016/17 or PY2017/18, but who were not enrolled in PY2018/19, in addition to those that formally opted-out. Further, customers that were identified as not continuing their participation were also asked to confirm that they voluntarily did not enroll in PIPP using the following survey question:

Based on our records you were not enrolled in [UTILITY]'s [PROGRAM_NAME] Program in 2019. Why were you not enrolled in 2019?

1. I was not qualified for the [PROGRAM_NAME] Program
2. I was not qualified for LEAP
3. I did not want to be enrolled in [PROGRAM_NAME] Program
4. I did not want to be enrolled in LEAP
5. I thought I was enrolled in [PROGRAM_NAME] Program

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6. For some other reason (Please explain)

Customers who responded by answering 1 or 2 were disqualified from the survey.

3.4.1.1 Survey Administration Procedures

Customers were contacted by email or telephone to complete the survey. The contact procedures were as follows:

- Email contacts: For customers with email addresses available, one initial email was sent to the customer, followed by two reminder emails.
- Telephone contacts: Up to five calls were placed with each of the customers.

Customers were offered a \$10 visa gift card for completing the survey. Because an incentive was provided for completing the survey, quotas were set for each customer group. For single-fuel utilities, the quotas were 70 participant and 70 nonparticipant surveys. For dual-fuel utilities, the quotas were 140 participant and 140 nonparticipant surveys. The quotas for dual-fuel utilities were set in proportion to the number of contacts available for each of the types of benefits received (i.e., gas-only, electric-only, and gas and electric).

Table 3-6 summarizes the population and survey responses. In total, 392 of participant surveys were completed and 207 of nonparticipant (Opt-out or non-re-enrollment) were completed.

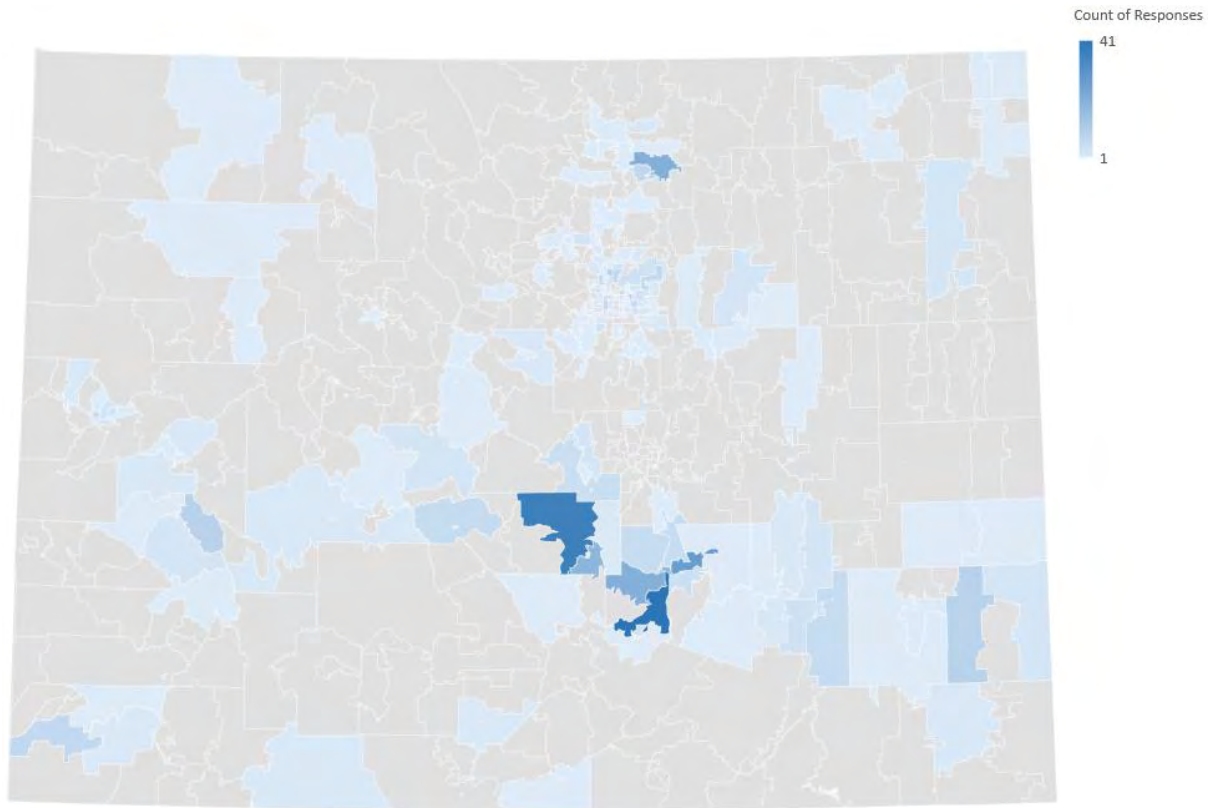
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Table 3-6 Summary of Survey Populations and Response

Utility	PIPP Participant Fuel Type	Group	Number of Customer Contacts	Survey Responses	Percent of Contacts
Atmos Energy	Natural Gas	2019 Participant	753	71	9%
		Non-participant	1,067	56	5%
Colorado Natural Gas	Natural Gas	2019 Participant	195	30	15%
		Non-participant	72	4	6%
Public Service	Natural Gas	2019 Participant	1,213	30	2%
		Non-participant	833	49	6%
	Electricity	2019 Participant	332	10	3%
		Non-participant	41	3	7%
	Natural Gas and Electricity	2019 Participant	7,298	103	1%
		Non-participant	414	27	7%
Black Hills	Natural Gas	2019 Participant	133	13	10%
		Non-participant	266	30	11%
	Electricity	2019 Participant	1,031	132	13%
		Non-participant	403	37	9%
	Natural Gas and Electricity	2019 Participant	20	3	15%
		Non-participant	8	1	13%
Total		2019 Participant	10,975	392	4%
		Non-participant	3,104	207	7%

Figure 3-1 displays the geographic distribution of survey responses. The figure shows responses tabulated by zip code. Zip codes for respondents were provided by Atmos Energy and CNG. For Black Hills Energy and Public Service, ADM geocoded respondents addresses that did not include zip codes. Ninety-one percent of the respondent addresses were successfully geocoded to identify the zip code.

Figure 3-1 Geographic Distribution of Responses



3.4.2 Participant Interviews

ADM completed 22 interviews with participants and those who opted-out or discontinued their enrollment (referred to as non-participants) and we offered a \$50 incentive to complete the interview. These interviews provided an opportunity to collect additional in-depth qualitative information on customer experiences with the PIPP programs and the impact its availability has had on them. The interviews were an alternative data collection approach to the focus groups that were initially planned. In-person focus groups were not viable given the concerns over maintaining social distance to prevent the spread of Covid-19.

We recruited a list of customers willing to participate in the interviews through the survey of participants and nonparticipants. We selected customers to complete the interviews and contacted them by telephone. To select customers, we used targeted random selection so that we obtained a planned number of responses for the utilities and to ensure that we had representation across PIPP fuel types, but that the customers invited for the interviews were selected at random within the targeted groups.

The interviews were designed to be completed in 15 to 20 minutes and they covered the following topics:

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- Awareness and perception of PIPP;
- Comprehension of the benefit received;
- Barriers to participation;
- Perceptions of utility costs;
- Impact on household health and safety; and
- Energy-related needs and bill affordability needs.

Appendix D: Participant Interview Guide contains a copy of the interview guide.

Table 3-7 provides details on the number of interviews completed. In total we completed the following number of interviews for each of the utilities:

- Atmos Energy: 4
- Colorado Natural Gas: 3
- Public Service: 11
- Black Hills: 4

Table 3-7 Summary of Interviews Completed

Utility	PIPP Participant Fuel Type	Group	Number of Interviews Completed
Atmos Energy	Natural Gas	Participant	2
		Nonparticipant	2
Colorado Natural Gas	Natural Gas	Participant	2
		Nonparticipant	1
Public Service	Natural Gas	Participant	1
		Nonparticipant	1
	Electricity	Participant	0
		Nonparticipant	1
	Natural Gas and Electricity	Participant	8
		Nonparticipant	0
Black Hills	Natural Gas	Participant	0
		Nonparticipant	1
	Electricity	Participant	2
		Nonparticipant	1
	Natural Gas and Electricity	Participant	0
		Nonparticipant	0
Total			22

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3.5 Program Impacts

3.5.1 Data Collection

ADM requested PIPP participant and additional customer data for the use in developing a comparison group for the period from Nov 1, 2015 through Apr 15, 2020. Appendix G: Utility Data Request Memo provides a copy of the data request. Participants were defined as those customers who received PIPP program services from Nov 1, 2016 through October 31st, 2019 (i.e. the triennial period).

Table 3-8 Data Requested

Participant and Non-Participant Data	Data Fields
Billing and Cost Data	Premise ID, Customer ID, name, address, zip code, energy usage (kWh or therms), usage duration, date range, billed amounts (\$), customer payment amount, customer payment date, past due amount, PIPP payment amount.
PIPP Enrollment Data	Premise ID, Customer ID, name, address, PIPP enrollment status, PIPP enrollment start date, PIPP enrollment end date, program year, income, and other demographic information provided at enrollment.
Disconnect and Arrearage Data	Premise ID, Customer ID, disconnect notice, disconnect, date of disconnect/disconnect notice, amount owed on date of disconnect (arrears).
Customer Demographic/Home Characteristic Data	Premise ID, Customer ID, name, address, telephone number, and email address. As available, other heating and cooling type, housing type, etc...
Other Program Enrollment Data	Premise ID, Customer ID, name, address, LEAP status, other energy assistance program status, other energy efficiency program status, etc...

In addition, the evaluation team acquired:

- Monthly Heating degree days (HDD) and Cooling degree days (CDD) from [NOAA.gov](https://noaa.gov) for use in the regression analysis. Data was collected from weather stations in Colorado and assigned to each customer based on customer zip code and proximity to the nearest weather station with complete data from Jan 1, 2016 through June 1, 2020. Monthly HDDs are calculated as the sum of daily average temperature values under 63°F in a given month, while monthly CDDs are calculated as the sum of daily average temperature values over 70°F in a given month. The setpoint values for HDDs and CDDs were determined by running regressions with multiple setpoints from 60°F-80°F and choosing the setpoint combination with the highest adjusted R-squared value (i.e. best fit).
- Typical Meteorological Year (TMY) data³. TMY data from 13 weather stations across all four Colorado weather zones were obtained and average annual HDD/CDD values were

³ https://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/by_state_and_city.html

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calculated for each weather zone. Annual HDD and CDD values were calculated for Colorado overall by weighting HDD/CDD TMY values by the Colorado population represented in each weather zone.

3.5.2 Cohort Creation

ADM ran ordinary least-squares (OLS) regressions with a matched comparison group to model various outcomes before and after program participation.

Depending on the data available, ADM used either a propensity score-matched comparison group or a variance in adoption model to estimate program impacts.

3.5.2.1 Propensity Score-Matched Comparison Group

ADM used a propensity score matching approach to develop the comparison group for the Atmos Energy and Public Service programs. Using this approach, a propensity score is estimated for treatment customers (i.e. those who received program services) and a group of customers who did not receive program services using a logit model. Comparison group customers were selected from other low-income program enrollment lists or from geographic centers with high poverty rates per census data. Program drop-outs and waitlisted customers were also eligible for inclusion in the comparison group, but this data was not available for any of the utilities. In addition, comparison group customers were restricted to those receiving LEAP so that the effect of PIPP could be isolated.

Customers in the treatment and control groups were matched based on seasonal pre-period usage (e.g. summer, spring, fall, and winter) and 3-digit Zip Code. Other demographic characteristics, such as income level, housing type, and heating and cooling type were not available.

3.5.2.2 Variance in Adoption

It was not possible to develop a propensity matched comparison group for the analysis of the CNG and Black Hills programs. As an alternative, ADM estimated outcomes with a treatment only variance-in-adoption model. With variance-in-adoption, PIPP customers that have yet to participate in the PIPP program serve as controls for customers that have already enrolled. New PIPP customers are enrolled every program year, and while enrollment was concentrated at the start of the LIHEAP program year from October through December, PIPP participants could be enrolled at any time. Thus, variation in program enrollment comes from two sources, 1) new customer enrollment across PIPP program years, and 2) new customer enrollments within a given program year. In addition, treatment customers were restricted to those receiving LEAP in the pre-period so that the effect of PIPP could be isolated.

3.5.2.3 Comparison of Propensity Score and Variance in Adoption Approaches

The propensity score model approach compares the assessed outcomes for the PIPP participants to a group of customers that have similar energy consumption during the period before PIPP

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participants were enrolled in PIPP and who live in a similar region. The strengths of this approach are that:

- The periods of time in the treatment and comparison group are the same, and as such broader economic changes or other factors would have equal influence on both groups and not bias the results.
- The treatment and comparison groups are well matched on the known characteristics (energy use and geographic location) and help to account for differences between groups in terms of consumption and billing costs.

A weakness of propensity score-matched comparison group approach is that:

- Matching on economic criteria was not possible and as such there may be differences in the income and affordability of utility costs between the control and treatment group.

The variance in adoption approach compares PIPP recipients to those that received PIPP at a later point of time during the period of observation. The strengths of the variance in adoption approach are that:

- The economic conditions of the treatment and comparison group households are likely similar. The economic conditions during the period of observation (i.e., 2016 – 2019) were relatively stable and consequently, the comparison group of customers that received PIPP at a later date were likely similar during the period when they were used as a comparison group.

The weaknesses of the approach are that:

- There may be differences between those who ultimately enroll in PIPP and those who did not enroll during the period that are not observable in the data and are related to the impacts assessed.
- The periods of time are not directly comparable and there may be changes in the broader conditions that influenced the outcomes of interest (e.g., economic conditions generally improved during the period of observation).

3.5.3 Modeled Outcomes

ADM estimated five principal outcomes for each utility using OLS regressions: disconnects/year, disconnect notices/year, arrears (past due), total billed (\$), and energy usage (therms/kWh). ADM normalized each of the outcome variables into daily or annual values for each period for each customer by dividing the outcome of interest by the billing duration. Normalization is necessary because each customer has varying bill durations and different lengths for the pre- and post-periods.

For disconnects, period t represents the pre- and post-period, and the number of disconnects per year for customer i in period t is,

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$$Disconnects/Year_{it} = \left(\frac{\sum Disconnect\ Dummy_{it}}{\sum Bill\ Duration_{it}} \right) \times \frac{365.25\ Days}{Year}$$

For disconnect notices, period t represents the pre- and post-period, and the number of disconnect notices per year for customer i in period t is,

$$Disconnect\ Notices/Year_{it} = \left(\frac{\sum Disconnect\ Notice\ Dummy_{it}}{\sum Bill\ Duration_{it}} \right) \times \frac{365.25\ Days}{Year}$$

In the case of disconnects, ADM determined that most utilities did not perform disconnects for enrolled PIPP customers, and the modeling approach was chosen with this in mind. Modeling disconnects using a logistic framework results in odds ratios approaching zero (since zero disconnects occur in the post period) and the reduction in the number of disconnects relative to the baseline is less easily interpreted. With the outcome modeled in terms of the number of disconnects per year, the reduction in the number of disconnects due to the program intervention is more easily interpreted.

For arrearages, period t represents the duration of the invoiced bill, and arrears are calculated for customer i in period t as,

$$Arrears/Day_{it} = \left(\frac{\sum Past\ Due_{it}}{\sum Bill\ Duration_{it}} \right)$$

For total billed, period t represents the duration of the invoiced bill, and total billed calculated for customer i in period t as,

$$Total\ Billed/Day_{it} = \left(\frac{\sum Total\ Billed_{it}}{\sum Bill\ Duration_{it}} \right)$$

For usage (kWh or therms), period t represents the duration of the invoiced bill, and total usage calculated for customer i in period t as,

$$Usage\ (kWh\ or\ Therms)/Day_{it} = \left(\frac{\sum Usage_{it}}{\sum Bill\ Duration_{it}} \right)$$

ADM sought to estimate energy burden for PIPP participants by modeling energy costs and calculating energy costs as a percentage of annual income. However, issues in data collection and reporting hampered this effort. For instance, income was often not reported for PIPP customers, and when it was provided, energy costs reflected a rolling balance of what a customer owed (i.e. leveled budget billing) instead of the charged amount for a given billed invoice. However, one utility (Atmos) provided their own estimate of annual energy costs as well as annual income for PIPP participants and led to an estimate of energy burden for those customers.

3.5.4 Regression Specifications

The model specifications for each outcome are shown below. This specification assumes a control and treatment cohort is used; however, in the absence of a comparison group (e.g. variance-in-adoption) any terms associated with the treatment term (and the treatment term itself) will drop out. A fixed-effects linear model (FELM) was utilized for the majority of outcomes. FELM controls for customer-specific differences by creating a dummy variable for each customer. Disconnects and disconnect notices were modeled using OLS since the outcome was summed for the pre- and post-periods (due to the rarity of disconnects) and the addition of dummy variables for each customer would result in overfitting.

$$\begin{aligned} \text{Disconnects (or Disconnect Notices)/Year}_{it} \\ = \alpha_0 + \beta_1 \text{Post}_{it} + \beta_2 \text{Treatment}_{it} + \beta_3 \text{Post}_{it} * \text{Treatment}_{it} \end{aligned}$$

$$\begin{aligned} \text{Arrears (\$)}_{it} = \alpha_0 + \beta_1 \text{Post}_{it} + \beta_2 \text{Treatment}_{it} + \beta_3 \text{Post}_{it} * \text{Treatment}_{it} + \beta_4 \text{Month}_{it} \\ + \beta_5 \text{Customer}_i + \beta_6 \text{Post}_{it} * \text{Month}_{it} \end{aligned}$$

$$\begin{aligned} \text{Total Billed (\$)}_{it} \\ = \alpha_0 + \beta_1 \text{Post}_{it} + \beta_2 \text{Treatment}_{it} + \beta_3 \text{Post}_{it} * \text{Treatment}_{it} + \beta_4 \text{Month}_{it} \\ + \beta_5 \text{Customer}_i + \beta_6 \text{Post}_{it} * \text{Month}_{it} \end{aligned}$$

$$\begin{aligned} \text{Usage (kWh)/Day}_{it} \\ = \alpha_0 + \beta_1 \text{Post}_{it} + \beta_2 \text{Treatment}_{it} + \beta_3 \text{Post}_{it} * \text{Treatment}_{it} + \beta_4 \text{Month}_{it} \\ + \beta_5 \text{Customer}_i + \beta_6 \text{HDD}_{it} + \beta_7 \text{Post}_{it} * \text{Treatment}_{it} * \text{HDD}_{it} + \beta_8 \text{CDD}_{it} \\ + \beta_9 \text{Post}_{it} * \text{Treatment}_{it} * \text{CDD}_{it} \end{aligned}$$

$$\begin{aligned} \text{Usage (Therms)/Day}_{it} \\ = \alpha_0 + \beta_1 \text{Post}_{it} + \beta_2 \text{Treatment}_{it} + \beta_3 \text{Post}_{it} * \text{Treatment}_{it} + \beta_4 \text{Month}_{it} \\ + \beta_5 \text{Customer}_i + \beta_6 \text{HDD}_{it} + \beta_7 \text{Post}_{it} * \text{Treatment}_{it} * \text{HDD}_{it} \end{aligned}$$

Terms used in the models above are described below. Outcomes of interest were defined in Section 3.5.3.

α_0 is the intercept term;

β_k is a vector of coefficients. The primary coefficients of interest are those associated with Post and Treatment as they provide the treatment effect in the post-period. In the absence of a comparison group in the cohort (i.e. variance-in-adoption), Post and any interactions with Post are the primary coefficients of interest;

Post_{it} captures whether time period t is in the post-period for customer i ;

Treatment_i is a vector capturing the treatment or control status for customer i ;

Month_{it} is a vector of month dummy variables capturing the seasonal component;

Customer_i is a vector of dummy variables capturing customer-specific for an individual customer;

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HDD/CDD_{it} captures the average effect of heating/cooling degree days in month t (CDD for electric only) for customer i ;

3.6 Benefit Analysis

ADM monetized utility benefits resulting from three different program outcomes: arrearages, disconnects, and disconnect notices.

3.6.1 Monetization of Utility Benefits

The monetized value of arrearage benefits was calculated as equal to:

Average Arrearage Per Customer Per Year * Program Impact on Arrearage Reduction(%)
* Estimated Utility Rate * Number of PIPP Participants

Table 3-9 Data and Sources Used to Monetize Arrearages

Arrearages	Value	Source
Average Arrearage per Customer per Year	Varied by Program	Evaluation results
Estimated Program Induced % Reduction in Arrears	Varied by Program	Evaluation results
Utility Interest Rate	8.15%	TecMarket Works, SERA, and Megdal Associates (2001). The Low-income Public Purpose Test.
Number of Participants (PY2019)	Varied by Program	Program data

The monetized value of the disconnects was calculated as equal to:

Average Annual Number of Shutoffs * Program Impact on Disconnects (%) * Estimated Marginal Cost of Shutoffs

Table 3-10 Data and Sources Used to Monetize Disconnects

Disconnects	Value	Source
Average Annual Number of Shutoffs per Year	Varied by Program	Evaluation results
Program Impact on Disconnects (%)	Varied by Program	Evaluation results
Utility marginal cost to shutoff	\$8.29	TecMarket Works, SERA, and Megdal Associates (2001). The Low-income Public Purpose Test.
Number of Participants (PY2019)	Varied by Program	Program data

The monetized value of the disconnect notices was calculated as equal to:

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Average Annual Number of Notices per Customer * Program Impact on Disconnect Notices (%) * Estimated Marginal Cost of Shutoff Notice

Table 3-11 Data and Sources Used to Monetize Disconnect Notices

Fewer Disconnect Notices	Value	Source
Average Notices per Low Income Customer	Varied by Program	Evaluation results
Estimated Program-Induced Percentage Reduction in Notices	Varied by Program	Evaluation results
Utility's Marginal Cost per Notice	\$5.50	TecMarket Works, SERA, and Megdal Associates (2001). The Low-income Public Purpose Test.
Number of Participants (PY2019)	Varied by Program	Evaluation results

3.6.2 Monetization of Participant Benefits

ADM used participant survey data to estimate the monetized value of participant benefits.

Using a scale ranging from 0 (Do not agree at all) to 4 (Completely agree), survey respondents rated the extent to which they agreed that the PIPP led to the following benefits

- Helped them keep the home temperature more comfortable;
- Made it easier to pay other expenses;
- Made them less worried about utility bills;
- Helped them receive fewer shutoff notices;
- Helped them have fewer shutoffs; and
- Improved their health.

Respondents who rated their agreement that the program provided these benefits as a three or a four were asked to estimate how much they would be willing to pay for each of the benefits in dollars per year.

To develop an average per participant monetized value based on the responses, ADM assigned a value of \$0 to the benefit if the respondent did not rate their agreement as a three or a four. For respondents who did provide a value, ADM used the provided value but limited it to \$500 per year. This limit was imposed to correct for outliers in the data that indicated very high benefit values. While there were few of these instances, they affected the overall average. The per participant values were then multiplied by the PY2018/19 enrollment count to estimate the total annual benefit for the program.

4 PIPP and Other Low-Income Programs

This section provides information and analysis of the PIPP Program and three other programs or entities that assist low-income customers with their energy needs: the Low Income Energy Assistance Program, the Weatherization Assistance Program, and Energy Outreach Colorado.

4.1.1 PIPP Regulatory Rules

Prior to the onset of the triennial period (2016 – 2019), all of the utilities provided a program that limited customer energy costs. In 2016, a PUC rule-making (Proceeding No. 16R-0607EG) standardized the PIPP programs. Rule 3412 of the Commission’s Rules Regulating Electric Utilities, 4 Code of Colorado Regulations (CCR) 723-3 (Electric Rules), and Rule 4412 of the Commission’s Rules Regulating Gas Utilities and Pipeline Operators, 4 CCR 723-4 (Gas Rules) outlines the requirements for the PIPPs. Under 4 CCR 723-3-3412(e) and 4 CCR 723-4-4412(e), electric and gas utilities are required to offer payment plans such that the cost of gas and electricity does not exceed an affordable percentage of participants income.

Table 4-1 summarizes the applicable percentages that define affordable electricity and natural gas service under the rules.

Table 4-1 Percentage of Income Payments

Utility Service	Heating Type	Percentage of Income	Cap for Minimum Monthly Charge Allowed for Participants with Household Income of \$0
Electricity	Electric	3-6% of household income	\$20
Electricity	Non-electric	2-3% of household income	\$10
Natural Gas	Natural Gas	2-3% of household income	\$10

The rules require each utility to:

- Enroll participants in its levelized budget billing program; and
- Apply credits to pre-existing arrearages such that when combined with participant copayment, the arrearages are reduced to \$0.00 within 24 months;
- Apply Low-income Energy Assistance Program (LEAP) grants to the dollar value of the credits granted to program participants and to apply any amount of assistance greater than the annual bill to arrearages or as a benefit to the participant; and
- Provide information on existing energy efficiency programs offered by the utility and other entities, and existing weatherization programs offered by the state.

Participation in the program is limited to those with a household income at or below 185% of the current federal poverty level.

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Revised rules (4412 and 3412) require that each PIPP program provides annual progress reports to the PUC. The PUC provided guidance for report contents, which is outlined in section (L) of the rules.

4.1.2 Other Low-Income Programs and Services

This section presents information on the following programs and services available to assist low-income Coloradans with energy costs:

- Low-income Energy Assistance Program (LEAP);
- Weatherization Assistance Program (WAP); and
- Programs and services offered by Energy Outreach Colorado.

Table 4-2 summarizes the income requirements for LEAP and WAP alongside the PIPP requirements.

Table 4-2 Summary of Income Requirements

Number of Household Members	PIPP (185% FPL) ¹	Weatherization Assistance Program		Low-Income Energy Assistance Program (60% of State Median) ³
		U.S. Department of Energy Funded (200% FPL) ¹	LIHEAP and Severance Tax Funded (60% of State Median) ²	
1	\$23,606	\$25,520	\$28,452	\$28,452
2	\$31,894	\$34,480	\$37,212	\$37,212
3	\$40,182	\$43,440	\$45,972	\$45,972
4	\$48,470	\$52,400	\$54,732	\$54,732
5	\$56,758	\$61,360	\$63,480	\$63,480
6	\$65,046	\$70,320	\$72,252	\$72,252
7	\$73,334	\$79,280	\$73,884	\$73,884
8	\$81,622	\$88,240	\$75,528	\$75,528

1. Source: U.S. Department of Health and Human Services. Based on 2020 Federal Poverty Levels. Retrieved August 7, 2020 from: <https://aspe.hhs.gov/poverty-guidelines>

2. The Weatherization Assistance Program has two different income requirements depending on funding source.

3. Source: Colorado Energy Office. Retrieved August 7, 2020 from <https://www.colorado.gov/pacific/cdhs/program-eligibility>. The income requirement changed from 185% of FPL in 2020.

Energy Outreach Colorado (EOC) offers three programs with income requirements that are either 80% of county median income or the same as the LEAP requirements (not shown in table below). Additional information on the EOC programs is presented in Section 4.1.2.3.

4.1.2.1 Low-income Energy Assistance Program (LEAP)

The Low-income Energy Assistance Program (LEAP) provides assistance to reduce heating costs for low-income Coloradans. LEAP is funded by federal block grants – the federal program is known as Low Income Home Energy Assistance Program. LEAP provides financial payments to

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offset heating costs. The amount of these benefits is based on the applicants' heating cost and the amount of funding available. LEAP also offers a heating repair and replacement program for those with broken heating systems.

LEAP functions as a gateway to receiving the benefits of PIPP. Each of the four utilities that offer the PIPPs requires the customer to apply for LEAP to receive PIPP benefits and in most cases enrollment in PIPP is automatic for qualified participants. The exception for this is for the Black Hills Electricity program that was oversubscribed during the triennial period. The LEAP office has vendor agreements with many vendors across the state who coordinate on data sharing to provide income and heating type for customers. LEAP provides PIPP programs with customer information (income and heating type).

LEAP applications are accepted from November 1 to April 30 of each year. Applicants must apply each year.

As of October 1st, 2019, the income requirement for LEAP is an income at or below 60% of the state median income. During most of the evaluation triennial period, the income requirement was 165% of federal poverty level. Table 4-2 summarizes the income requirements for LEAP and PIPP in annual dollars. As shown, for most household sizes, the LEAP income threshold is above that for PIPP, meaning that those who qualify for LEAP also qualify for PIPP. Eight-person households are the exception to this – the PIPP income threshold is higher than the LEAP threshold.

To receive LEAP benefits, participants also need to meet the following qualifications:

- Pay their home heating costs to a utility company or as part of rent paid to a landlord.
- Be a permanent legal resident of the United States and a Colorado resident or have household members that are U.S. citizens and be able to provide a valid identification.
- Pay home heating costs, either directly to a utility company or to a landlord as part of rent.

Table 4-3 summarizes funding levels for LEAP and the numbers served for the two most recent years for which data was available.

Table 4-3 LEAP Funding and Numbers Served

Year	Number Served	Funding Amount	Funding Source	Percent of Eligible Colorado Population Served
FY2018	70,246	\$57,183,877	Federal block Grants/Carry over funds	18%
FY2017	75,782	\$55,995,629	Federal block Grants/Carry over funds	18%

Source: U.S. Department of Health and Human Services. Retrieved August 6, 2020 from https://liheappm.acf.hhs.gov/data_warehouse/

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Table 4-4 summarizes LEAP and PIPP enrollments. As shown LEAP enrollments are generally several times larger than PIPP enrollments. This may be due to multiple reasons.

For all of the utilities, one factor is that for households with seven or fewer members, the annual income requirement for PIPP is approximately \$5,000 to \$7,000 lower than for LEAP.

For Atmos Energy, one reason for the difference in LEAP and PIPP enrollments likely lies in how Atmos applies LEAP credits when calculating the affordable bill percentage. Based on the material provided in the Atmos tariff sheet and stated during the interviews, Atmos applies the LEAP credit prior to calculating the affordable percentage. It was also noted during the interview that customers are most frequently not qualified for PIPP because LEAP covers the affordable portion of their bill.

For Black Hills Electric, the number of PIPP enrollments exceed LEAP enrollments because customers with natural gas heating receive an electric benefit but do not receive a LEAP electric credit.

For Colorado Natural Gas, the reported PIPP enrollments were also considerably smaller than what ADM estimated, as discussed in Section 7.2.

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Table 4-4 LEAP and PIPP Enrollments

Utility	Fuel Type	Program Year	LEAP Enrollments	PIPP Enrollments
Atmos Energy	Natural Gas	PY2016/17	24,579	925
		PY2017/18	25,422	588
		PY2018/19	22,259	750
Black Hills Energy	Natural Gas	PY2016/17	5,906	499
		PY2017/18	6,127	214
		PY2018/19	5,600	82
	Electricity	PY2016/17	603	1,109
		PY2017/18	603	985
		PY2018/19	509	746
Colorado Natural Gas	Natural Gas	PY2016/17	192	167
		PY2017/18	205	164
		PY2018/19	338	195
Public Service Company of Colorado	Natural Gas	PY2016/17	42,436	13,145
	Electricity	PY2016/17		10,068
	Natural Gas	PY2017/18	38,451	13,033
	Electricity	PY2017/18		10,115
	Natural Gas	PY2018/19	37,490	18,058
	Electricity	PY2018/19		15,232

Sources:

PIPP enrollments based on the average monthly enrollment reported in the Annual report for Low Income Program for Colorado Utilities

CNG and Public Service LEAP enrollments were provided in an email response. Atmos and Black Hills enrollments were estimated using the data provided by the utilities.

Note: Black Hills PIPP electric enrollments exceed LEAP electric enrollments because most use natural gas heating and, in most cases, receive LEAP from a different natural gas utility.

The program manager for LEAP characterized the outreach campaign as “pretty massive” and comprised of media releases, television advertisement, applications provided to non-profits, materials on the program website, and a toll-free telephone number. Additionally, at the start of each LEAP application season, the program does a large mailing of applications and instructions to participants who received a LEAP benefit during the prior year.

The program includes marketing materials on its website. These materials provide information on the program benefit, eligibility requirements, and how to apply. The materials are in English and Spanish.

Colorado residents that are interested in applying for the program can apply by:

- Returning an application mailed to them (if they participated the year before);
- Calling a toll-free number to request an application;

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- Downloading an application form from the program website; or
- Obtaining an application from the local county office.

Colorado also offers a “one-stop” online application form (referred to as PEAK) that residents can use to obtain LEAP assistance as well as other benefits such as Temporary Assistance for Needy Families (TANF). The PEAK application form were accepted beginning on November 1st, 2018.

A requirement of LEAP is that recipients must agree to have a dwelling weatherized through the state Weatherization Assistance Program (WAP) if contacted to receive the service. If a recipient fails to comply with this requirement, LEAP will receive notification from WAP and will place a hold on the LEAP application in response.

4.1.2.2 Weatherization Assistance Program

The Weatherization Assistance Program (WAP) offers weatherization improvements to low-income Coloradans. There are two federal funding sources for WAP through the Department of Energy and the LIHEAP Housing and Human Services. Additionally, WAP receives funding from severance taxes and utility funding in the form of rebates (all of the investor owned utilities contribute rebates).

The program funding during the triennial period and number households served is provided in Table 4-5. The director of the WAP stated that there are an estimated 500,000 homes in Colorado in need of weatherization services and as such, the needs are considerably larger than the available funding.

Table 4-5 Weatherization Funding and Households Served

Fiscal Year	Funding	Number of Households Served
FY2016/17	\$14,215,678	2,205
FY2017/18	\$13,835,869	1,975
FY2018/19	\$16,374,124	2,126

Source: Email communication from Colorado Energy Office

The current prioritization approach used by WAP is to prioritize homes with higher energy costs. The focus on costs places greater priority on homes with electric or propane heating, which are higher cost heating fuels in comparison to natural gas. Additionally, the program prioritizes homes with children under five, elderly, or disabled members.

The program director stated that approximately 60 to 70% of those that receive WAP services also receive LEAP.

The regulations governing PIPP require that utilities refer the name and service address of participant households with electricity use of more than 10,000 kWh or 600 therms to the WAP. The program director stated that they are not currently using these lists because they use the consolidated list provided by LEAP instead of multiple utility lists.

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The numbers of PIPP recipients referred to weatherization services reported in the annual reports is shown in Table 4-6. Although not all utilities reported this information, the numbers reported indicate that the number of households referred in a year are at least 10 times the number of households that receive WAP services in a year.

Table 4-6 PIPP Weatherization Referrals

Utility	FY2016/17	FY2017/18	FY2018/19
Atmos Energy	0	590	566
Black Hills Energy	Not reported.	Not reported.	Not reported.
Colorado Natural Gas	0	Not reported.	Not reported.
Public Service	13,681	19,071	24,176

Source: Annual report for Low Income Program for Colorado Utilities per 3412(l) and 4412(l).

The gap between the funding for weatherization and the need would be difficult to surmount despite the benefits of reducing energy costs through improving energy efficiency and the associated health benefits of weatherization. An approach that could be considered to obtain additional funding by leveraging federal health care funding. The American Council for an Energy-Efficient Economy (ACEEE) has identified multiple federal funding sources that could be used to support home energy efficiency improvements that are summarized below in Table 4-7.⁴

Table 4-7 Federal Health Care Funding that May Potentially be Used for Energy Efficiency

Opportunity	Administering Agency	Scale of Program Funding	Potential Uses of Funding
Medicaid	CMS (HHS)	\$593 billion annual budget; potential for preventive spending uncapped	Home assessment, relationship management, labor/materials, education/training, and impact assessment
CHIP Health Services Initiative (HSI)	CMS (HHS)	Approximately \$956 million nationally based on 2018 numbers; varies by state (scaled to CHIP allotment and administrative costs) and by Congressional budgetary actions	Home assessment, relationship management, labor/materials, education/training, and impact assessment
Preventive Health and Health Services Block Grant (PHHSBG)	CDC (HHS)	\$147 million disbursed in 2019 as part of annual grant cycle	Home assessment, relationship management, labor/materials, education/training, and impact assessment

⁴ Hayes, Sara and Gerbode, Christine. "Braiding Energy and Health Funding for In-Home Programs: Federal Funding Opportunities." American Council for an Energy Efficient Economy. 2020.

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Opportunity	Administering Agency	Scale of Program Funding	Potential Uses of Funding
Social Impact Partnerships to Pay for Results Act (SIPRA) Grants	Dept. of the Treasury	\$100 million to be awarded as one-time grants in multiple funding rounds; next opportunity will be approximately \$10 million	Home assessment, relationship management, labor/materials, education/training, and impact assessment
Lead Hazard Control Grants	OLHCHH (HUD)	\$324 million total awarded as renewable grants of \$19.1 million to be used over up to five years	Home assessment, labor/materials, and impact assessment
National Asthma Control Program (NACP)	CDC (HHS)	\$70 million total awarded as five-year grants allotted to approximately 24 states; variable funding scaled to population (\$100,000–800,000/year/state)	Home assessment, relationship management, labor/materials, education/training, and impact assessment

Reproduced from Braiding Energy and Health Funding for In-Home Programs: Federal Funding Opportunities. ACEEE. 2020.

4.1.2.3 Energy Outreach Colorado

Energy Outreach Colorado (EOC) is a non-profit entity that works to improve home affordability for Coloradans. EOC provides a variety of services to residential customers:

- Weatherization services through the state Weatherization Assistance Program for multifamily properties.
- Bill payment assistance for households made directly to local utilities or fuel companies.
- Heating system repair and replacement.
- Energy efficiency improvements for customers of Public Service, Atmos Energy, and Black Hills Energy, as well as customers of other municipal utilities and electrical cooperatives.
- Energy education.

Table 4-8 summarizes the qualification requirements for the residential assistance programs that they deliver.

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Table 4-8 Summary of CEO Assistance Program Qualifications

Program	Qualification
Bill payment assistance	Past due bill or running low on fuel. Income at or below 80% of county median income. Pay energy vendor or utility directly for energy costs. Apply for LEAP.
Heating system repair/replacement	Apply for and receive LEAP benefits. Income at 60% of state median income (LEAP qualification). Primary heating system is not working.
CARE energy efficiency improvements	Live in a qualified county. Income at or below 80% of county median income. Served by a participating utility company.

Source: Retrieved August 8 2020, from <https://www.energyoutreach.org/programs-for-individuals/>

EOC receives funding from a variety of sources with utility and corporate contributions representing the largest source of funding.

Table 4-9 EOC Funding Sources

Public Support and Revenue	FY2016/17	FY2017/18	FY2018/19
Customer contributions	\$1,778,345	\$1,913,760	\$1,757,823
Utility and corporate contributions	\$12,831,345	\$14,293,525	\$15,592,356
Unclaimed utility deposits and refunds	\$281,770	\$445,265	\$956,159
Less amount passed through to LEAP	\$(281,770)	\$(445,265)	\$(510,894)
State appropriations	\$473,127		
Foundation grants	\$271,559	\$253,099	\$405,629
Other government funding	\$5,782,817	\$8,173,958	\$7,286,668
Special event revenue	\$199,272	\$183,840	\$213,296
Less direct benefits to donors	\$(71,337)	\$(73,692)	\$(71,269)

Source: Reports to Legislature. Retrieved August 8 2020, from <https://www.energyoutreach.org/reports/>

Table 4-10 summarizes EOC expenditures for providing client services (bill payment assistance, heating system repair/replacement, CARE energy efficiency improvements) and the number of clients. As shown, EOC provides services to nearly 17,000 clients a year.

Table 4-10 EOC Calendar Year Expenditures and Number of Clients

Metric	2017	2018	2019
Expenditures	\$7,143,138	\$6,688,242	\$7,283,734
Number of Clients	16,919	15,721	16,903

Source: Reports to Legislature. Retrieved August 8 2020, from <https://www.energyoutreach.org/reports/>

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4.1.3 Utility Program Implementation

4.1.3.1 Program Funding and Costs

The regulations governing the PIPP program provide for cost recovery through monthly fees paid by residential and nonresidential customers. The fee amounts are based on the program costs and the amount of recovered costs. On an annual basis, utilities are required to file the net difference in cost recovery over program costs and if that value is greater than 50%, then the utility is required to file an advice letter seeking approval for rates that will bring program costs and cost recovery funds into balance.

The residential surcharge is capped at a maximum fee of \$0.31 per month, but they may be less than that if costs are recoverable with a lesser fee. Table 4-11 summarizes the residential fees based on current tariff sheets retrieved from the utility websites in August 2020.

Table 4-11 Residential Rate Surcharge Amount

Utility	Fuel Type	Residential Fee (per Month)
Atmos Energy	Natural Gas	\$0.10
Black Hills Energy	Natural Gas	\$0.15
	Electricity	\$0.31
Colorado Natural Gas	Natural Gas	\$0.31
Public Service	Natural Gas	\$0.21
	Electricity	\$0.18

Cost recovery from nonresidential rate classes is permissible under the regulations. Specifically, the regulations state that:

...program costs shall be allocated to each retail rate based on each rate class's share of the test year revenue requirement established in the utility's last Phase II rate case, or under another reasonable methodology supported by quantifiable information. The monthly rate per this subparagraph to be charged each rate schedule customer shall be clearly stated on a tariff sheet.

Three of the four utilities recover costs through fees applied to nonresidential customers. Table 4-12 summarizes the nonresidential surcharge amounts to fund PIPP as reported in the tariff sheets retrieved in August 2020. Colorado Natural Gas did not list a nonresidential charge in the tariff sheet.

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Table 4-12 Nonresidential Rate Surcharge Amounts

Utility	PIPP Participant Fuel Type	Rate Class	Fee Amount	Unit
Atmos Energy	Natural Gas	Small Commercial & Commercial	\$0.10	/month
Atmos Energy	Natural Gas	Irrigation Service	\$0.10	/month
Black Hills	Electricity	Small General Service	\$0.31	/month
		Large General Service	\$1.00	/month
		Street/PAL Lighting	\$26.09	/month
		Irrigation Service	\$0.43	/month
		Large Power	\$0.0005	/kWh
	Natural Gas	Small Commercial	\$0.23	/month
		Small Volume Firm	\$1.13	/month
		Small Volume Interruptible	\$1.13	/month
		Large Volume Firm	\$3.87	/month
		Small Volume Interruptible	\$3.87	/month
		Irrigation Service	\$0.45	/month
Public Service	Electricity	Commercial	\$0.25	/month
		Secondary General	\$5.07	/month
		Primary General	\$70.19	/month
		Transmission General	\$494.73	/month
	Natural Gas	Schedule CSG	\$0.88	/month
		Schedule CLG	\$14.15	/month
		Schedule IG	\$33.86	/month
		Schedule TFS	\$0.88	/month
		Schedule TFL	\$14.15	/month
		Schedule TI	\$33.86	/month

Source: Tariff sheets published on utility websites and retrieved August 2020.

Table 4-13 through Table 4-15 summarize PIPP costs and average monthly participation for each year of the triennial period.

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Table 4-13 PIPP Program Costs PY16/17

Metric	Atmos	Black Hills - Electric	Black Hills - Natural Gas	CNG	Public Service - Electric	Public Service -Gas
Number of Participants	925	1,109	499	167	10,068	13,145
Total Administration Costs	\$1,886	\$32,138	\$56,453	\$5,574	\$167,348	
Fixed Bill Credits	\$84,356	\$811,799	\$631,983	\$0	\$7,586,590	
Arrearage Credits	\$45,112	\$22,234		\$0	\$0	
Other Costs	\$0	\$647	\$1,612	\$0	\$0	
Total Costs	\$131,354	\$866,818	\$690,049	\$5,574	\$7,753,938	

Source: Annual report for Low Income Program for Colorado Utilities. For Black Hills Natural Gas, the filed Low-Income Program (BHEAP) Cost Accounting document was referenced.

Number of participants based on average of the monthly count of active participants.

Table 4-14 PIPP Program Costs PY17/18

Metric	Atmos	Black Hills - Electric	Black Hills - Natural Gas	CNG	Public Service - Electric	Public Service -Gas
Number of Participants	588	985	214	164	10,115	13,033
Total Administration Costs	\$7,779	\$30,188	\$58,525	\$1,543	\$162,566	
Fixed Bill Credits	\$19,435	\$794,220	\$690,217	\$0	\$6,849,791	
Arrearage Credits	\$21,164	\$184,817		\$0	\$0	
Other Costs	\$0	\$1,967	\$67,424	\$0	\$0	
Total Costs	\$48,378	\$1,011,192	\$816,166	\$1,543	\$7,012,357	

Source: Annual report for Low Income Program for Colorado Utilities. For Black Hills Natural Gas, the filed Low-Income Program (BHEAP) Cost Accounting document was referenced.

Number of participants based on average of the monthly count of active participants.

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Table 4-15 PIPP Program Costs PY18/19

Metric	Atmos	Black Hills - Electric	Black Hills - Natural Gas	CNG	Public Service - Electric	Public Service - Gas
Number of Participants	750	746	82	195	15,232	18,058
Total Administration Costs	\$18,749	\$28,201	\$63,610	\$7,202	\$218,369	
Fixed Bill Credits	\$100,108	\$787,679	\$713,512	\$66,895	\$9,716,738	
Arrearage Credits	\$28,607	\$69,583		\$16,849	\$0	
Other Costs	\$0	\$0	\$67,672	\$0	\$0	
Total Costs	\$147,464	\$885,463	\$844,794	\$90,946	\$9,935,107	

Source: Annual report for Low Income Program for Colorado Utilities. For Black Hills Natural Gas, the filed Low-Income Program (BHEAP) Cost Accounting document was referenced.

Number of participants based on average of the monthly count of active participants.

Table 4-16 presents trends in benefit costs as a percent of total costs. The percentage of costs funding benefits (fixed monthly credits and arrearage credits) was higher for utilities with larger participation and benefits. This is likely due to a fixed administrative cost required to provide the PIPP, regardless of program size. Note that CNG did not report costs associated with monthly credit and arrearage credits for PY2016/17 and PY2017/18.

Table 4-16 Trends in Benefit Costs as a Percent of Total Costs

Program Year	Atmos	CNG	Black Hills - Electric	Black Hills - Natural Gas	Public Service
PY2016/17	99%	0%	96%	92%	98%
PY2017/18	84%	0%	97%	85%	98%
PY2018/19	87%	92%	97%	84%	98%

Source: Annual report for Low Income Program for Colorado Utilities

Table 4-17 summarizes administration costs as a percent of bill and arrearage credits. The rules for the PIPP require that:

“Administrative cost” means the utility’s direct cost for labor (to include the cost of benefit loadings), materials, and other verifiable expenditures directly related to the administration and operation of the program not to exceed ten percent of the total cost of program credits applied against bills for current usage and pre-existing arrearages or \$10,000, whichever amount is greater.

In PY2018/19, the administrative costs constituted 15% of benefit costs and exceeded \$10,000.

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Table 4-17 Administration Costs as a Percent of Bill and Arrearage Credits

Program Year	Atmos	CNG	Black Hills - Electric	Black Hills - Natural Gas	Public Service
PY2016/17	1%	4%	9%	9%	2%
PY2017/18*	19%	3%	8%	8%	2%
PY2018/19	15%	3%	9%	9%	2%

*Administrative costs were less than \$10,000.

Table 4-18 summarizes trends in administrative costs for each of the utilities. The administrative costs for the utilities with smaller sized programs, i.e., Atmos Energy, CNG, and Black Hills Energy – Natural Gas, had variable administrative costs from year-to-year. Participation levels did not change as much during these years. The administration costs were notably higher for Atmos Energy and Public Service in PY2018/19 than in prior years.

Table 4-18 Trends in Administration Costs

Program Year	Atmos	CNG	Black Hills - Electric	Black Hills - Natural Gas	Public Service
PY2016/17	\$1,886	\$5,574	\$32,138	\$56,453	\$167,348
PY2017/18	\$7,779	\$1,543	\$30,188	\$58,525	\$162,566
PY2018/19	\$18,749	\$7,202	\$28,201	\$63,610	\$218,369

Source: Annual report for Low Income Program for Colorado Utilities

4.1.3.2 Outreach

Overall, all of the utilities engage in limited outreach for the PIPP. A review of the utility websites found that each utility provides information on their website about the PIPP program as well as other forms of assistance available.

The main outreach approaches discussed were as follows:

- CNG has information on their website and social media accounts. Also, they notify customers of their eligible benefit amount.
- Atmos Energy staff noted that they promote all available forms of assistance to low-income customers through promotion of the availability of their assistance line. Additionally, some of the promotional activities they have engaged in include use of bill inserts and messaging printed on the bill; limited radio advertisement targeted at specific communities. They have also donated a bus to Discover Goodwill which is used to visit

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rural communities and promote assistance including bill payment assistance. It was noted that advertising is limited because of the cost in comparison to the size of the program.

- Black Hills Energy stated that historically they have used community assistance agencies to inform customers of the available assistance, as well as radio spots, newspaper advertisements, and also social media channels. It was noted that advertisements are limited because the electric program is oversubscribed.
- Public Service maintains information on their website about the program and they have a program application. However, the program application is not necessary because all qualified customers are auto enrolled in PIPP. Public Service does not market PIPP, but has engaged in outgoing telephone campaigns to market LEAP. The telephone calling campaign was a recent activity (as of the June 2020 interview).

4.1.3.3 Enrollment Approach

The enrollment approach is consistent across the utilities. Consistent with the regulatory guidelines, all programs use LEAP enrollment as the point of entry to the PIPP. The LEAP data is used to determine customer income to qualify them for PIPP. To this end all utilities reported they receive monthly reports from LEAP which identifies customers who qualify for PIPP.

Once a customer qualifies for LEAP, all utilities utilize an autoenrollment system to enroll all qualified customers into their PIPP program as summarized in Table 4-19.

Black Hills Energy's electricity program is the only instance of implementation that requires the customer to submit an application. An application is required because this program has been oversubscribed through the triennial period. It was noted during the interview that the waitlist has about as many customers as are enrolled in the program.

Black Hills uses a third-party to verify electric program applications to ensure they are qualified and are then placed on the waitlist. They rank the waitlist by household income and these customers are contacted once a spot becomes available. No other utilities indicated they have waitlists for the PIPP programs.

At the end of the triennial period (September 30, 2019), Black Hills Energy reported that the electric PIPP had 1,036 customers on the waitlist.

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Table 4-19 Summary of Enrollment Approach

Utility	PIPP Participant Fuel Type	Enrollment Process	Re-enrollment Process
Atmos Energy	Natural Gas	Apply for LEAP, Auto enrolled if qualified	Re-apply for LEAP
Black Hills Energy	Natural Gas	Apply for LEAP, Auto enrolled if qualified	Re-apply for LEAP
	Electricity	Apply for LEAP, Submit application	Re-apply for LEAP and PIPP
Colorado Natural Gas	Natural Gas	Apply for LEAP, Auto enrolled if qualified	Re-apply for LEAP
Public Service Company of Colorado	Natural Gas	Apply for LEAP, Auto enrolled if qualified	Re-apply for LEAP
	Electricity		Re-apply for LEAP

ADM estimated the cost to enroll all of the 1,036 customers on the waitlist into PIPP. Table 4-20 summarizes the results.⁵ The estimated cost of benefits to enroll the additional customers is \$1,190,647, which equates to a cost of \$0.54 per month per residential customer. The estimate may be high because Black Hills prioritizes lower income customers for enrollments and consequently the benefit costs for the waitlisted customer may be lower per customer than for those participating. However, the estimate below assumes no change in administrative costs but some of those costs likely vary with the number of customers enrolled.

⁵ To allocate costs between residential and nonresidential customer classes, ADM applied the allocation factors used by Black Hills to illustrate the allocation of non-protected Excess Deferred Federal Income Taxes to each customer class in the Black Hills Colorado Electric, LLC's Unopposed Motion to Modify TCJA Plan filed in Proceeding No. 18M-0074EG.

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Table 4-20 Estimate of Cost to Enroll Black Hills Customers on Waitlist

Metric	Amount
Number on waitlist at end of triennial period	1,036
Number enrolled in PY2018/19	746
PY2018/19 benefit costs	
Fixed bill credits	\$787,679.00
Arrearage credits	\$69,583.00
Total benefit costs	\$857,262.00
Total benefits per enrollment	\$1,149.27
Total expected benefit costs to enroll waitlisted customers	\$1,190,646.99
Benefit costs allocated to residential customers	\$550,674.23
Benefit costs allocated to nonresidential customers	\$639,972.76
Small General Service	\$138,115.05
Large General Service	\$276,230.10
Large Power Service	\$209,315.74
Lighting	\$11,430.21
Irrigation	\$4,881.65
Number of residential customers	85,218
Number of nonresidential customers	12,547
Small General Service	10,494
Large General Service	817
Large Power Service	18
Lighting	805
Irrigation	413
Additional monthly charge per residential customer	\$0.54
Additional monthly charge per nonresidential customer	\$4.25
Small General Service	\$1.10
Large General Service	\$28.18
Large Power Service	\$969.05
Lighting	\$1.18
Irrigation	\$0.98

4.1.3.4 Utility Definition of an Affordable Bill

The regulations governing the PIPP program define what constitutes an affordable bill. The regulations allow for flexibility in how the income cap is applied.⁶ Specifically, the regulations

⁶⁶ Rule 3412 of the Commission's Rules Regulating Electric Utilities, 4 Code of Colorado Regulations (CCR) 723-3 (Electric Rules), and Rule 4412 of the Commission's Rules Regulating Gas Utilities and Pipeline Operators, 4 CCR 723-4 (Gas Rules)

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provide for a range in the percentage of income that the customer's utility bill should be capped at between 2 – 3% for customers with natural gas heating and between 3 – 6% for customers with electric heating. Table 4-21 summarizes the utility approaches to applying the rules. As shown, several used a sliding scale for the income cap based on the customer's income level.

One utility, Public Service, provides benefits to customers who meet the PIPP income requirements but have an energy cost that is less than 3% of income. The benefit functions as a discount on the customer's rate.

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Table 4-21 Summary of PIPP Benefit

Utility	Program Name	Fuel Type	Application of LEAP Benefit	Benefit Tier	Benefit
Atmos Energy		Natural Gas	LEAP applied after PIPP cap calculation	Annual income at or below 75% FPL	Bill capped at 2.0% of income
				Annual income between 76% and 125% of FPL	Bill capped at 2.5% of income
				Annual income between 126% and 185% of FPL	Bill capped at 3.0% of income
Black Hills Energy	Black Hills Energy Assistance Program	Natural Gas	LEAP applied after PIPP cap calculation	Annual income at or below 75% FPL	Bill capped at 2.0% of income
		Natural Gas		Annual income between 76% and 125% of FPL	Bill capped at 2.5% of income
		Natural Gas		Annual income between 126% and 185% of FPL	Bill capped at 3.0% of income
Black Hills Energy	Black Hills Energy Assistance Program	Electricity	LEAP applied after PIPP cap calculation	Annual income between 0% and 25% of FPL	Bill capped at 3.0% of income
		Electricity		Annual income between 30% and 55% of FPL	Bill capped at 4.0% of income
		Electricity		Annual income between 60% and 70% of FPL	Bill capped at 5.0% of income
		Electricity		Annual income between 75% and 185% of FPL	Bill capped at 6.0% of income
Colorado Natural Gas	Customer Assistance Program	Natural Gas	LEAP applied after PIPP cap calculation	Annual income at or below 75% FPL	Bill capped at 2.0% of income
				Annual income between 76% and 125% of FPL	Bill capped at 2.5% of income
				Annual income between 126% and 185% of FPL	Bill capped at 3.0% of income
	Electric Affordability Program	Electricity	LEAP applied after PIPP cap	All Qualifying Customers	Bill capped at 3.0% of income

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Utility	Program Name	Fuel Type	Application of LEAP Benefit	Benefit Tier	Benefit
Public Service Company of Colorado		Electricity	LEAP is not included in the calculation of affordable bills	All Qualifying Customers with Bills that are less than 3% of Income	Discount of 20% or 25% applied to residential rate
	Gas Affordability Program	Natural Gas	LEAP applied after PIPP cap	All Qualifying Customers	Bill capped at 3.0% of income
		Natural Gas	LEAP is not included in the calculation of affordable bills	All Qualifying Customers with Bills that are less than 3% of Income	Discount of 20% or 25% applied to residential rate

Source: Utility tariff sheets retrieved August 8 2020. Income ranges for Atmos Energy were provided in an email communication.

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4.1.3.5 Notice of Benefits

Customers are informed by each utility that they have been enrolled into the PIPP program. Some utilities indicated they send customers a letter to inform them they have been enrolled in PIPP. Once a customer is enrolled in the program, program credits are calculated. Credits are calculated based on customers' income. PUC Rules provide minimum and maximum percentage of incomes (2 – 3%) for participants to pay for their utilities. All utilities indicated they use a sliding scale based on income provided in regulation. Utilities stated they include billing data and energy consumption when calculating the program credit received by PIPP participants. Some utilities indicated they have a computer program that does the calculation and applies the credit to customers' account automatically. Some utilities use income/poverty tiers to determine the percentage of income that will be used to determine the program credit.

4.1.3.6 Enrollment in Levelized Billing

All of the Utilities interviewed indicated they enroll PIPP participants in a levelized budget billing program. All utilities indicated they use the past 12 months of utility bills to estimate the monthly payment.

Table 4-22 Levelized Budget Billing for PIPP Participants

Utility	Levelized Budget Billing	Utility Approach to Implementation of Levelized Budget Billing
Atmos Energy	Yes	All PIPP recipients are enrolled in a levelized budget billing plan. A rolling calculation based on previous 11 months of usage is used to levelized the billing use. A balance is due when an account is closed.
Black Hills Energy	Yes	All PIPP customers are enrolled. Bills are estimated based on average monthly usage. Bills are adjusted if usage changes by 10% or more. After 12 months of enrollment, actual energy costs are factored into the levelized-billing calculation for the next 12 months.
CNG	Yes	All PIPP customers are enrolled. Bills are based on average of 12 months of usage and then reconciled with amounts owed during the 12 th month.
Public Service	Yes	All PIPP customers are enrolled. An exception may occur if a customer has a lower bill with credits applied than the levelized billing amount. The accounts are settled on the 13-month of enrollment with customers responsible for any additional utility cost.

Source: Utility staff interviews and email communications.

Some consideration as to whether or not the levelized budget billing component should be required is worthwhile because it may not provide the intended benefits and may encourage opting out of PIPP. The evidence for not requiring is as follows:

- During interviews with utility representatives, they informed ADM that some customers dislike the levelized budget billing component and some negative feedback was provided by program participants (see Section 6.2).

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- A stakeholder commented that levelized budget billing can be more challenging for those with seasonal employment because while their costs may remain consistent, income may vary.
- The intended benefits may not be realized as some research findings indicate that that levelized budget billing may increase consumption. A study in California found that enrollment in levelized budget billing was associated with an approximately 4% increase in energy use and therefore costs.⁷ Similarly, a study published in an academic journal found that levelized budget billing was associated with increased electricity use.⁸ The theory is that the levelized budget billing obscures information on the relationship between patterns of consumption and energy costs.

However, customer survey responses support keeping the levelized budget billing component as it was commonly reported to be helpful in managing energy costs.

4.1.3.7 Program Opt-Out

Customers may opt-out of the PIPP program. ADM requested records of customer opt-outs as part of our data request to the utilities. Table 4-23 summarizes the opt-outs by program year based on the data provided by the utilities.⁹ As shown, CNG and Public Service data did not have information on opt-outs. Program staff at Public Service stated that they have had very few opt-outs, “We probably had one or two.”

Atmos Energy had the most opt-outs. Staff indicated that customers opt-out because they dislike the levelized budget billing component. It should be noted that the number of opt-outs declined precipitously between the first and last year of the triennial period.

⁷ DNV GL. “Auto Bill Pay and Budget Billing Impact Evaluation – Residential.” 2017.

⁸ Sexton, Steven. “Automatic Bill Payment and Salience Effects: Evidence from Electricity Consumption.” The Review of Economics and Statistics. 2015.

⁹ Opt-outs are defined as customers formally asked to be removed from the PIPP program.

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Table 4-23 Summary of Opt-Outs

Program Year	Atmos ¹	Black Hills – Electric ²	Black Hills - Natural Gas ²	CNG ³	Public Service ⁴
PY2016/17	773	4	5	Not tracked	Not identified in data
PY2017/18	250	12	9	Not tracked	Not identified in data
PY2018/19	85	47	0	Not tracked	Not identified in data

1. Source: Customers with status value of “C” were treated as opt-out as per email communication from Atmos Energy, May 2020.
2. Sources Customer data with status value of “D” were treated as opt-outs as per email communication from Black Hills Energy, July 2020
3. Opt-outs are not tracked, per email communication from CNG, June 2020
4. During the utility staff interview it was stated that almost no customers opt-out.

4.1.3.8 Data Tracking and Program Analysis

ADM Evaluators asked each utility if they are tracking PIPP program data. All Utilities track data specific to the program and none identified any issues with their current data systems (see Table 4-24).

No utility had undertaken analysis of program impacts on customers like the effects on disconnection or arrearage rates. Each utility stated that PIPP participants should not experience a disconnection while enrolled in the program.

Table 4-24 Data Tracking

Utility	Data Tracking Capacity	Example of type of data tracked	Challenges
Atmos Energy	Yes	Number of gas participants, number of PIPP program participants, benefit amount, LEAP benefit applied, administrative costs, applicants not enrolled (leap participants but not enrolled in PIPP), average bill credit by month, average arrearage amount, average monthly consumption, and total monthly consumption.	None identified. Staff stated they would like to track if the PIPP participants are paying what they can afford.
Black Hills	Yes	Applicants and denials.	None identified.
CNG	Yes	Applicant name, account number, number of household members, monthly income, annual income, prior 12-month bills, and any arrearage on the account.	None identified
Public Service	Yes	Yearly income information, monthly reports of customer credits, and opt-outs.	None identified

Source: Utility staff interviews

4.1.3.9 Coordination / Integration with Energy Efficiency Programs

Utilities provide information about their energy efficiency programs to PIPP participants through letters sent to customers and the other marketing channels used to promote the energy efficiency programs.

4.1.4 Customer Demographics

Table 4-25 summarizes the estimated number of qualified households based on the American Community Survey data. The methodology for developing these estimates is summarized in Section 3.3. As discussed in Section 3.3, PIPP Qualified households were defined as follows:

- **Electric PIPP Qualified:** Households with 1) an electricity bill, 2) an income at 185% of federal poverty or less, 3) with an electricity bill greater than 6% of their income if they had electric heat, or a utility bill greater than 3% of their income if they heated using a different fuel.
- **Gas PIPP Qualified:** Households with 1) a utility gas bill, 2) an income at 185% of federal poverty or less, 3) a natural gas bill greater than 3% of their income.

PIPP Non-Qualified households include all other households.

As shown, the estimated eligible population is notably larger than the number of enrolled customers.

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Table 4-25 Summary of Estimated PIPP - Qualified Households by Heating Fuel and Building Type

Heating Fuel Type	Building Type	Atmos	Black Hills - Electric	Black Hills - Gas	CNG	Public Service - Electric	Public Service - Gas	Total
Electricity	Apartment	0	1,434	0	0	16,595	0	18,029
	Detached single family	0	1,418	0	0	12,572	0	13,990
	Mobile home or trailer	0	241	0	0	1,430	0	1,671
Utility gas	Apartment	1,492	2,145	1,783	293	35,639	19,261	59,121
	Detached single family	6,664	11,562	8,363	1,770	77,100	70,429	169,225
	Mobile home or trailer	1,995	1,276	2,137	152	11,834	10,825	26,225
Other	Apartment	0	246	0	0	2,532	0	2,778
	Detached single family	0	1,711	0	0	8,414	0	10,125
	Mobile home or trailer	0	643	0	0	1,846	0	2,489
Total		10,150	20,678	12,284	2,215	167,962	100,515	303,653
Number of PIPP Participants Reported for PY2018/19		588	985	82	195	10,115	13,033	24,748
Enrolled Participants as Percent of Estimated Qualified Residents		6%	5%	<1%	8.9%	6%	13%	8%

The geographic distribution of the PIPP qualified households are shown in Figure 4-1 for gas qualified homes and Figure 4-2 electric qualified homes.

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Figure 4-1 Distribution of Gas PIPP Qualified Households

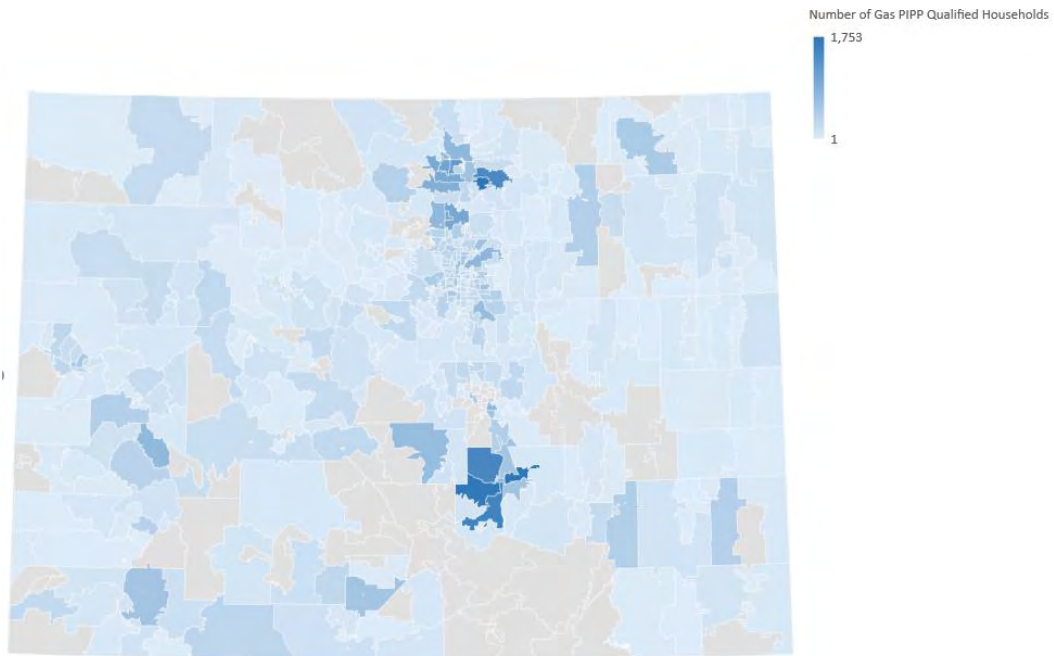
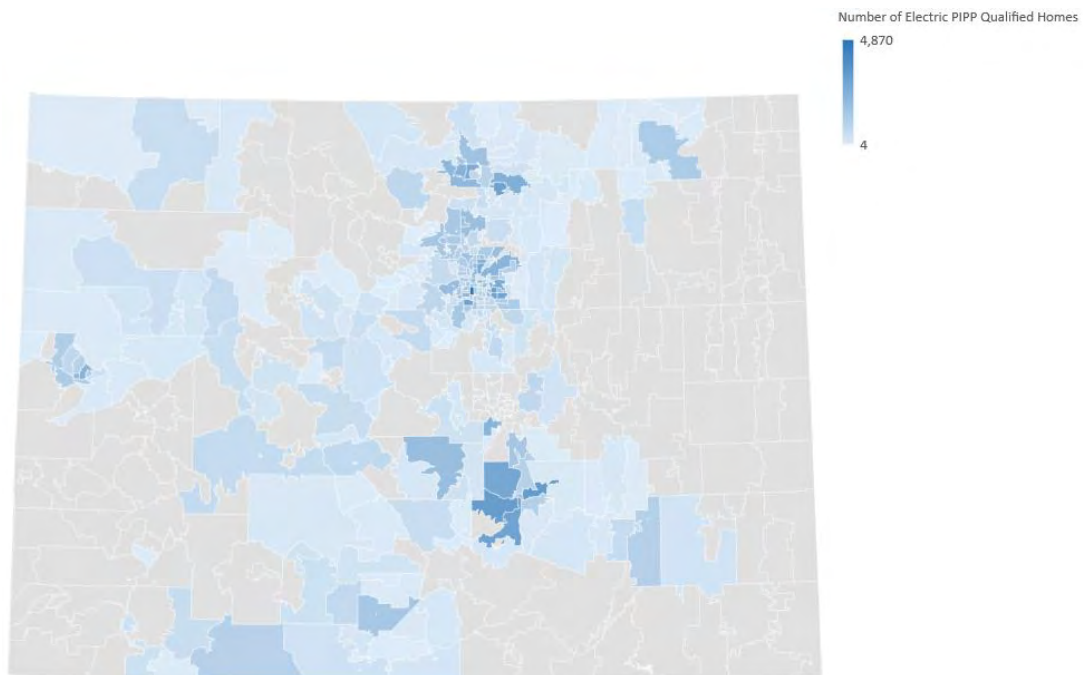


Figure 4-2 Distribution of Electric PIPP Qualified Households



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As shown in Table 4-26 the share of qualified customers ranged from 7% to 24%, and across all utilities, it was estimated that 11% of customers were qualified for PIPP.

Table 4-26 Percent of Customers Qualified for PIPP

Utility	EIA Count of Residential Customers	Percent of Customers Qualified
Atmos	108,634	9%
Black Hills Electric	84,990	24%
Black Hills Gas	165,953	7%
CNG	21,013	11%
Public Service Electric	1,262,866	13%
Public Service Gas	1,293,327	8%

Table 4-27 summarizes estimated numbers of PIPP-qualified Households by heating fuel and occupancy type. Residents qualified for electric PIPP credits more commonly resided in rented properties whereas those qualified for gas credits tended to reside in owned properties.

Table 4-27 Summary of Estimated PIPP - Qualified Households by Heating Fuel and Occupancy Type

Heating Fuel Type	Occupancy Type	Atmos	Black Hills - Electric	Black Hills - Gas	CNG	Public Service- Electric	Public Service - Gas	Total
Electricity	Owned	0	792	0	0	8,782	0	9,574
	Rented	0	2,251	0	0	21,160	0	23,411
	Occupied without payment of rent	0	50	0	0	654	0	704
Other	Owned	0	1,818	0	0	8,014	0	9,832
	Rented	0	589	0	0	4,117	0	4,706
	Occupied without payment of rent	0	193	0	0	661	0	854
Utility gas	Owned	6,175	7,838	7,648	1,236	64,418	59,977	141,117
	Rented	3,645	6,744	4,259	907	57,300	37,839	107,050
	Occupied without payment of rent	329	402	377	72	2,855	2,699	6,404
Total		10,150	20,678	12,284	2,215	167,962	100,515	303,653

Table 4-28 summarizes the average monthly natural gas and electricity costs for PIPP-Qualified residents and residents not qualified for PIPP. As shown, residents qualified for PIPP tended to have higher natural gas and electricity costs.

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Table 4-28 Average Monthly Natural Gas and Electricity Cost

Heating Fuel Type	PIPP Qualified	Monthly Natural Gas Cost				Monthly Electricity Cost	
		Atmos	Black Hills - Gas	CNG	Public Service - Gas	Black Hills - Electric	Public Service - Electric
Electricity	PIPP Qualified	\$0.00	\$0.00	\$0.00	\$0.00	\$156.79	\$142.77
	Non-qualified	\$64.95	\$66.73	\$63.31	\$61.07	\$140.11	\$115.98
Utility gas	PIPP Qualified	\$87.07	\$93.55	\$92.76	\$91.52	\$125.28	\$119.72
	Non-qualified	\$70.10	\$74.39	\$74.76	\$70.65	\$124.53	\$118.51

Note: PIPP qualified households do not have any gas costs for electricity and other heating fuels because to qualify for PIPP gas credits, the household must have gas heating. Costs are the utility costs reported by American Community Survey respondents for the most recent month.

Table 4-29 summarizes the share of natural gas and electricity costs as a percent of income by federal poverty level. As shown, energy burden increases as income declines. The greatest energy burdens fall on those with incomes at or below federal poverty level and the increase is substantial in comparison to those above the poverty level. Additionally, the table shows that the energy burden of households between 151% and 185% of FPL was similar to those households between 125% and 150% of FPL. Base on this analysis, the 185% of federal poverty level appears reasonable to target higher energy burden households, particularly in relation to the 150% FPL threshold used in some other states (see Section 4.2). It should also be noted that natural gas costs consumed a sizable share of income (ranging from 6.4% to 36.7% of income) for customers at or below the 185% federal poverty level and who have electric heat and natural gas service. These households gas costs are not eligible for the PIPP under the current rules.

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Table 4-29 Natural Gas and Electricity Costs as a Percent of Income

Heating Fuel Type	Federal Poverty Level (FPL)	Average Gas Cost as a Percent of Income				Average Electricity Cost as a Percent of Income	
		Atmos	Black Hills - Gas	CNG	Public Service - Gas	Black Hills - Electric	Public Service - Electric
Electricity	At or below 185% FPL	6.4%	16.9%	7.6%	36.7%	18.9%	82.7%
	No income (Percent of households)	0.2%	0.1%	0.1%	0.1%	2.0%	1.1%
	At or below 100% FPL	11.7%	39.9%	14.8%	93.8%	33.9%	191.7%
	More than 100% FPL to 125% FPL	2.7%	3.5%	2.7%	3.3%	7.8%	6.2%
	More than 125% FPL to 150% FPL	3.5%	2.9%	2.8%	3.2%	5.6%	4.9%
	More than 150% FPL to 185% FPL	2.2%	2.4%	2.2%	2.5%	5.6%	4.4%
	More than 185% FPL to 200% FPL	2.1%	2.2%	2.0%	2.4%	4.9%	4.0%
	More than 200% FPL to 250% FPL	1.6%	2.3%	1.9%	1.6%	4.2%	3.2%
	More than 250% FPL	1.0%	0.8%	0.9%	0.8%	2.4%	1.7%
Utility gas	At or below 185% FPL	24.8%	36.9%	26.5%	52.9%	16.2%	56.8%
	No income (Percent of households)	0.7%	0.5%	0.9%	0.6%	1.4%	0.8%
	At or below 100% FPL	62.4%	92.9%	62.7%	138.9%	32.3%	144.9%
	More than 100% FPL to 125% FPL	4.4%	4.9%	4.8%	4.7%	7.0%	6.2%
	More than 125% FPL to 150% FPL	3.3%	3.6%	4.3%	3.5%	5.7%	5.1%
	More than 150% FPL to 185% FPL	2.8%	3.0%	3.0%	2.8%	4.8%	4.2%
	More than 185% FPL to 200% FPL	3.0%	2.6%	2.4%	2.5%	3.8%	3.6%
	More than 200% FPL to 250% FPL	2.0%	2.2%	2.2%	2.1%	3.5%	3.1%
	More than 250% FPL	1.1%	1.0%	1.1%	0.9%	2.0%	1.5%

Note: For households without an income, the percent of homes instead of percent of cost is shown.
Gas cost analysis is limited to homes with a natural gas bill.

Selected demographic characteristics of PIPP-qualified households and households not qualified for PIPP are summarized in Table 4-30. As shown, in the table, PIPP qualified households were more likely to reside in limited English-speaking households, Spanish-speaking households, and have considerably lower average income. There were no appreciable differences between age of oldest household member, presence of children, or the number of household members.

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Table 4-30 Summary of Demographic Characteristics

PIPP Qualified	Atmos	Black Hills - Electric	Black Hills - Gas	CNG	Public Service - Electric	Public Service - Gas
Limited English household						
PIPP Qualified	6%	3%	5%	4%	7%	5%
Non-qualified	2%	3%	1%	1%	2%	2%
Spanish speaking household						
PIPP Qualified	23%	18%	16%	19%	20%	16%
Non-qualified	14%	12%	9%	10%	11%	10%
Children present in household						
PIPP Qualified	32%	34%	29%	29%	35%	28%
Non-qualified	33%	29%	35%	29%	31%	32%
Average age of oldest household member						
PIPP Qualified	55	54	57	57	52	57
Non-qualified	54	54	54	55	51	54
Average number of household members						
PIPP Qualified	2.3	2.3	2.2	2.0	2.4	2.1
Non-qualified	2.6	2.5	2.7	2.5	2.5	2.6
Average household income						
PIPP Qualified	\$15,468	\$17,135	\$15,281	\$14,123	\$17,024	\$14,472
Non-qualified	\$87,821	\$85,110	\$109,358	\$100,067	\$110,326	\$109,338

4.2 Review of Other Programs and Best Practices

This section presents findings on comparisons of the Colorado PIPP to programs offered in other states as well as findings from a best practice literature review.

4.2.1 Comparison of Other Percentage of Income Payment Plans

This section presents findings on comparisons of the Colorado PIPP to programs offered in other states as well as findings from a best practice literature review. Table 4-31 summarizes information found for seven programs operating in other states. The key findings of the comparison of these programs to the listed programs are as follows:

- **Colorado's PIPP percentage of income cap is consistent with other states.** The highest percentage of income that a customer can pay in Colorado's PIPP is 6%, however, a customer with electric heating would not have a capped natural gas bill and therefore may end up paying more than 6% of their income to cover utility costs. For states that an explicit cap on income could be found, 6% was a common combined utility cap. However, customers in Ohio with electric heating may pay up to 10% of their income to cover utility costs.
- **Colorado allows for higher incomes to qualify for PIPP than other states.** Three of the states reviewed used 150% of the federal poverty level (FPL) as an income requirement in comparison to the 185% of FPL required for Colorado.

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- **Most states do not have automatic enrollment.** The review found one other state, New Jersey, had automatic enrollment. Most PIPP programs operated by Colorado utilities have automatic enrollment, with the exception of the Black Hills Electric program that requires an application because it is oversubscribed.
- **Annual re-certification / re-application is common practice.** Consistent with Colorado requirements, annual re-certification and application is the norm.

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Table 4-31 Summary of PIPP Programs

Program	State	Administration	Utility (Utilities)	Utility Burden	Qualifications	How Income Data is Verified	Reapplication /Recertification	Has Automatic Enrollment	Renters can apply?
PIPP Plus	OH	Ohio Public Utilities Commission	Gas and electric companies aside from small gas companies. The ones that do not offer this same version of PIPP plus include: Ohio Gas, Eastern Natural Gas, Pike Natural Gas, Duke Energy, and Southeastern Natural Gas	\$10 or 6% of your gross monthly household income each month whichever is greater for electric and natural gas homes. For all electric homes, it is \$10 or 10% of your gross monthly household income whichever is greater.	Eligible to participate if it is a household with a gross yearly household income at or below 150% of the federal poverty guidelines	Provide proof of gross monthly household income for the last 30 days.	Annually	No	Not specified
Universal Service Fund (USF)	NJ	State of New Jersey: Department of Community Affairs	All NJ utilities	Participants are required to pay no more than 6% of their annual income toward electric and gas bills. Capped at \$1,800 for electric and gas combined on the utility bill as a credit.	Electric and natural gas customers whose household income is equal to or less than 200% of the federal poverty level.	LIHEAP customers enrollment. Provide proof of income documentation. Reapplication is required annually.	Annually	LIHEAP customers are automatically enrolled	Yes - Bill must be in the applicant's name and they must meet other eligibility requirements.

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Program	State	Administration	Utility (Utilities)	Utility Burden	Qualifications	How Income Data is Verified	Reapplication /Recertification	Has Automatic Enrollment	Renters can apply?
Fixed Annual Credit (FAC)	NV	Division of Welfare and Supportive Services (Nevada's division)	All Nevada utilities	Reduce the amount spent on the natural gas/electricity bill to the median percentage of the household income spent on natural gas / electricity statewide	The income must not exceed 150% of the federal poverty level.	Submit proof of payment documents (pay stubs) along with the application.	Not found	No – apply and it is based on first come first serve	Yes -if utilities are in the landlord's name, but the household receives a separate bill that includes consumption and dollar usage, the household is eligible for a fixed annual credit of \$180 whichever is greater
LIHEAP PIPP Plus	IL	Illinois Department of Commerce and Economic Opportunity	Ameren Illinois, ComEd, Nicor Gas and Peoples Gas/North Shore Gas	Participants pay no more than 6% of their incomes.	Households income for the 30 days prior to the application is at or below 150% of the federal poverty level.	LIHEAP customers may choose to be in the PIPP Plan.	Annually	No –apply and it is based on first come first serve	Yes- rent must be greater than 30% of your income in order to be eligible to receive assistance.
Customer Assistance Program (CAP)	PA	Pennsylvania Public Utilities Commission	Various Utilities	Some customers have saved more than 50% on their bill	Customers must be at or below 150% of the federal poverty level	Proof of gross household income for the past 30 days	No	No	Not specified
Electric Assistance Program (EAP)	NH	New Hampshire Public Utilities Commission	Electric utilities; Eversource Energy, Liberty Utilities, New Hampshire	The discounts range from 8% to 76%, depending on the customer's	Depends on family size. A family size of 1, the gross annual income needs to be \$34,181. A family size	Most likely through the Community Action Agency	Annually	No	Yes

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Program	State	Administration	Utility (Utilities)	Utility Burden	Qualifications	How Income Data is Verified	Reapplication /Recertification	Has Automatic Enrollment	Renters can apply?
			Electric Cooperative, Unitil	gross household income and household size	of 8, the gross annual income needs to be \$90,710				
Arrearage Management Program (AMP)	MA	Various Utilities with Department of Public Utilities oversight	Utilities can design their own AMP; for this one we will use National Grid	Based on arrearage amount.	National Grid will review the customer's account billing history and set a monthly budget payment amount based on the average of their monthly bills. Once a payment amount is set, this amount will need to be paid on time each month in order to remain in the program.	National Grid selects the customer Account must have confirmed enrollment in their National Grid Low Income Rate.	Not applicable to the arrearage repayment. The period is based on amount owed and time needed for repayment.	Yes	Does not specify

4.2.2 Review of Best Practices

This section presents a review of literature pertaining to best practices in the design and delivery of percentage of income payment plans (PIPP) targeting low-income customers. The purpose of the review is to provide perspective on PIPP program design and implementation to inform potential program improvements. The literature reviewed included papers by the American Council for an Energy Efficiency Economy (ACEEE), the National Consumer Law Center, and Synapse Energy Economics.

Table 4-32 summarizes PIPP consistency with best practices identified from a review of the literature. Additional details on the practices are provided following the table. The practices described focus on improvements to the processes and implementation of the percentage of income payment plan programs that focus on helping the low -income residents pay their energy bill. These are practices taken from various utilities across the United States.

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Table 4-32 Summary of Colorado PIPP Best Practice

Best Practice	CO PIPP Consistency with Practice	Description
Use auto-enrollment	●	Auto-enrollment is in places for all PIPP programs aside from the oversubscribed Black Hills – Electric program.
Use a standard name for all PIPPs	○	Each utility has a different name for the PIPP assistance
Streamline enrollment with other low-income programs	●	PIPP leverages LEAP enrollments and in most cases automatically enrolls customers in PIPP if qualified. CO has an online application (PEAK) that allows residents to apply for multiple assistance programs including LEAP.
Coordinate with energy efficiency programs	◐	Information is provided on other energy efficiency programs offered by the utilities and customers are referred to the WAP. However, WAP budget constraints limit the number of customers served.
Offer PIPPs to customers with disconnect	○	Customers are eligible based on fuel costs and income, regardless of disconnect history.
Provide more frequent and longer-term distribution of benefits.	●	Program provides a monthly credit, arrearage repayment, and levelized budget billing instead of a lump sum.
Scale benefits based on need.	◐	All utilities aside from Public Service do this. The Public Service program does not scale the benefit, but does include assistance to customers with bills below the PIPP cap.
Energy burden should not exceed 6% of income.	◐	Customers with electric heating may have natural gas costs that result in their total burden exceeding 6%.
Use arrearage management	●	PIPP provides arrearage assistance for customers who continue to make payments.
Leverage other means tested programs to qualify and enroll customers	●	PIPP uses income and heating type information obtained through the LEAP application process to qualify customers.
Use community organizations / government entities to enroll customers	●	LEAP works with nonprofits to assist residents with enrollment.
Allocate costs to all rate classes is a common approach	◐	Atmos, Black Hills, and Public Service recover costs from non-residential customer classes. CNG does not.

- Fully consistent with the practice
- ◐ Partially consistent with the practice
- Not consistent with the practice

4.2.2.1 Summary of Best Practices

This section provides additional detail on the best practices identified in the table above. Note that the Colorado PIPP is consistent with many of these practices, as identified in Table 4-32.

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- **Low income customers should be auto-enrolled into PIPP programs.** A study conducted about Massachusetts utilities showed that automatic enrollments reach a greater number of customers. Colorado currently uses auto-enrollment.
- **All the PIPP programs in the state should be run under a standard name.** This could help communications statewide about the programs and avoiding communication amongst customers. PIPP programs tend to have various names across different states. For example, in Pennsylvania, these can be referred to as “Customer Assistance Programs,” but in the neighboring state, “New Jersey,” they can be referenced as the “Universal Service Fund.”
- **Low income program enrollment should be streamlined with coordination between the various low-income programs becoming practice.** Streamlining program enrollment helps as it can use data from other low-income programs to increase enrollment in the targeted program. An ACEEE study found that streamlining eligibility reduces administrative costs as well as it allows individuals who are enrolled in one type of low-income program to easily enroll into another.¹⁰ An example of this would be using eligibility criteria from a federal program such as LIHEAP and streamlining that information into the PIPP program.
- **Coordinate between energy efficiency and bill payment assistance programs; incorporate energy efficiency education into information given to customers participating in the PIPP programs.** A study about the Illinois PIPP¹¹ found that customers who participated in the PIPP program increased their energy usage between 0.9-3.8%. It was suggested in the evaluation that the Illinois utility should offer weatherization programs for PIPP customers to offset any increases in energy usage. An ACEEE study found that \$6.31 billion goes to bill payment assistance and \$1.17 billion goes to energy efficiency in terms of funding. It was suggested that offering energy efficiency improvements can help reduce the amount of bill assistance customers need. Furthermore, customers participating in PIPP can be educated about energy efficiency because education is something that can help increase realization rates from installed measures.
- **Offer the PIPP plans to customers whose service has been disconnected.** Customers’ service gets disconnected if the customers do not pay their energy bill. Those that are disconnected are able to file bankruptcy and get the service re-connected. However, a PIPP plan for those individuals causes the customer to earn the forgiveness through on-

¹⁰ Cluett, Rachel, et al. “Building Better Energy Efficiency Programs for Low-Income Households.” ACEEE, American Council for an Energy-Efficient Economy, Mar. 2016, www.aceee.org/sites/default/files/publications/researchreports/a1601.pdf.

¹¹ Applied Public Policy Research. “Illinois PIPP Program Impact Evaluation.” *APPRISE*, Dec. 2009, www.appriseinc.org/reports/Illinois%20PIPP%20Impact%20Report%20-%20FINAL.pdf.

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time payments and thus the customer does not have to file bankruptcy. An example of a PIPP program that offers this arrearage forgiveness is the Illinois PIPP. It includes a one-time arrearage forgiveness benefit with no maximum forgiveness amount. Arrearage forgiveness is also an aspect of some PIPP's in Pennsylvania.

- **Provide more frequent and longer-term distribution of benefits.** By providing monthly benefits instead of one-time, lump-sum payments, benefit programs can deliver more stable and consistent benefits.
- **Scale benefits based on need.** Scaling benefits allows for the provision of greater benefits to the customer needs.
- **Energy burden should not exceed 6% of income.** The six percent of income standard is based on the view that 30% of household income for shelter is affordable and that 20% of shelter costs are utility costs. Additionally, an analysis performed by APPRISE determined that 11% of income constitutes a high energy burden. Referencing non low-income energy burden is another approach to determining energy burden. A study by ACEEE found that low income customers pay an average of 6% of their income to utility bills as compared to 2.7% that is typical for households.
- **Use arrearage management.** Forgive a portion of customers arrearages if the customer continues to pay the bill going forward.
- **Leverage other means tested programs to qualify and enroll customers.** Leveraging other programs will reduce burdens on applicants and allow for qualification without independent validation of means. Colorado is consistent with this practice by using LEAP qualifications and applicant information to qualify customers for PIPP.
- **Use community organizations and government entities to enroll customers.** These types of entities typically have established relationships with low-income customers. An example cited in one of the reports reviewed include a program in San Francisco that partnered with community organizations to address language barriers to enrollment in customer assistance options by serving as a trusted communicator. Similarly, ADM evaluated a program that provided grants to community groups that served specific types of hard-to-reach groups (e.g., non-English-speaking households, senior citizens, customers in disadvantaged communities) to provide information on the services the organization offered.
- **There are tradeoffs between fixed and variable budget setting options.** Fixed benefits ensure rate payers that there is a limit to the total potential cost while variable budgets allow the program to scale to the level of need.
- **Allocation of costs to all rate classes is a common approach.** Cost recovery from nonresidential rate classes for low-income assistance programs is a common practice.

5 Stakeholder Findings

This Chapter summarizes findings from interviews with stakeholders. The interviewed stakeholders were representatives from the utilities, the Colorado Energy Office, Energy Outreach Colorado, Colorado Office of Consumer Counsel, and the Public Utilities Commission.

5.1 State Approach to Meeting Energy Needs

The utility representatives and other stakeholders interviewed had diverging views about the state's ability to meet energy needs for Coloradans. Many stakeholders believed that the PIPPs are an important part of meeting energy needs for low-income customers, but some felt there may be requirements of the PIPP programs that may negatively impact the ability for consumers to participate. For example, levelized budget billing as a requirement was highlighted by some as a potential barrier or challenge for low-income households because they may face an unexpected expense that could jeopardize their ability to maintain a payment plan. One utility program staff believed that seniors who rely solely on SSI may be a group that could benefit from additional supports to ensure they have affordable energy.

One stakeholder noted that because LEAP is federally funded, customers who do not meet citizenship requirements cannot participate in the program, and thereby do not receive the PIPP benefit. This stakeholder also indicated that LEAP and PIPP are serving approximately 15% of customers who would otherwise qualify for the programs in some counties, and that additional outreach is needed to increase awareness.¹² They also discussed the balance of increasing advertising for the program and the potential for running out of funding.

Colorado's low natural gas price was cited by some utility program staff and stakeholders as a potential challenge for fully subscribing the PIPP programs. It was also mentioned as a challenge for weatherization because lower energy costs reduce the financial benefits from energy efficiency improvements. The representative for the WAP stated that electric heating is more costly and so the focus has been to incorporate solar to offset those costs. The representative also stated that having access to utility data would help them better target households with high electricity costs. Customers who rely on propane for heating in rural communities were cited as a group that could be left behind because it is harder to provide them services.

The overall level of funding available for low income assistance was raised as a concern by some stakeholders. It was suggested that there should be a discussion of the \$0.31 per month cap on funding.

¹² We note that the 15% figure for the share of eligible customers participating is higher than ADM's estimates that ranged between 1% and 13%.

5.2 Coordination of Low-Income Energy Assistance Efforts

One of two bodies in the state that has a role in coordinating efforts to meet the needs of low-income customers and to engage stakeholders is the Low-Income Rate Assistance Coalition (LIRAC or Coalition). LIRAC membership includes representatives from LEAP, the Public Utility Commission, the Office of Consumer Counsel, Energy Outreach of Colorado, the Colorado Energy Office, and the utilities. The Coalition meets to discuss best practices for assistance programs and improving services for low income and vulnerable households.

A second body is the Colorado Commission on Low-Income Energy Assistance (the Commission). The purpose of the Commission is to assure that energy assistance services are efficiently delivered. The Commission is a more formal group than the Coalition and is authorized in statute that consists of 11 members appointed by the governor.

Stakeholders indicated that there was generally good and effective communication between the various concerned groups.

It was suggested that it would be valuable for the state to take a more comprehensive approach to addressing low-income needs. The suggestion was to start with developing an understanding of what the goals and objectives were related to meeting low-income needs and then to look comprehensive solutions that integrated multiple processes or components such as integrated resource planning, transportation, and electrification, in addition to low income rate assistance.

5.3 Covid-19 Impacts

All interviewed utilities and stakeholders agreed that the onset of Covid-19 will impact the extent of assistance needs. At the time of the interviews, there was a moratorium on disconnections that was believed to have delayed the effects of Covid-19 on energy security, but many were concerned that once it is lifted there could be a large increase in need. LEAP staff indicated they have observed approximately a 5% increase in applications since the onset of Covid-19. Three utilities indicated they have experienced an uptick in the number of PIPP enrollments and applications since the pandemic began in March. There were additional LEAP funds provided through the CARES Act, approximately 13 million to address the need and there is severance tax funding from oil and gas extraction, but it varies from year-to-year.

6 Participant and Nonparticipant Findings

This section presents the findings of the survey of PIPP participants and nonparticipants as well as findings from the in-depth interviews. The methodology used for the survey is discussed in Section 3.4. As noted there, non-participants include those customers who formally opted-out of the PIPP or who discontinued their enrollment.

A copy of the survey instrument can be found in Chapter 10 and a tabulation of all survey responses is presented in Chapter 11.

Section 3.4 also discusses the methodology used for the in-depth interviews. A copy of the interview guide can be found in Chapter 12 a full summary of the interview findings in Chapter 13.

6.1 Awareness

Awareness of the PIPP program and benefit is limited for programs that auto-enroll qualified customers. Table 6-1 summarizes participant awareness of the program and the benefit received. Awareness was higher for Black Hills customers. This is likely because the majority of the 147 respondents received the electric benefit (92%) that they are required to submit an application for. For the other utilities, between one-half and two-thirds of participants were aware of the program and that they receive the benefit.

Table 6-1 Awareness of PIPP Program and Benefit

Awareness of Program and Benefit	Atmos	Black Hills	CNG	Public Service
	Participant (n = 71)	Participant (n = 147)	Participant (n = 30)	Participant (n = 141)
Have heard of the program	54%	96%	53%	62%
Aware that they received the benefit	66%	97%	50%	54%

The in-depth interviews also found that most participant respondents did not understand that the PIPP benefit. Seventy-four percent of PIPP participant respondents interviewed did not realize they were enrolled in a PIPP program and 89% did they understand they would qualify for the additional assistance when they applied for LEAP. Some PIPP participant respondents learned about PIPP through the interview.

The financial benefit provided through PIPP is not well understood among most participants. Interviewed PIPP participant respondents reported not fully understanding how the PIPP worked and the amount of the assistance they receive on their utility bills. Interviewees did indicate they understood the LEAP benefits as they were notified by a letter how much would be credited to their account and they saw this reflected on their monthly bills. In terms of the PIPP credit, none reported a line item on their bill to identify the assistance provided. Below are the verbatim

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responses from participant respondents about their understanding of PIPP or suggestions on how to better inform them of the program.

“Once I started getting pamphlets, I understood what it was. I would call Atmos to learn more about it. Once I learned, I passed the information along to others.”

“I think some information was mailed to me. I don't understand a lot, but I have had payments kick in when there was an overflow of credit.”

“I understood they both came under assistance. The amount of assistance I get for electricity it great, it makes it possible to have AC in the summer. [I] understood the BHEAP assistance but did not understand the Xcel Energy Assistance.”

“Give an explanation about the credit. Send a letter or written information or in the bill say what the credit is.”

“I'm confused about the credit and I don't understand how it works. Maybe they could send a letter or even a phone call stating how it works and if it changes why it changes.”

“They send an energy comparison report card every month (compares with neighbors). I think it would be a good place to put it.”

“Actually, I just need to open the online account so I could see the breakdown. But I am sure I could learn or ask somebody.”

Participants' social networks and the Colorado Department of Human Services website were the primary ways that customers learned of LEAP. LEAP functions as a gateway to receiving the PIPP benefit because a LEAP application is required to receive the benefit and for most of the programs, qualifying customers are automatically enrolled in PIPP. As shown in Table 6-2, most participant respondents learned of the LEAP program through their social networks and from the Colorado Department of Human Services website. Social workers were another source of awareness of for LEAP.

Utility bill notices and mailings were the source of awareness for around 10% of the participant respondents.

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Table 6-2 How Participants Learned of LEAP

Source of Awareness of LEAP	Atmos	Black Hills	CNG	Public Service
	Participant (n = 71)	Participant (n = 148)	Participant (n = 30)	Participant (n = 142)
From a friend, family member or neighbor	24%	20%	13%	22%
The Colorado Department of Human Services website	20%	11%	20%	21%
From a social worker	13%	22%	7%	9%
From my local or state government	7%	12%	13%	14%
Through a bill notice or mailing from my [UTILITY]	8%	9%	13%	12%
By calling the Colorado Department of Human Services toll-free number	6%	7%	20%	4%
The [UTILITY] website or customer service	1%	3%	0%	4%
A charity or nonprofit organization such as Discover Goodwill	1%	1%	0%	4%
Radio, television, or newspaper advertisement	0%	1%	0%	1%
[Had LEAP previously or known for a long time]	3%	1%	0%	0%
[Case Worker]	1%	1%	0%	0%
Do not recall	11%	9%	10%	6%
Other	3%	1%	3%	2%

6.2 Barriers and Challenges to Enrollment and Participation

Few participants and non-participants reported difficulty applying for LEAP, but there was evidence that non-participants had greater difficulty applying for LEAP. As shown in Table 6-3, few participant and non-participant respondents reported difficulty applying for LEAP. The difference between participants and non-participants that reported difficulty applying for LEAP for Public Service was statistically significant for Public Service. For Public Service, more non-participants reported difficulty applying for LEAP.

The difficulties in applying for LEAP cited by respondents included challenges completing the application, providing documentation, having an initial application denied, and not knowing how to apply. Additionally, a few respondents reported that the enrollment period had closed on them (see Table 6-4).

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Table 6-3 Difficulty Applying for LEAP

Had Difficulty Applying for LEAP	Atmos		Black Hills		CNG		Public Service*	
	Participant (n = 71)	Non-Participant (n = 54)	Participant (n = 148)	Non-Participant (n = 66)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 142)	Non-Participant (n = 78)
Yes	13%	4%	3%	6%	0%	25%	6%	19%
No	86%	94%	94%	89%	97%	75%	92%	73%
Do not Recall	1%	2%	3%	5%	3%	0%	2%	8%

* Statistically significant difference at $p < .05$

Table 6-4 Reason for Difficulty Applying for LEAP

Reasons for Difficulty	Atmos		Black Hills		CNG		Public Service	
	Participant (n = 9)	Non-Participant (n = 2)	Participant (n = 4)	Non-Participant (n = 4)	Participant (n = 0)	Non-Participant (n = 1)	Participant (n = 9)	Non-Participant (n = 15)
Completing the application	44%	50%	50%	0%	n/a	0%	33%	13%
Providing documentation such as proof of income	44%	0%	25%	0%	n/a	0%	11%	27%
My application was initially denied	22%	0%	25%	50%	n/a	100%	22%	40%
The enrollment period had closed	11%	0%	0%	25%	n/a	0%	11%	27%
I didn't know how to apply	11%	0%	0%	25%	n/a	0%	0%	13%
Some other reason	0%	50%	25%	0%	n/a	0%	33%	13%

Lack of awareness of LEAP was the primary reason respondents did not apply for it when they believed they qualified for the benefit. About one-third of all respondents stated they did not receive LEAP during a year when they believed they qualified. The most common reasons for this were lack of awareness of the LEAP benefit, missing the application period, and not being able to complete the application (see Table 6-5).

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Table 6-5 Reasons for Not Receiving LEAP

Reasons for Not Receiving LEAP when Qualified	Atmos		Black Hills		CNG		Public Service	
	Participant (n = 13)	Non-Participant (n = 3)	Participant (n = 13)	Non-Participant (n = 15)	Participant (n = 5)	Non-Participant (n = 2)	Participant (n = 38)	Non-Participant (n = 34)
I was not aware of the LEAP benefit and did not apply	54%	33%	62%	13%	0%	0%	50%	29%
I missed the application period	23%	0%	8%	53%	40%	0%	26%	53%
I was not able to complete the application	0%	33%	15%	27%	20%	50%	13%	18%
I was not interested in getting the benefit	15%	0%	0%	0%	0%	0%	3%	3%
[Covid 19]	0%	0%	8%	0%	0%	0%	0%	3%
[Did not qualify]	0%	0%	0%	0%	0%	50%	0%	6%
[I did not have all the information to apply]	0%	0%	0%	0%	0%	0%	3%	6%
Other	8%	0%	15%	20%	40%	0%	16%	0%
Don't know	0%	33%	0%	7%	0%	0%	0%	0%

Dislike of levelized budget billing was the most cited reason for not wanting to receive the PIPP benefit. Table 6-6 summarizes the reasons why non-participants elected to not receive PIPP or LEAP. Dislike of levelized budget billing was the most commonly mentioned reason for not wanting the benefit.

The interviews completed with the participants found mixed views of the levelized budget billing component. Some respondents liked this aspect, as one noted, “I think it helps families with children and seniors.” Another respondent noted that it was helpful with a caveat:

“It does help to a point.... Sometimes it is hard. If you do not stay current, it kicks you out of it. But it does help outlining plan.”

Two respondents stated that they would like to have a choice in enrolling in the levelized budget billing component:

“They didn't ask me; it would have been nice to ask me. It would be my choice. It should be the customer's choice. I guess it would help manage the utility...maybe more for water. If I got a credit at the end of the year.”

“It should be provided with accurate information and consumers should make that decision themselves.”

An interview respondent who opted out of the PIPP stated that they stopped participating because they owed money at the end of the year when enrolled in levelized budget billing and

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this prevented them from participating in PIPP again. Another interview respondent who disliked the leveled budget billing component said:

“I do not like it. I have to pay a lump sum at the end of the year (this was many years). LEAP is helping because they bill in winter. They cover about 1 month of bills every 3 months. I cancelled the budget billing because I want to know the usage every month.”

Table 6-6 Reasons for Not Wanting to Receive PIPP or LEAP

Most Important Reason for Not Wanting Assistance	Atmos	Black Hills	CNG	Public Service
	Non-Participant (n = 55)	Non-Participant (n = 4)	Non-Participant (n = 0)	Non-Participant (n = 7)
I didn't like the that I was required to have my utility bill adjusted so that it didn't change from month-to-month (also known as budget billing)	16%	50%	n/a	29%
I didn't understand what the benefit was	16%	0%	n/a	0%
[I moved]	16%	0%	n/a	0%
[I got LEAP payments]	13%	0%	n/a	0%
I didn't want assistance	4%	0%	n/a	0%
[I didn't understand the billing or payments under the program]	2%	25%	n/a	0%
[I didn't need the benefit]	2%	0%	n/a	0%
[I didn't like the change/confused]	2%	0%	n/a	0%
I didn't want to enroll in LEAP	0%	0%	n/a	14%
I didn't have the documentation necessary to enroll in LEAP	0%	0%	n/a	14%
The application was too much effort	0%	0%	n/a	0%
[I didn't know how to apply]	0%	0%	n/a	14%
[The benefit is lower in the warmer weather]	0%	0%	n/a	0%
Other	9%	25%	n/a	14%
Don't know	20%	0%	n/a	14%

Note: This questions was asked of customers who opted-out or who did not re-enroll and stated that they did not want to be enrolled in the LEAP or PIPP program.

6.3 Other Types of Assistance and Program Participation

6.3.1 Energy Outreach Colorado Assistance

Relatively few respondents reported that they applied for bill payment assistance from Energy Outreach Colorado. As shown in Table 6-7, relatively few participants applied for EOC benefits. The application rates were generally under 10% but were somewhat higher for Public Service. Respondents reported learning of EOC from a variety of sources as summarized in Table 6-8.

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Table 6-7 Applied for EOC Bill Payment Assistance

Applied for EOC Bill Payment Assistance	Atmos		Black Hills		CNG		Public Service	
	Participant (n = 71)	Non-Participant (n = 56)	Participant (n = 148)	Non-Participant (n = 67)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 142)	Non-Participant (n = 79)
Yes	4%	2%	7%	6%	7%	0%	17%	13%
No	70%	84%	71%	75%	70%	100%	58%	66%
Not sure	25%	14%	22%	19%	23%	0%	25%	22%

Table 6-8 Source of EOC Awareness

Source of Awareness of EOC	Atmos		Black Hills		CNG		Public Service	
	Participant (n = 3)	Non-Participant (n = 1)	Participant (n = 11)	Non-Participant (n = 4)	Participant (n = 2)	Non-Participant (n = 0)	Participant (n = 24)	Non-Participant (n = 10)
From [UTILITY]	0%	0%	64%	25%	50%	n/a	29%	70%
From the Energy Outreach Colorado website	33%	0%	0%	0%	0%	n/a	13%	10%
From an internet search (google, etc.)	0%	0%	0%	0%	0%	n/a	4%	0%
Social media	0%	0%	9%	0%	0%	n/a	13%	10%
From a friend, family member or neighbor	33%	0%	27%	50%	0%	n/a	17%	0%
Other	0%	0%	0%	0%	0%	n/a	13%	0%
[Human resources]	0%	100%	0%	0%	50%	n/a	0%	0%
[Church]	33%	0%	0%	0%	0%	n/a	0%	0%
Do not recall	0%	0%	0%	25%	0%	n/a	13%	10%

6.3.2 Energy Efficiency Program Awareness and Participation

A majority of participants recall receiving information on the Weatherization Assistance Program. As shown in Table 6-9, around two-thirds of participants and non-participants stated that they received information on the Weatherization Assistance Program. As shown in Table 6-10, approximately a quarter of participants received weatherization services.

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Table 6-9 Receipt of Information of Weatherization Assistance Program

Received information on Weatherization Assistance Program	Atmos		Black Hills		CNG		Public Service	
	Participant (n = 71)	Non-Participant (n = 55)	Participant (n = 147)	Non-Participant (n = 68)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 142)	Non-Participant (n = 78)
Received information on WAP	70%	64%	67%	59%	83%	100%	68%	53%
Yes, from LEAP	61%	47%	40%	43%	73%	75%	40%	28%
Yes, from [UTILITY]	3%	2%	6%	3%	10%	25%	10%	14%
Yes, from both [UTILITY] and LEAP	7%	15%	20%	13%	0%	0%	18%	10%
No, did not receive information on the weatherization program	14%	27%	26%	25%	13%	0%	15%	27%
Do not recall	15%	9%	7%	16%	3%	0%	17%	21%

Table 6-10 Receipt of Weatherization Services

Home Received Weatherization Services	Atmos		Black Hills		CNG		Public Service	
	Participant (n = 71)	Non-Participant (n = 55)	Participant (n = 147)	Non-Participant (n = 68)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 142)	Non-Participant (n = 78)
Yes	28%	25%	26%	32%	43%	100%	22%	21%
No	61%	60%	64%	56%	57%	0%	61%	63%
Not sure	11%	15%	10%	12%	0%	0%	17%	17%

Around one-half of PIPP participants were aware that the utilities offered energy efficiency programs. The levels of awareness were similar across utilities and between participants and non-participants. A smaller share of respondents reported that they learned of the energy efficiency program when enrolled in PIPP.

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Table 6-11 Awareness of Utility Energy Efficiency Programs

Aware that Utilities offer Energy Efficiency Programs	Atmos		Black Hills		CNG		Public Service	
	Participant (n = 71)	Non-Participant (n = 55)	Participant (n = 146)	Non-Participant (n = 68)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 142)	Non-Participant (n = 78)
Not aware of Utility EE Programs / did not receive information from Utilities	48%	44%	47%	50%	37%	25%	44%	56%
Aware of utility energy efficiency programs	52%	56%	53%	50%	63%	75%	56%	44%
Received information from utility on EE programs when enrolled in PIPP	28%	44%	40%	34%	53%	50%	38%	31%

Note: The percentage of respondents that received information on the programs from the utility overlaps with the percentage that were aware of the programs. Consequently, the percentages do not sum to 100%.

About one-fifth of respondents participated in an energy efficiency program. As shown below, about one-fifth of respondents had participated in an energy efficiency program with similar levels of participation across the PIPP participant and nonparticipant groups and across utilities. Weatherization programs were the most commonly recalled and these recollections may include participation in the statewide Weatherization Assistance Program.

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Table 6-12 Participation in Utility Energy Efficiency Programs

Participation in Utility Energy Efficiency Programs	Atmos		Black Hills		CNG		Public Service	
	Participant (n = 71)	Non-Participant (n = 55)	Participant (n = 147)	Non-Participant (n = 68)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 142)	Non-Participant (n = 78)
Participated in a program	20%	4%	23%	19%	23%	50%	23%	21%
<i>A program that makes energy improvements to my home such as adding insulation and sealing off air leaks. (Weatherization)</i>	9%	2%	5%	7%	20%	0%	6%	4%
<i>A program that provides rebates for energy efficient appliances</i>	1%	0%	2%	3%	3%	25%	1%	1%
<i>A program that provides free or discounted LED light bulbs</i>	6%	0%	15%	7%	0%	25%	14%	14%
<i>[Time of use pricing]</i>	0%	0%	0%	0%	0%	0%	1%	0%
<i>[A program that provides a water usage kit or discounted LED light bulbs]</i>	0%	0%	0%	1%	0%	0%	0%	0%
<i>Did not recall program type</i>	3%	2%	1%	0%	0%	0%	1%	1%
Has not participated in a utility program	54%	78%	60%	62%	60%	50%	45%	53%
Not sure if participated in a utility program	27%	18%	17%	19%	17%	0%	32%	27%

A majority of respondents recalled receiving tips on saving energy from their utility. As shown between one-half and two-thirds of respondents recalled receiving tips on energy efficiency.

Table 6-13 Receipt of Energy Saving Tips

Utility provided tips to save energy	Atmos		Black Hills		CNG		Public Service	
	Participant (n = 71)	Non-Participant (n = 55)	Participant (n = 147)	Non-Participant (n = 68)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 142)	Non-Participant (n = 78)
Yes	51%	60%	62%	47%	63%	75%	63%	49%
No	30%	29%	22%	35%	20%	25%	18%	24%
Not sure	20%	11%	16%	18%	17%	0%	18%	27%

More than half (60%) of in-depth interview respondents believe their home is energy efficient and pointed to storm windows and weatherization improvements as to why. Among those who

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did not believe their home was energy efficient, drafty windows and cold rooms were common responses.

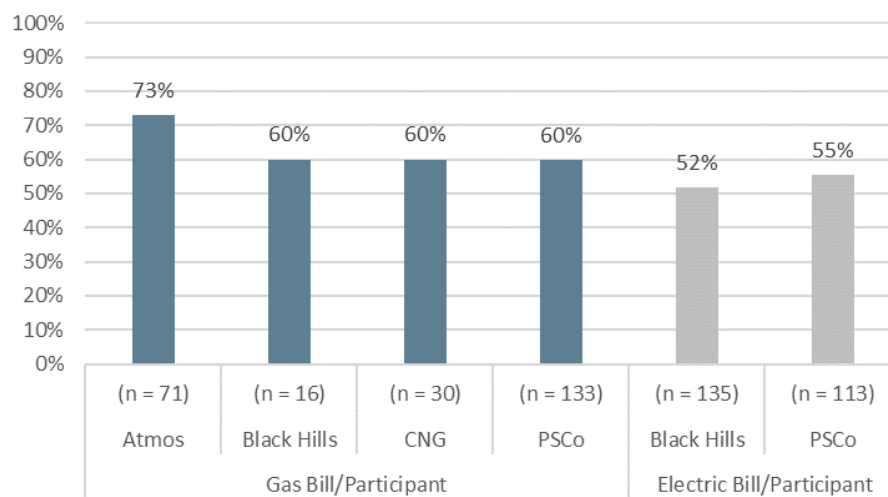
6.4 Bill Affordability and Benefits

This section presents findings on bill affordability and the benefits of PIPP. The results are presented for participants and shown separately for those participating in a natural gas program and an electricity program. Several respondents receiving service from Black Hills and Public Service received both gas and electric benefits and these responses are included in both the gas and electric participants summaries.

For these questions, respondents were asked about the benefits of PIPP. However, it should be noted that lack of awareness of receipt of PIPP benefits was common and because PIPP and LEAP benefits are received conjointly, the responses likely reflect the perceived benefits of both forms of assistance.

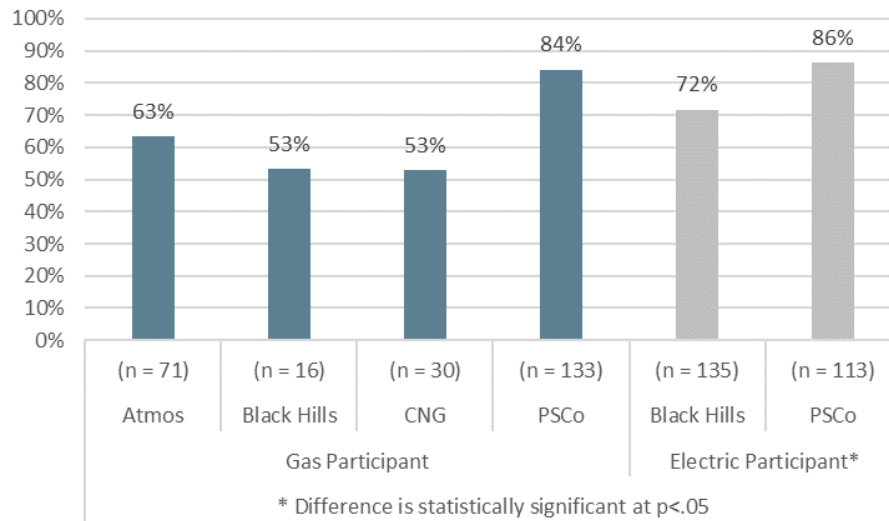
About one-half of participants reported that their natural gas and/or electric bill was affordable. The differences between affordability of gas bills and electric bills across the utilities were not statistically significant (see Figure 6-1). Similar shares of gas participants said they had difficulty paying their utility prior to receiving PIPP benefits (see Figure 6-2). Approximately three-quarters of electric participants said they had difficulty paying their utility bill prior to participating in PIPP. The share of Public Service participants that had difficulty paying their bills was greater than Black Hills participants.

Figure 6-1 Affordability of Gas and Electric Bill



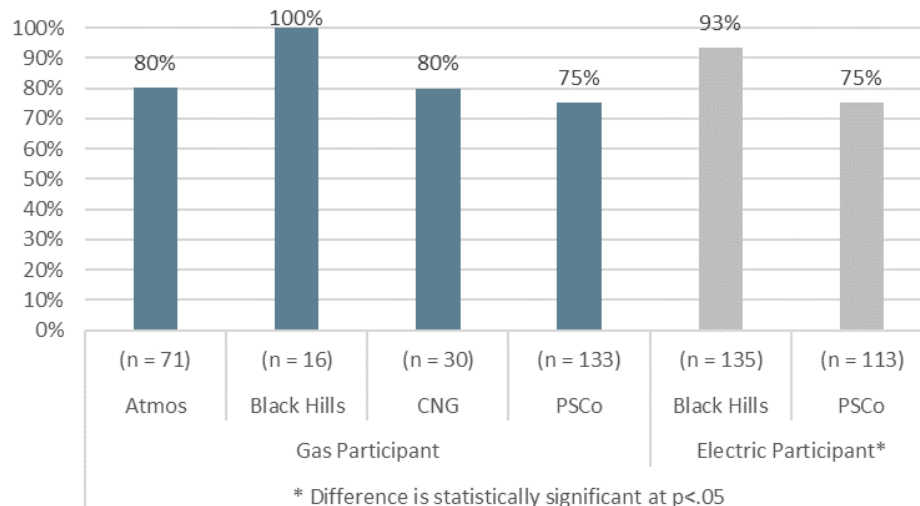
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Figure 6-2 Difficulty Paying Utility Bill before PIPP



A clear majority of participants thought PIPP made paying their utility bill a lot or somewhat easier. As shown, a large share of participant respondents reported that PIPP has made paying their utility bills a lot or somewhat easier. The share of Black Hills participants stating this was higher than Public Service participants.

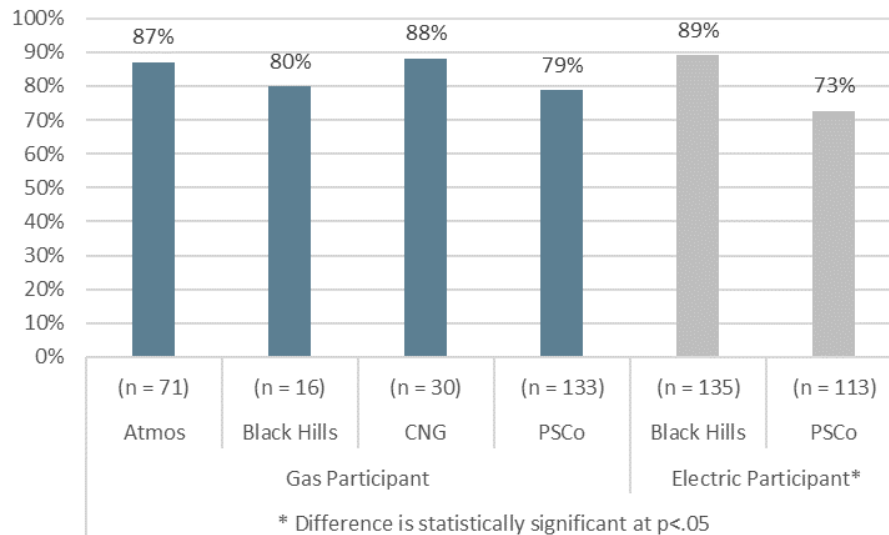
Figure 6-3 PIPP Made Paying Utility Bills A Lot or Somewhat Easier



As shown in Figure 6-4, most participants believed that levelized budget billing helped them pay their utility bills. The share in the Black Hills program that thought this was higher than those in the Public Service program.

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Figure 6-4 Levelized Budget Billing Helps a Lot or Helps Some with Paying Utility



Most participants reported that they had realized benefits from participating in PIPP. The benefits realized included improved home comfort, reduced stress, and the improved ability to pay utility costs (see Table 6-14 and Table 6-15). A larger share of Black Hills electric program participants reported realizing benefits of improved home comfort, easier payment of expenses, reduced worry about utility costs, and reduced shutoff notices, than Public Service participants (see Table 6-15).

Table 6-14 Benefits of PIPP (Gas Participant)

Benefit	Atmos	Black Hills	CNG	Public Service
	(n = 71)	(n = 16)	(n = 30)	(n = 133)
Improved home comfort	82%	94%	83%	76%
Easier to pay other expenses	77%	81%	93%	73%
Less worried about paying utility costs	82%	88%	83%	70%
Reduced shutoff notices	85%	69%	87%	75%
Reduced shutoffs	83%	69%	83%	79%
Improved your health	65%	75%	70%	61%

Note: Percent agreement is shown in the table and is defined as the percent of respondents rating their agreement as a three or a four on the 1 (Do not agree at all) to 4 (Completely agree) scale.

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Table 6-15 Benefits of PIPP (Electric Participant)

Benefit	Black Hills	Public Service
	(n = 135)	(n = 113)
Improved home comfort*	90%	77%
Easier to pay other expenses*	91%	72%
Less worried about paying utility costs*	89%	68%
Reduced shutoff notices*	85%	72%
Reduced shutoffs	84%	79%
Improved your health	71%	64%

Note: Percent agreement is shown in the table and is defined as the percent of respondents rating their agreement as a three or a four on the 1 (Do not agree at all) to 4 (Completely agree) scale.

*Difference is statistically significant at $p < .05$

The majority (79%) of in-depth interview respondents indicated they were able to run their heating systems more because of the assistance they received. Eighty-four percent of respondents reported having some type of cooling system (window AC, central AC, or swamp cooler) and 69% indicated they were able to run their cooling systems more often because of the assistance they have received. A total of three interviewed PIPP participants recalled receiving a heating system replacement from LEAP and five participants received services from the Weatherization Assistance Program (WAP). Among the participants who receive WAP services, three indicated they received improvements to their homes that improve the health and safety of their homes, three indicated the weatherization work improved the indoor quality of their home, and three stated there were repairs to the heating system, broken windows, and holes to the outside of their homes. One respondent indicated they have experienced fewer illness due to the WAP services

Several in-depth interview respondents reported the energy assistance they have received has decreased their worry about paying utility and other bills. Below are some verbatim responses regarding decreased worry and stress after participating in LEAP and PIPP.

“Because when I was married raising kids, with a business, I never had enough. Now I am making very little, but I have very few bills. My worry has decreased.”

“I am the kind of person that gets stressed. High stress and anxiety and I thought I would end up in the hospital. I gave up stuff but after LEAP I don't have the worries any more about my utilities. They really helped me a lot, stopped me from getting sick. I feel great and don't worry about anything.”

“The assistance was there when I didn't have grocery money. I was able to pay the correct amount on my other bills. Reduce stress.”

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"The assistance I get from LEAP and BHEAP and Xcel given they all come under the same umbrella; it takes a great deal of pressure off me. I pay a small amount to BH and my Xcel has always been fair."

"I don't worry because I know that there's is always help coming. I do not get help with my cell phone and internet. My Xcel bill is lowest priority because it is less stressful. I have MS, so in the summertime I get help from Xcel. So, the programs are a direct benefit to my health. It is literally be dangerous for me to leave the house during the summer."

"I am a single mom before I was not able to afford it without this program, I don't know what I would have done. It has made it affordable for something we need."

"It just reassures me that I will have electricity and not have to worry that I need to move in with my daughter."

"You know the assistance programs gives me leeway to pay other bills."

6.5 Covid-19 Impacts

A large share of respondents reported Covid-19 work impacts, primarily lost jobs and reduced pay. As shown in Table 6-16, approximately one-third of respondents that their work had been impacted by Covid-19. Relatively few reported that that these impacts resulted in their working from home, but that the impacts were primarily due to layoffs and reduced pay. The increased time at home resulting from reduced work hours and to a lesser extent, working from home, may account for the increased utility costs reported by close to one-half of respondents and summarized in Table 6-17.

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Table 6-16 Work Impacts due to Covid-19

Covid-19 impacts on work	Atmos		Black Hills		CNG		Public Service	
	Participant (n = 71)	Non-Participant (n = 55)	Participant (n = 147)	Non-Participant (n = 67)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 142)	Non-Participant (n = 78)
Lost a job due to layoff	11%	4%	16%	10%	7%	0%	22%	31%
Lost a job due to a furlough or temporary layoff	11%	9%	12%	3%	10%	0%	17%	22%
Had a reduction in hours of work or salary	15%	18%	16%	12%	20%	50%	25%	40%
Transitioned to working from home	6%	7%	5%	0%	7%	0%	7%	14%
None of the above	65%	62%	55%	70%	63%	50%	36%	22%
Prefer not to state	6%	9%	9%	10%	3%	0%	11%	10%

Table 6-17 Utility Cost Impacts due to Covid-19

Increased utility costs since Covid-19	Atmos		Black Hills		CNG		Public Service	
	Participant (n = 70)	Non-Participant (n = 55)	Participant (n = 147)	Non-Participant (n = 68)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 142)	Non-Participant (n = 79)
Yes	43%	38%	46%	44%	57%	0%	61%	82%
No	57%	62%	54%	56%	43%	100%	39%	18%

Between one-quarter and one-half of participants reported that they were aware of the extension of LEAP season.

Table 6-18 Awareness of Extended LEAP Season

Aware of extended LEAP season	Atmos		Black Hills		CNG		Public Service	
	Participant (n = 71)	Non-Participant (n = 55)	Participant (n = 147)	Non-Participant (n = 68)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 142)	Non-Participant (n = 79)
Yes	49%	38%	25%	22%	53%	0%	40%	22%
No	51%	62%	75%	78%	47%	100%	60%	78%

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6.6 Home and Demographic Characteristics

Approximately one-half of respondents reported that they own their home. The rates of home ownership were similar to but some somewhat lower than was estimated for the population of PIPP qualified customers using census data.

Table 6-19 Homeownership

Home Ownership	Atmos		Black Hills		CNG		Public Service	
	Participant (n = 71)	Non-Participant (n = 54)	Participant (n = 147)	Non-Participant (n = 68)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 141)	Non-Participant (n = 78)
Own	48%	48%	35%	46%	73%	50%	35%	24%
Rent	49%	43%	60%	49%	23%	50%	59%	71%
Don't know	0%	0%	1%	0%	0%	0%	0%	0%
Prefer not to answer	3%	9%	5%	6%	3%	0%	6%	5%

Natural gas heating was common among respondents. As shown, the share of customers reporting natural gas heating was common among respondents. It should also be noted that some participants in the gas program reported electric heating, which would make them ineligible for the gas program. For Atmos, CNG, and Black Hills (6%, not shown in table) these rates were small, but a sizable share (39%, not shown in table) of Public Service respondents received gas benefits and reported electric heating.

Table 6-20 Heating Fuel Type

Heating Fuel Type	Atmos		Black Hills		CNG		Public Service	
	Participant (n = 71)	Non-Participant (n = 56)	Participant (n = 148)	Non-Participant (n = 68)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 142)	Non-Participant (n = 78)
Natural gas	90%	80%	76%	71%	90%	100%	46%	42%
Electricity	4%	5%	18%	21%	10%	0%	39%	47%
Other	1%	0%	1%	1%	0%	0%	1%	0%
Don't know	4%	2%	3%	3%	0%	0%	13%	10%
Prefer not to answer	0%	13%	1%	4%	0%	0%	1%	1%

Table 6-21 provides a summary of the demographic characteristics of the survey respondents. Noteworthy findings include:

- About one-third to one-half of households had members under the age of 18.
- A sizable share of respondents, between one-third and one-half, reported that a member of their household is diagnosed with a disability of impairment.

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- The presence of a member of the household age 65 or more varied by utility and participant group.

Table 6-21 Demographic Characteristics

Characteristic	Atmos		Black Hills		CNG		Public Service	
	Partici pant (n = 71)	Non- Partici pant (n = 55)	Partici pant (n = 147)	Non- Partici pant (n = 68)	Partici pant (n = 30)	Non- Partici pant (n = 4)	Partici pant (n = 140)	Non- Partici pant (n = 79)
Number of people in household								
Average	2.7	2.1	2.7	2.2	2.5	2.5	3.1	3.5
Don't know	0%	0%	1%	0%	0%	0%	0%	0%
Prefer not to answer	0%	7%	3%	6%	0%	0%	4%	1%
Household members under 18 present	39%	33%	48%	34%	30%	50%	59%	75%
Age 5 or under (Average number)	1.3	1.6	1.6	1.5	n/a	3.0	1.2	1.5
Age 6-10 (Average number)	1.8	2.8	2.6	4.8	3.0	n/a	1.9	2.0
Age 11-18 (Average number)	4.7	1.7	2.4	2.8	3.4	1.0	2.2	3.8
Household member diagnosed with disability of impairment	51%	33%	53%	53%	40%	67%	37%	46%
Household member over age 65	32%	40%	17%	40%	53%	75%	24%	10%
2019 Income								
Average (in thousands of dollars)	\$14.1	\$18.1	\$13.4	\$18.7	\$42.9	\$36.0	\$24.3	\$23.1
Prefer not to answer	21%	24%	22%	19%	27%	25%	27%	18%
Don't know	28%	27%	26%	42%	20%	25%	30%	46%
Race/ethnicity ¹								
Hispanic, Latino, or Spanish Origin	28%	18%	44%	41%	10%	0%	30%	41%
White	74%	71%	54%	57%	93%	75%	62%	51%
Black or African American	2%	4%	2%	3%	0%	25%	15%	13%
American Indian or Alaskan Native	8%	4%	8%	4%	0%	0%	4%	9%
Asian	0%	0%	2%	0%	4%	0%	1%	3%
Pacific Islander	0%	0%	1%	0%	0%	0%	1%	0%
Other	15%	13%	15%	21%	0%	0%	9%	17%
Prefer not to answer	6%	20%	25%	18%	7%	0%	16%	17%

1. The percentages for race/ethnicity do not add to 100% because Hispanic, Latino, or Spanish identification can apply to multiple racial/ethnic groups and because respondents were allowed to select more than racial/ethnic group.

7 Program Impacts

7.1 Data Collection

7.1.1 Data Collection Results

This section discusses the results of ADM's data collection efforts, and issues of data quality or consistency on estimation of outcomes and program metrics.

As described in Section 3.5.1, ADM requested five types of data for PIPP participants and non-participants: billing & cost data, PIPP enrollment data, disconnect data, demographic data, and other program enrollment data (e.g. LIHEAP). Broadly speaking, all the requested utilities were able to fulfill each of these data requests. However, there were issues relating to data consistency or missing data fields that made comparisons across utilities for certain metrics and outcomes difficult. Some of these data issues showed up repeatedly across utilities, suggesting that ADM needed to provide more detail and context in the data request. Below, key data issues encountered during the evaluation are discussed below to provide future evaluators with the means of obtaining consistent and relevant data.

Key data challenges:

- 1) Total billed amounts, or energy usage cost, was interpreted differently by the utilities. Atmos and CNG provided a data field which represented a rolling balance for a PIPP account and was based on levelized budget billing. Levelized budget billing for Atmos involves deducting LIHEAP and PIPP payments from an average of the customer's prior 11 months of bills. This calculation is done in such a way that the customer only pays 2% of their income towards energy bills. Essentially this data field accounted for LEAP, PIPP, and customer payments, and does not represent average energy cost for each billing interval. On the other hand, Public Service and Black Hills provided a data field called "Amount Billed" or "Billed Amount" which did not appear to be based on Levelized budget billing. This data field appeared to correspond to the monthly billed usage amount, which is what ADM needed to calculate energy burden.
- 2) Income was not provided for Public Service PIPP customers. This hampered efforts at calculating energy burden for customers enrolled in PIPP or LIHEAP.
- 3) CNG was unable to provide a non-participant group from which to construct a comparison group.
- 4) A past due amount at the monthly invoice level was provided by Atmos but could not be obtained for the other utilities. In some cases, utilities provided a past due amount (arrears) on the date of a disconnect. However, this is a less useful for determining changes in arrearage amounts due to the program intervention since pre- and post-period arrearage levels cannot be calculated. In addition, for some utilities, the past due amount represented the amount on the latest recorded disconnect or disconnect notice, which leads to a different interpretation for the outcome.

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- 5) Similar to item 4) above, one utility (Public Service) provided only the latest disconnect recorded during the evaluation period, while all the other utilities provided every recorded disconnect. This resulted in inconsistent interpretation of disconnect-related regression outcomes.
- 6) LEAP data was inconsistent and provided different sets of data fields. ADM attempted to estimate the share of PIPP customers found in LEAP, but in some cases LEAP enrollment was restricted to the PIPP population (or restricted in some other way).
- 7) Obtaining a definition of a PIPP enrollment was difficult due to a lack of certain data fields and a pre-defined enrollment methodology. For one utility (Atmos), the program enrollment start- and end- dates were provided. In other cases, only the year of program enrollment or an enrollment start date was provided. This resulted in the need for additional assumptions regarding the actual enrollment start and end dates and the year of program enrollment. ADM recommends the program start and end dates are provided in future evaluations, along with the year of program enrollment for each customer and enrollment interval.

7.1.2 Typical Meteorological Year (TMY) Data

Typical Meteorological Year (TMY) data was included in the modeling of program effects to adjust for differences in weather that may affect energy use and costs. Table 7-1 and Table 7-2 provide the results of estimating annual HDD and CDD for Colorado using TMY data¹³. Table 7-1 shows estimated HDD and CDD for selected cities representing each of the International Energy Conservation Code (IECC) weather zones found in Colorado. In Table 7-2, average degree days for each weather zone are calculated and an overall weighted average is constructed for Colorado using the census population reported in each weather zone. The population weighted TMY-based annual degree day values are used when extrapolating changes in annual energy usage.

¹³ https://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/by_state_and_city.html

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Table 7-1 Typical Meteorological Year (TMY) Degree Days

Location	City Population (Census 2010-2018) ¹⁴	County	IECC Zone ¹⁵	TMY HDD	TMY CDD
Denver	693,417	Denver	5B	4,769	1,116
Colorado Springs	457,502	El Paso	5B	5,152	800
Aurora	363,550	Adams	5B	5,202	1,013
Fort Collins	162,511	Larimer	5B	5,964	766
Pueblo	109,985	Pueblo	5B	4,561	1,363
Greeley	103,773	Weld	5B	5,990	833
Craig-Moffat	8,888	Moffat	6B	7,664	620
Cortez	8,637	Montezuma	5B	5,225	1,096
Trinidad	8,043	Las Animas	4B	4,550	1,077
La Junta	6,914	Otero	4B	4,485	1,598
Eagle	6,816	Eagle	6B	7,047	559
Gunnison	6,322	Gunnison	7B	8,073	320
Leadville	2,679	Lake	7B	8,659	90
Average				5,949	866
Weighted Average				5,132	985

Table 7-2 TMY Degree Day Weighted Averages

IECC Zone	CO Population (Census 2010- 2018) ¹⁶	% of Population in TMY Data	HDD (Weighted)	CDD (Weighted)
4B	36,067	41%	4,520	1,318
5B	5,181,145	37%	5,103	989
6B	159,866	10%	7,396	593
7B	154,063	6%	8,247	252
Weighted Average			5,253	959

7.2 Program Metrics

Table 7-3 provides the number of PIPP enrollees for each utility and fuel type for each year of the triennial period. Reenrollment rates were also calculated for each program year and represent

¹⁴ https://www.colorado-demographics.com/cities_by_population

¹⁵ IECC weather zones for Colorado counties: <https://www.steelbuildinginsulation.com/colorado.html>

¹⁶ https://www.colorado-demographics.com/counties_by_population

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the number of PIPP enrollees in a given program year that were found to have enrolled in the following program year.

There results presented in this section are from analysis of utility provided data on enrollments and participation, except where noted.

Table 7-3 PIPP Enrollment by Utility and Fuel Type

Utility	Fuel Type	Program Year	Number Enrolled	Reenrollment Rates
Atmos	Gas	PY2016/17	1,053	21%
Atmos	Gas	PY2017/18	653	32%
Atmos	Gas	PY2018/19	806	N/A
Colorado Natural Gas	Gas	PY2016/17	186	41%
Colorado Natural Gas	Gas	PY2017/18	213	65%
Colorado Natural Gas	Gas	PY2018/19	348	70%
Black Hills	Electric	PY2016/17	1,735	63%
Black Hills	Electric	PY2017/18	1,362	69%
Black Hills	Electric	PY2018/19	1,106	71%
Black Hills	Gas	PY2016/17	609	77%
Black Hills	Gas	PY2017/18	495	39%
Black Hills	Gas	PY2018/19	209	50%
Public Service	Electric	PY2016/17	4,803	7%
Public Service	Electric	PY2017/18	2,206	17%
Public Service	Electric	PY2018/19	10,063	20%
Public Service	Gas	PY2016/17	7,074	6%
Public Service	Gas	PY2017/18	3,519	20%
Public Service	Gas	PY2018/19	11,424	22%

Table 7-4 summarizes PIPP and LEAP enrollment for each utility and program year.

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Table 7-4 LEAP and PIPP Enrollment by Utility and Fuel Type

Utility	Fuel Type	Program Year	Number Enrolled in PIPP	Number Enrolled in LEAP
Atmos	Gas	PY2016/17	1,053	24,579
Atmos	Gas	PY2017/18	653	25,422
Atmos	Gas	PY2018/19	806	22,259
Colorado Natural Gas ¹	Gas	PY2016/17	186	192
Colorado Natural Gas ¹	Gas	PY2017/18	213	205
Colorado Natural Gas ¹	Gas	PY2018/19	348	338
Black Hills ²	Electric	PY2016/17	1,735	603
Black Hills ²	Electric	PY2017/18	1,362	603
Black Hills ²	Electric	PY2018/19	1,106	509
Black Hills	Gas	PY2016/17	609	5,906
Black Hills	Gas	PY2017/18	495	6,127
Black Hills	Gas	PY2018/19	209	5,600
Public Service ³	Electric	PY2016/17	4,803	42,436
Public Service ³	Gas	PY2016/17	7,074	
Public Service ³	Electric	PY2017/18	2,206	38,451
Public Service ³	Gas	PY2017/18	3,519	
Public Service ³	Electric	PY2018/19	10,063	37,490
Public Service ³	Gas	PY2018/19	11,424	

1. LEAP enrollments were provided in an email response.

2. PIPP electric enrollments exceed LEAP electric enrollments because most use natural gas heating and in most cases receive LEAP from a different natural gas utility.

3. LEAP enrollments were provided in an email response.

Table 7-5 provides additional summary metrics for each PIPP program, including the average PIPP credit amount (\$), average annual energy cost (\$), the percent share of annual bills covered by PIPP, and energy burden for the average PIPP customer. In the case of Public Service, a monthly PIPP payment was provided for each customer rather than an annual PIPP credit. ADM multiplied this average PIPP payment by 12, to convert to an annual amount. In the case of Atmos, the average annual energy cost is an estimate of energy cost provided by Atmos, however, it is not clear if this estimate includes LEAP credits or not.¹⁷ For Colorado Natural Gas (CNG), average annual income was estimated based on average monthly income for PIPP customers.

¹⁷ Total billing for Atmos is based on the Budget Billing method and could not be used to calculate annual energy cost. Customer payments were also not used for annual energy costs since customers may not keep up with their payments.

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Table 7-5 Summary PIPP Program Metrics

Utility	Fuel Type	Program Year	Average Annual Income (\$)	Average PIPP Credit (\$)	Average Annual Energy Cost (\$)	Average Share of Bills Covered by PIPP	Average Energy Burden ¹⁸
Atmos	Gas	PY2016/17	\$9,453	\$161	\$544	30%	4%
Atmos	Gas	PY2017/18	\$9,015	\$156	\$661	24%	6%
Atmos	Gas	PY2018/19	\$9,675	\$162	\$643	25%	5%
Colorado Natural Gas	Gas	PY2016/17	\$16,478	\$691	N/A	N/A	N/A
Colorado Natural Gas	Gas	PY2017/18	\$16,841	\$804	N/A	N/A	N/A
Colorado Natural Gas	Gas	PY2018/19	\$16,883	\$656	N/A	N/A	N/A
Black Hills	Electric	PY2016/17	\$10,917	\$603	\$1,237	49%	6%
Black Hills	Electric	PY2017/18	\$9,981	\$856	\$1,369	62%	5%
Black Hills	Electric	PY2018/19	\$13,384	\$475	\$1,287	37%	6%
Black Hills	Gas	PY2016/17	\$10,526	\$240	\$753	32%	5%
Black Hills	Gas	PY2017/18	\$10,527	\$187	\$766	24%	6%
Black Hills	Gas	PY2018/19	\$11,295	\$130	\$745	17%	5%
Public Service	Electric	PY2016/17	N/A	\$516	\$827	62%	N/A
Public Service	Electric	PY2017/18	N/A	\$615	\$966	64%	N/A
Public Service	Electric	PY2018/19	N/A	\$420	\$932	45%	N/A
Public Service	Gas	PY2016/17	N/A	\$286	\$476	60%	N/A
Public Service	Gas	PY2017/18	N/A	\$312	\$521	60%	N/A
Public Service	Gas	PY2018/19	N/A	\$207	\$564	37%	N/A

The following figures depict the number of PIPP participants enrolled by program year. In addition, for each program year, the number of reenrollments and the number of participants enrolled in prior years are shown (in %). For example, in PY 2018, Atmos enrolled 653 customers in PIPP (middle panel of Figure 7-1), and of these customers, 34% were also enrolled in PY 2017, while 32% of reenrolled in PY 2019.

¹⁸ Energy burden = (average annual energy cost - average PIPP credit)/average annual income.

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Figure 7-1 Atmos PIPP Enrollment by Program Year

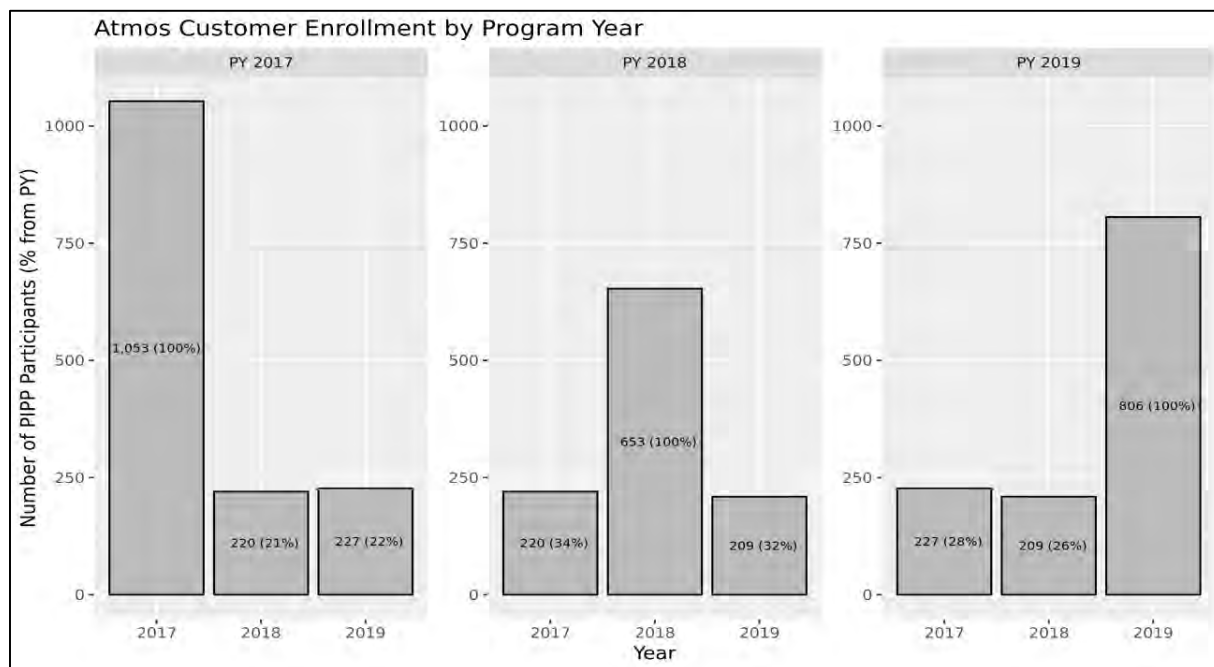
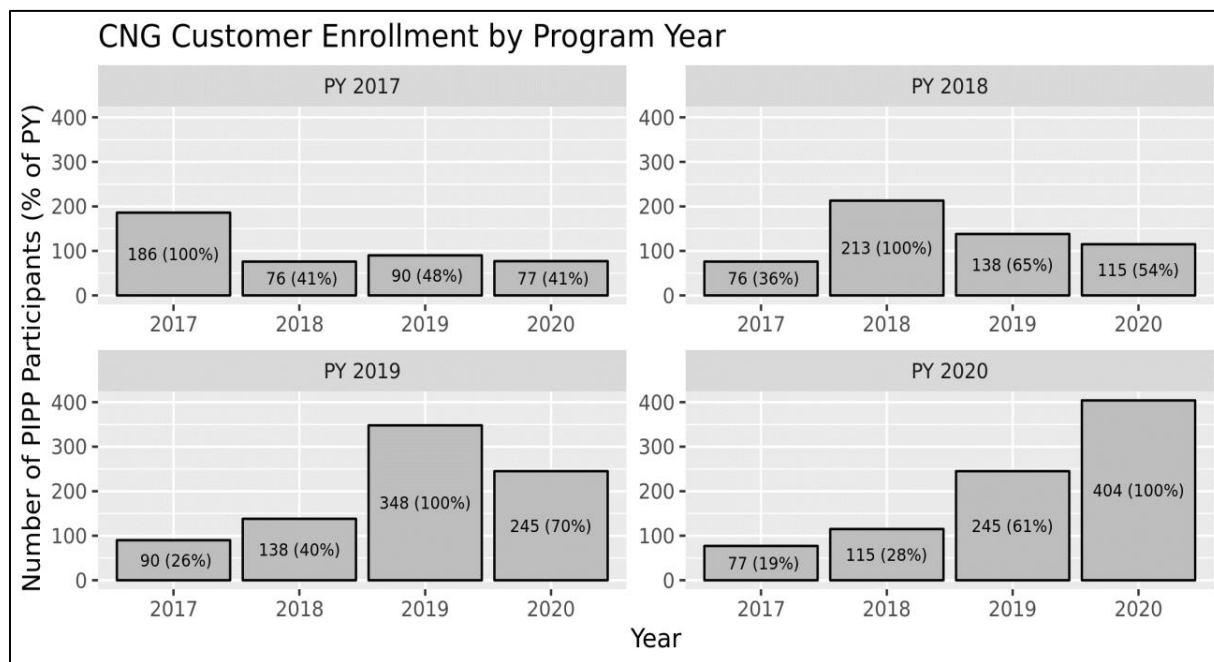


Figure 7-2 CNG PIPP Enrollment by Program Year



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Figure 7-3 Black Hills Electric PIPP Enrollment by Program Year

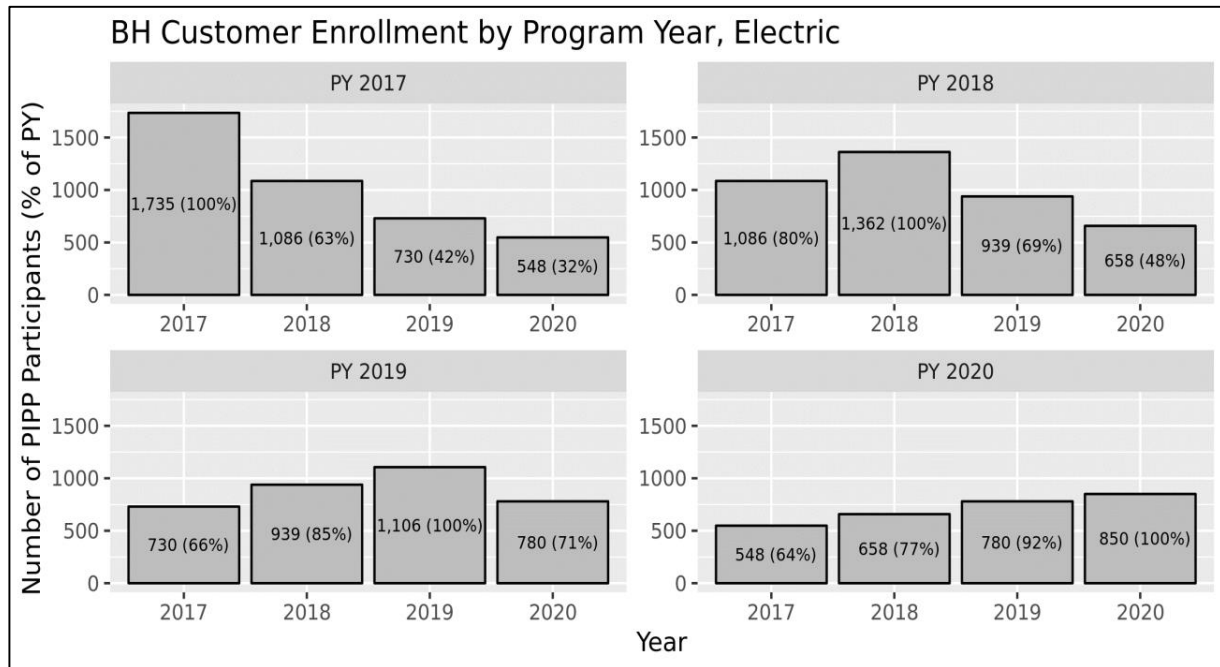
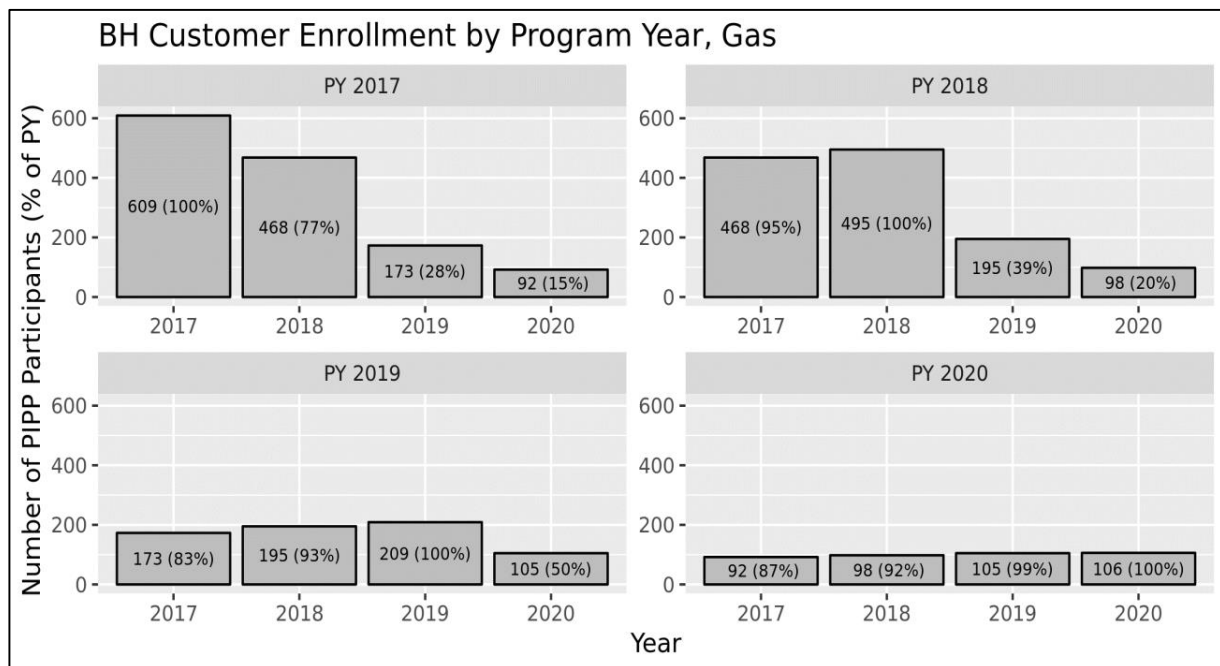


Figure 7-4 Black Hills Gas PIPP Enrollment by Program Year



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Figure 7-5 Public Service Electric PIPP Enrollment by Program Year

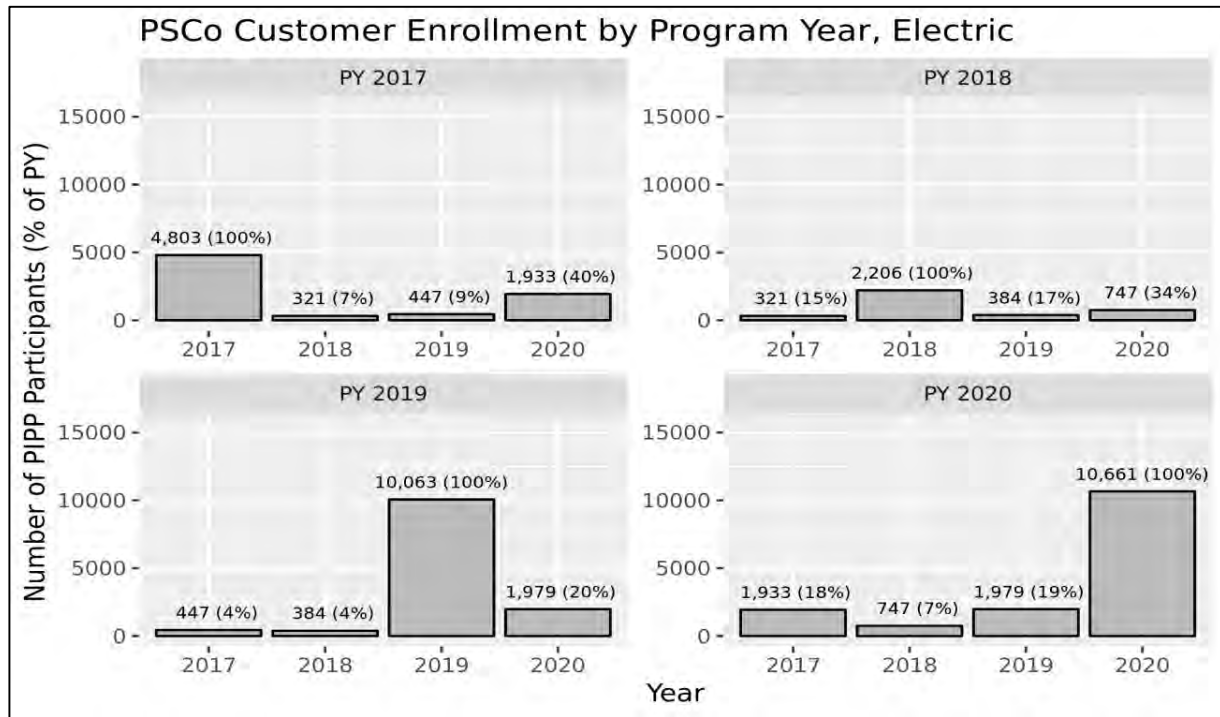
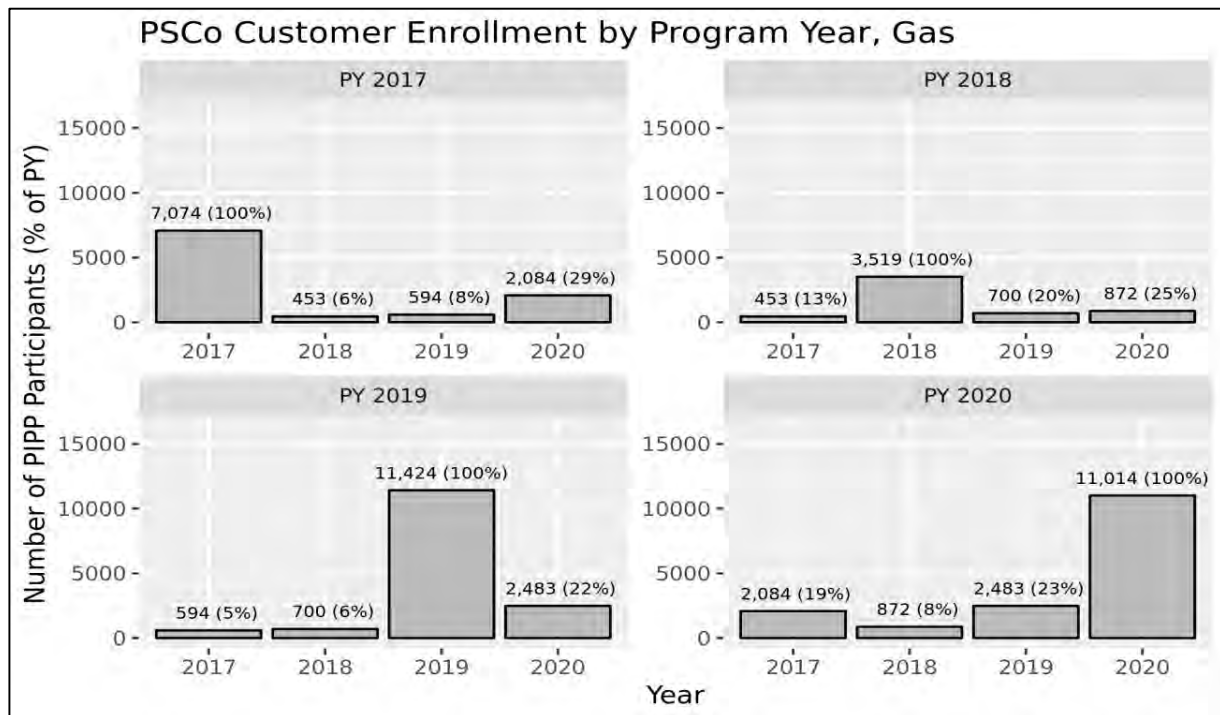


Figure 7-6 Public Service Gas PIPP Enrollment by Program Year



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The figures below provide summary averages for PIPP participants for several common measures found in each utility's billing data, including consumption, past due amounts, PIPP payments, and total billed. In some cases, the provided data covered more than the triennial period and these years were included for reference.

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Figure 7-7 Atmos Billing Data Summary

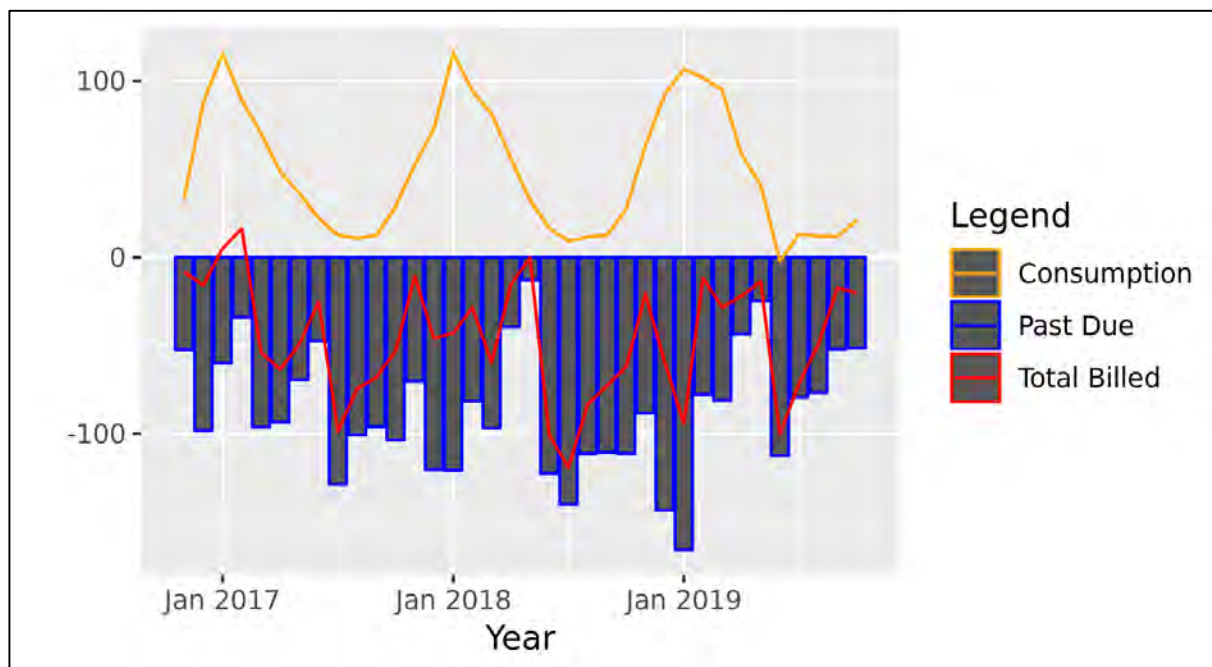
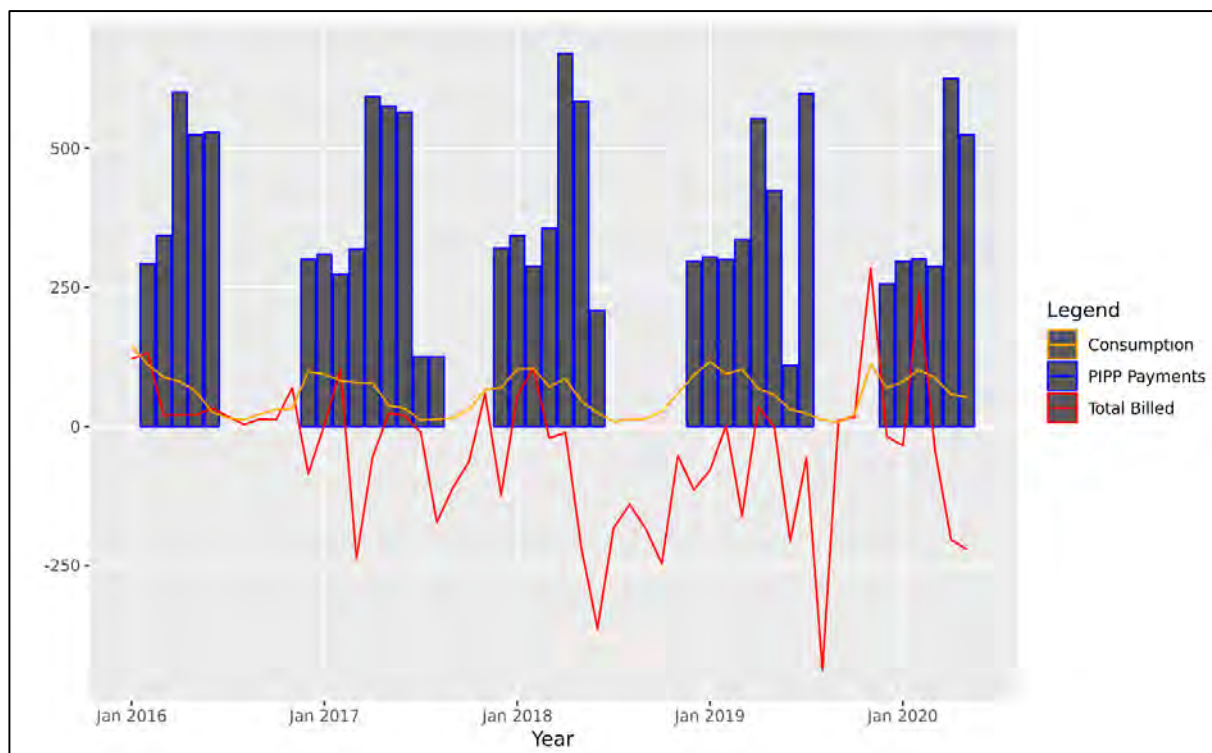


Figure 7-8 CNG Billing Data Summary



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Figure 7-9 Black Hills Electric Billing Data Summary

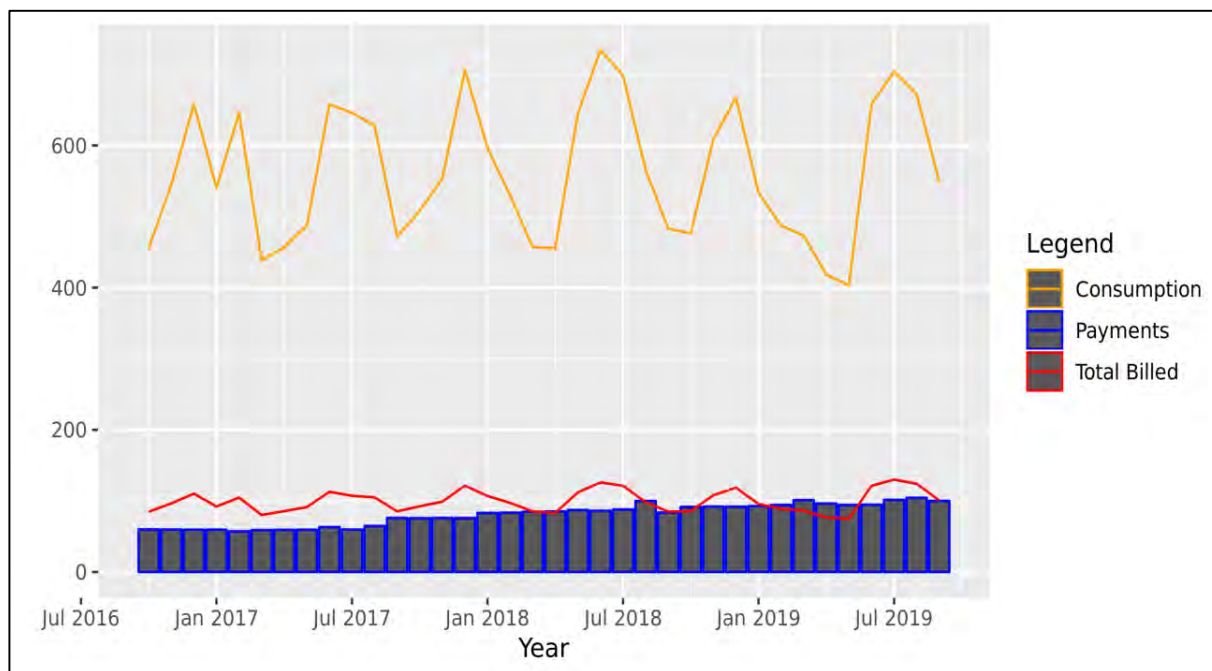
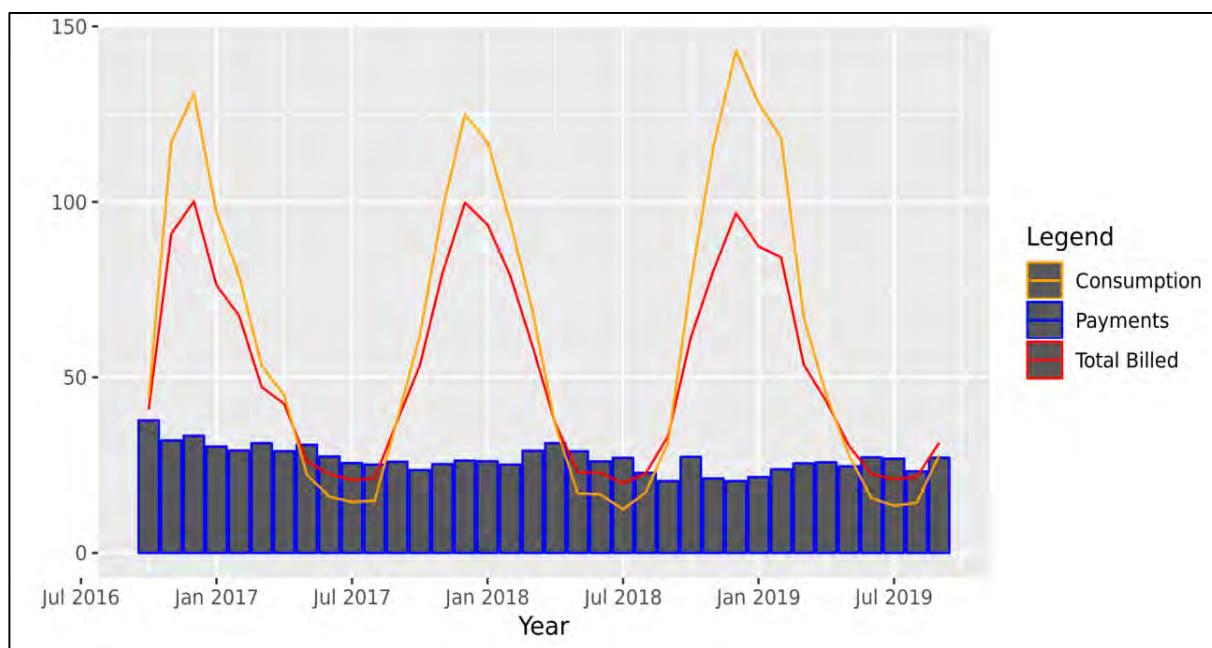


Figure 7-10 Black Hills Gas Billing Data Summary



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Figure 7-11 Public Service Electric Billing Data Summary

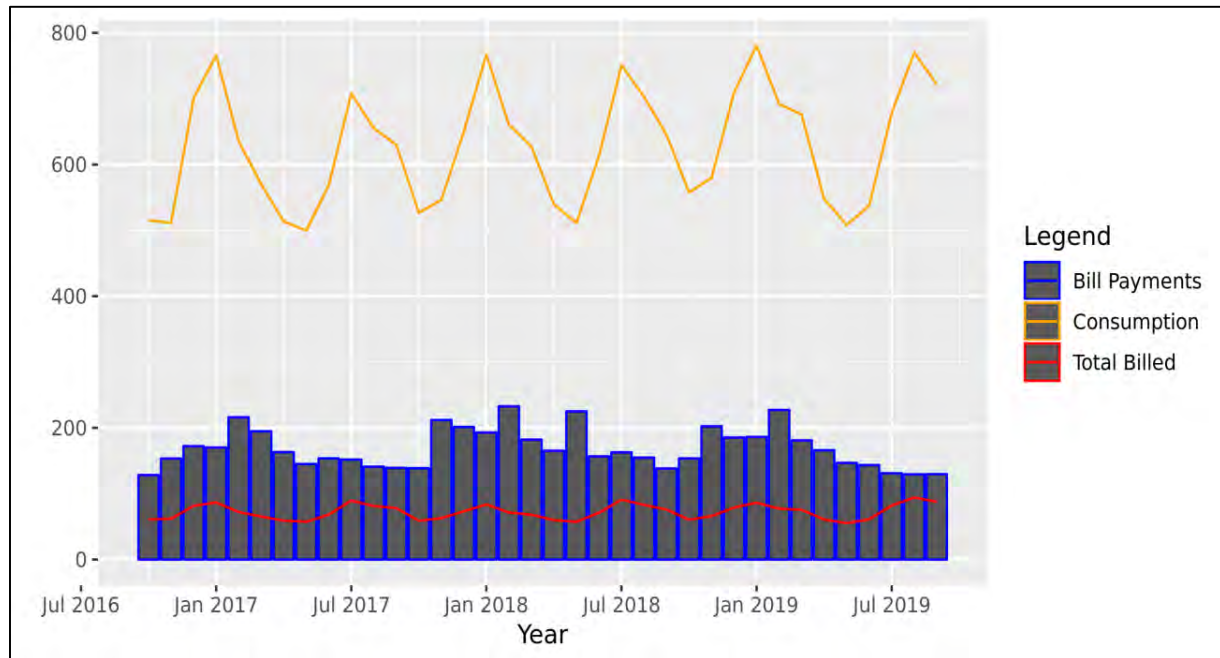
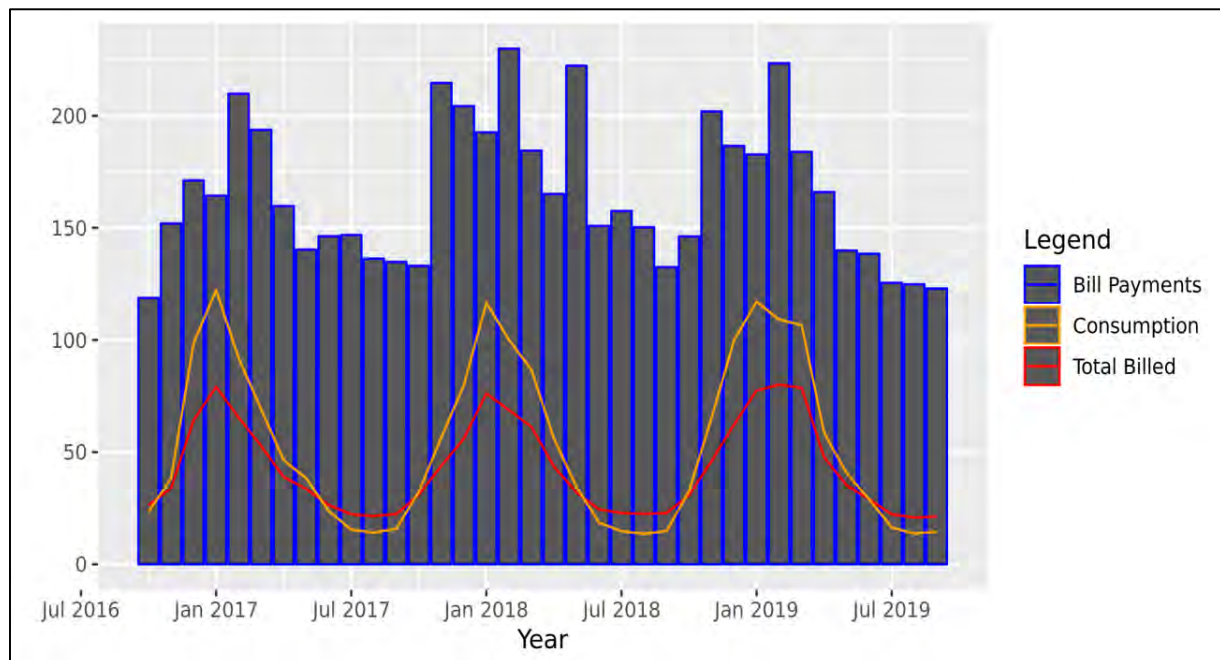


Figure 7-12 Public Service Gas Billing Data Summary



7.3 Cohort Creation

The following sections summarize the data cleaning and preparation steps taken for each of the utilities prior to analysis of the program impacts.

7.3.1 Atmos Cohort Creation

ADM performed the following restrictions and data cleaning steps as part of cohort creation and preparation for the billing analyses, as shown in Table 7-6. A standard difference-in-difference estimate typically involves a single point in time in which an intervention occurs. However, PIPP customers could enroll at any point during a program year and they could enroll across multiple program years, therefore, an artificial intervention date was created on November 1st, 2017. Any PIPP customers with enrollments prior to this date were excluded from the cohort in order to allow for a clean pre-period for treatment customers. For both treatment and control customers, the constructed pre-period is from November 1st, 2016 through October 31st, 2017. However, the post-period is handled differently for treatment and control customers. For control customers, all available billing data from November 1st, 2017 onwards falls into the post period, while for treatment customers, the billing data must also fall within the PIPP enrollment window.

Table 7-6 Cohort Restrictions, Atmos

Restriction	Number of Treatment Customers	Number of Control Customers
Starting point	1,940	68,436
Removed enrollments with program start dates prior to PY2017 (program year cutoff to obtain clean pre-period)	1,246	68,436
Removed treatment customers with enrollments in PY2017 (clean period)	891	68,436
Keep if in pre- or post- period	890	68,379
Removed billing duration outliers	890	68,012
Removed usage/day outlier	890	68,001
Removed if insufficient bills ¹⁹ or average usage equal to zero	567	37,789
Keep PIPP or LEAP customers	567	4,020
Keep if customer had complete pre-period	567	4,020

ADM was successful in creating a matched cohort and the results of PSM are summarized below. ADM used nearest neighbor, 1 to 1 ratio matching and had a considerable pool of control customers to draw upon, as shown in Table 7-7. Customers were matched on their average pre-period seasonal usage, including winter, spring, summer and fall for each control and treatment household.

¹⁹ ADM required at least 3 months of pre-period and 3 months of post-period billing data, and at least 12 months of billing data overall.

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Table 7-7 PSM Customer Matches, Atmos

Status	Control	Treated
All	3,767	547
Matched	547	547
Unmatched	3,220	0

Table 7-8 presents the propensity score covariate summary of pre-period usage for treatment and control customers before and after matching. The standardized mean difference prior to matching is often over 0.2 for many covariates; however, after matching the absolute value of the standardized mean difference is less than 0.1, which is an ideal outcome.

Table 7-8 PSM Covariate Summary, Atmos

Variable	Before Matching			After Matching		
	Mean Treated	Mean Control	Standardized Mean Difference	Mean Treated	Mean Control	Standardized Mean Difference
Distance	0.159	0.122	0.406	0.159	0.159	0.005
Pre-period Winter Usage	3.848	3.104	0.456	3.848	3.840	0.004
Pre-period Spring Usage	2.277	1.793	0.469	2.277	2.277	0.000
Pre-period Summer Usage	0.747	0.574	0.427	0.747	0.746	0.003
Pre-period Fall Usage	0.816	0.616	0.396	0.816	0.812	0.008

Table 7-9 provides results for a t-test which helps determine the success of matching. The test measures whether there are statistically significant differences in average daily therms used between the treatment and comparison groups in the pre-period by month. Statistically significant differences are defined as p-value of less than 0.05 at the 95% significance level. As shown in both tables, the p-value is greater than 0.05 for each month. This result further indicates propensity score matching performed well because the differences between the treatment and comparison groups are not statistically significant.

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Table 7-9 Post Matching T-Test of Difference in Usage by Month, Atmos

Month	Average Daily Therms Control	Average Daily Therms Treatment	T Stat	Std Error	P-Value	Reject Null?
Jan	4.567	4.687	-1.016	0.118	0.310	No
Feb	4.239	4.358	-1.073	0.111	0.283	No
Mar	2.914	2.929	-0.200	0.077	0.841	No
Apr	2.366	2.459	-1.347	0.070	0.178	No
May	1.653	1.678	-0.524	0.049	0.601	No
June	1.138	1.181	-1.067	0.039	0.286	No
July	0.689	0.708	-0.727	0.027	0.467	No
Aug	0.470	0.472	-0.096	0.020	0.924	No
Sept	0.522	0.563	-1.743	0.023	0.082	No
Oct	0.632	0.668	-0.975	0.037	0.330	No
Nov	1.303	1.279	0.484	0.050	0.629	No
Dec	2.530	2.550	-0.246	0.082	0.806	No

Figure 7-13 displays the density of each variable employed in propensity score matching, before conducting matching. Figure 7-14 displays the density of each variable employed in propensity score matching, after conducting matching.

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Figure 7-13 Average Daily Usage by Season for Treatment and Comparison Groups Before Matching, Atmos

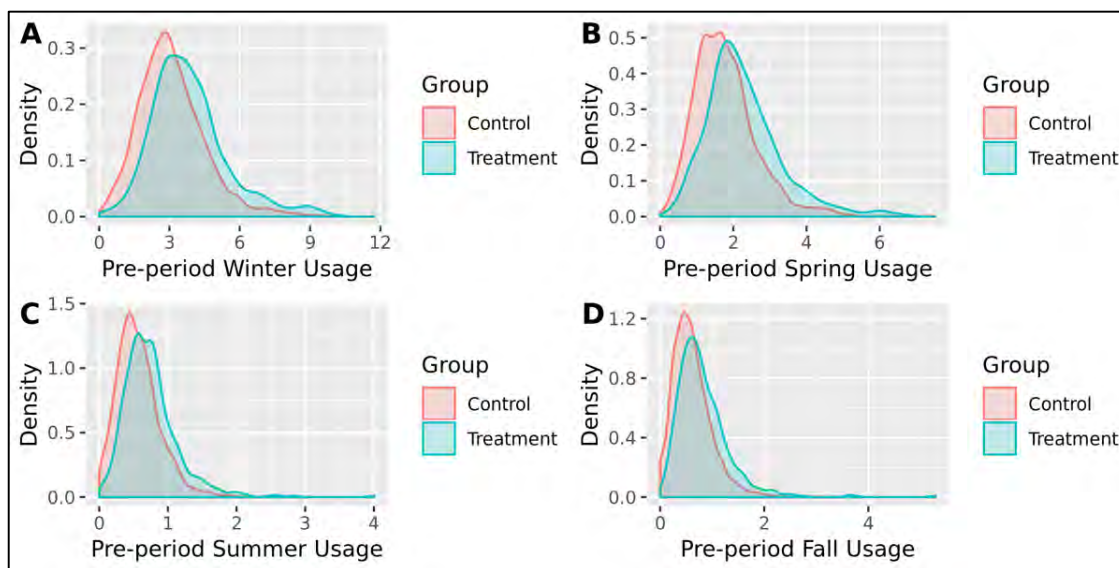
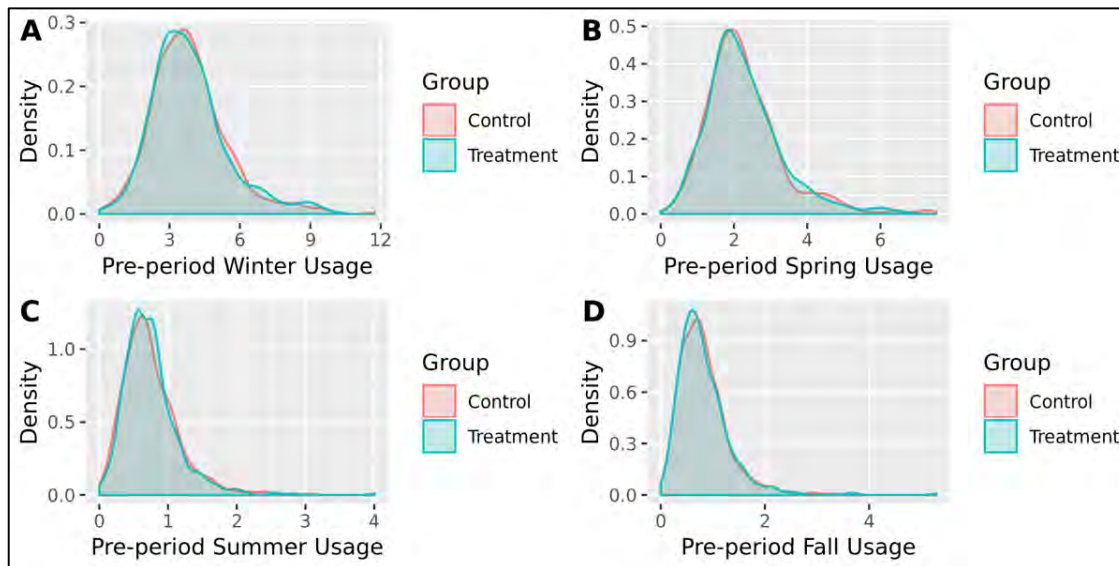


Figure 7-14 Average Daily Usage by Season for Treatment and Comparison Groups After Matching, Atmos



Lastly, the joint chi-square test for covariate balance had a p-value of 0.71, meaning ADM failed to reject the null hypothesis of covariate imbalance (i.e., the treatment and comparison group are similar).

7.3.2 CNG Cohort Creation

ADM performed the following restrictions and data cleaning steps as part of cohort creation and preparation for the billing analyses, as shown in Table 7-10. CNG was unable to provide a group of customers to use for a comparison group. As a result, ADM utilized the variance-in-adoption method discussed in Section 3.5.2. With this cohort method, there is no need to create an artificial intervention date since a difference-in-difference with controls is not utilized. However, customer enrollments with insufficient pre- and post-period bills are removed from the cohort.

The data for PIPP enrollment for CNG did not list program start and end dates and evaluators only knew the enrollment year. As such, ADM assumed a program start date of November 1st and an end date of October 31st for a given program year since PIPP enrollment matches LIHEAP program enrollment dates. However, if customers were not enrolled for the entire program year, which was often the case for other utilities analyzed, there would be some amount of bias, that would lessen the apparent program impacts, introduced by considering all customers to have full program year enrollment (i.e. the post-period would include periods when a customer is not enrolled in PIPP).

Table 7-10 Cohort Restrictions, CNG

Restriction	Number of Treatment Customers
Starting point	638
Keep if in pre- or post-period	638
Removed billing duration outliers	638
Removed usage/day outlier	638
Removed if insufficient bills ²⁰ or average usage equal to zero	571

7.3.3 Black Hills Cohort Creation

ADM performed the following restrictions and data cleaning steps as part of cohort creation and preparation for the billing analyses, as shown in Table 7-11 and Table 7-12. Black Hills did provide a group of customers to use for a comparison group. However, the majority of PIPP customers enrolled during the triennial period were enrolled in PY2017. As a result, a clean pre-period could not be created for a large enough treatment cohort for PSM. ADM utilized the variance-in-adoption method discussed in Section 3.5.2. With this cohort method, there is no need to create an artificial intervention date since a difference-in-difference with controls is not utilized.

²⁰ ADM required at least 3 months of pre-period and 3 months of post-period billing data, and at least 12 months of billing data overall.

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However, customer enrollments with insufficient pre- and post-period bills are removed from the cohort²¹.

Table 7-11 Cohort Restrictions, Black Hills Electric

Restriction	Number of Treatment Customers
Starting point	2778
Removed PIPP with < 90-day enrollment period	2657
Keep if in pre- or post-period	2007
Keep if bill during triennial period	1962
Removed billing duration outliers	1958
Removed usage/day outlier	1958
Removed if insufficient bills or average usage equal to zero	363

Table 7-12 Cohort Restrictions, Black Hills Gas

Restriction	Number of Treatment Customers
Starting point	716
Removed PIPP with < 90-day enrollment period	660
Keep if in pre- or post-period	572
Keep if bill during triennial period	571
Removed billing duration outliers	569
Removed usage/day outlier	569
Removed if insufficient bills ²² or average usage equal to zero	68

7.3.4 Public Service Cohort Creation

ADM performed the following restrictions and data cleaning steps as part of cohort creation and preparation for the billing analyses, as shown in Table 7-13 and Table 7-14. A standard difference-in-difference estimate typically involves a single point in time in which an intervention occurs. However, PIPP customers could enroll at any point during a program year and they could enroll across multiple program years, therefore, an artificial intervention date was created on November 1st, 2017. Any PIPP customers with enrollments prior to this date were excluded from the cohort in order to allow for a clean pre-period for treatment customers. For both treatment

²¹ ADM required at least 3 months of pre-period and 3 months of post-period billing data.

²² ADM required at least 3 months of pre-period and 3 months of post-period billing data, and at least 12 months of billing data overall.

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and control customers, the constructed pre-period is from November 1st, 2016 through October 31st, 2017. However, the post-period is handled differently for treatment and control customers. For control customers, all available billing data from November 1st, 2017 onwards falls into the post period, while for treatment customers, the billing data must also fall within the PIPP enrollment window.

Table 7-13 Cohort Restrictions, Public Service Electric

Restriction	Number of Treatment Customers	Number of Control Customers
Starting point	23,147	55,453
Removed enrollments with program start dates prior to PY2017 (program year cutoff to obtain clean pre-period)	20,187	55,453
Removed treatment customers with enrollments in PY2017 (clean period)	20,020	55,453
Removed PIPP with < 90-day enrollment period	19,866	55,453
Removed program years outside triennial period	11,689	55,453
Keep if in pre- or post-period	11,580	55,442
Removed billing duration outliers	11,562	55,220
Removed usage/day outlier	11,561	55,208
Removed if insufficient bills or average usage equal to zero	4,210	5,635

Table 7-14 Cohort Restrictions, Public Service Gas

Restriction	Number of Treatment Customers	Number of Control Customers
Starting point	27,440	61,843
Removed enrollments with program start dates prior to PY2017 (program year cutoff to obtain clean pre-period)	22,286	61,843
Removed treatment customers with enrollments in PY2017 (clean period)	22,042	61,843
Removed PIPP with < 90-day enrollment period	21,867	61,843
Removed program years outside triennial period	13,985	61,843
Keep if in pre- or post-period	13,859	61,830
Removed billing duration outliers	13,839	61,592
Removed usage/day outlier	13,834	61,516
Removed if insufficient bills ²³ or average usage equal to zero	4,897	9,186

²³ ADM required at least 3 months of pre-period and 3 months of post-period billing data, and at least 12 months of billing data overall.

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ADM was successful in creating a matched cohort and the results of PSM are summarized below. ADM used nearest neighbor, 1 to 1 ratio matching and had a considerable pool of control customers to draw upon, as shown in Table 7-15 and Table 7-16. Customers were matched on their average pre-period seasonal usage, including winter, spring, summer and fall for each control and treatment household.

Table 7-15 PSM Customer Matches, Public Service Electric

Status	Control	Treated
All	5,633	4,210
Matched	4,210	4,210
Unmatched	1,423	0

Table 7-16 PSM Customer Matches, Public Service Gas

Status	Control	Treated
All	9,184	4,894
Matched	4,894	4,894
Unmatched	4,290	0

Table 7-17 and Table 7-18 present the propensity score covariate summary of pre-period usage for treatment and control customers before and after matching. The standardized mean difference prior to matching is often over 0.2 for many covariates; however, after matching the absolute value of the standardized mean difference is less than 0.1, which is an ideal outcome.

Table 7-17 PSM Covariate Summary, Public Service Electric

Variable	Before Matching			After Matching		
	Mean Treated	Mean Control	Standardized Mean Difference	Mean Treated	Mean Control	Standardized Mean Difference
Distance	0.430	0.426	0.111	0.430	0.429	0.012
Pre-period Winter Usage	23.776	22.573	0.076	23.776	23.722	0.003
Pre-period Spring Usage	19.372	18.139	0.100	19.372	19.275	0.008
Pre-period Summer Usage	21.140	20.093	0.084	21.140	21.194	-0.004
Pre-period Fall Usage	19.297	18.434	0.075	19.297	19.349	-0.004

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Table 7-18 PSM Covariate Summary, Public Service Gas

Variable	Before Matching			After Matching		
	Mean Treated	Mean Control	Standardized Mean Difference	Mean Treated	Mean Control	Standardized Mean Difference
Distance	0.352	0.345	0.160	0.352	0.352	0.003
Pre-period Winter Usage	3.659	3.537	0.072	3.659	3.667	-0.005
Pre-period Spring Usage	2.251	2.138	0.104	2.251	2.246	0.004
Pre-period Summer Usage	0.747	0.690	0.140	0.747	0.745	0.006
Pre-period Fall Usage	0.659	0.600	0.152	0.659	0.660	-0.002

Table 7-19 and Table 7-20 provide results for a t-test which helps determine the success of matching. The test measures whether there are statistically significant differences in average daily therms used between the treatment and comparison groups in the pre-period by month. Statistically significant differences are defined as p-value of less than 0.05 at the 95% significance level. As shown in both tables, the p-value is greater than 0.05 for each month, with one exception for Public Service Gas in May²⁴. This result further indicates propensity score matching performed well.

²⁴ Rejection of the null hypothesis for a single month does not indicate cohort imbalance. Repeated t-testing with an alpha value of 5% (rejection of a true null hypothesis) may sometimes lead to rejecting the null hypothesis simply due to the number of t-tests performed. The binomial distribution can be used to determine the probability of one or more rejections of the null hypothesis for a given alpha (5%) and number of t-tests performed (12). Using the binomial distribution, ADM determined that the probability of rejecting a single null hypothesis when the null hypothesis is in fact true is 46%, which leads to the conclusion that this is a likely event that on its own does not indicate cohort imbalance. Rejection of the null hypothesis for three or more months, assuming the null hypothesis were true, would occur only 1.96% of the time and this would be strong evidence for the conclusion that the cohorts are imbalanced after matching; however this did not occur.

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Table 7-19 Post Matching T-Test of Difference in Usage by Month, Public Service Electric

Month	Average Daily kWh Control	Average Daily kWh Treatment	T Stat	Std Error	P-Value	Reject Null?
Jan	26.052	25.918	0.393	0.343	0.695	No
Feb	24.273	24.209	0.218	0.292	0.827	No
Mar	21.145	21.329	-0.798	0.231	0.425	No
Apr	19.263	19.323	-0.296	0.204	0.768	No
May	17.401	17.545	-0.808	0.178	0.419	No
June	17.311	17.562	-1.431	0.176	0.152	No
July	21.344	21.337	0.030	0.216	0.976	No
Aug	24.489	24.360	0.530	0.243	0.596	No
Sept	20.846	20.835	0.049	0.210	0.961	No
Oct	19.851	19.964	-0.518	0.217	0.604	No
Nov	16.086	16.258	-0.767	0.225	0.443	No
Dec	18.676	18.722	-0.163	0.285	0.871	No

Table 7-20 Post Matching T-Test of Difference in Usage by Month, Public Service Gas

Month	Average Daily Therms Control	Average Daily Therms Treatment	T Stat	Std Error	P-Value	Reject Null?
Jan	4.165	4.190	-0.718	0.035	0.473	No
Feb	3.992	3.970	0.787	0.029	0.431	No
Mar	2.948	2.915	1.620	0.021	0.105	No
Apr	2.195	2.209	-0.821	0.017	0.412	No
May	1.610	1.639	-2.287	0.013	0.022	Yes
June	1.152	1.166	-1.390	0.010	0.165	No
July	0.624	0.622	0.390	0.006	0.697	No
Aug	0.512	0.510	0.431	0.005	0.666	No
Sept	0.501	0.499	0.502	0.005	0.616	No
Oct	0.650	0.657	-1.018	0.007	0.309	No
Nov	0.984	0.982	0.111	0.012	0.912	No
Dec	2.070	2.096	-0.942	0.028	0.346	No

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Figure 7-15 and Figure 7-17 display the density of each variable employed in propensity score matching, before conducting matching. Figure 7-16 and Figure 7-18 display the density of each variable employed in propensity score matching, after conducting matching.

Figure 7-15 Average Daily Usage by Season for Treatment and Comparison Groups Before Matching, Public Service Electric

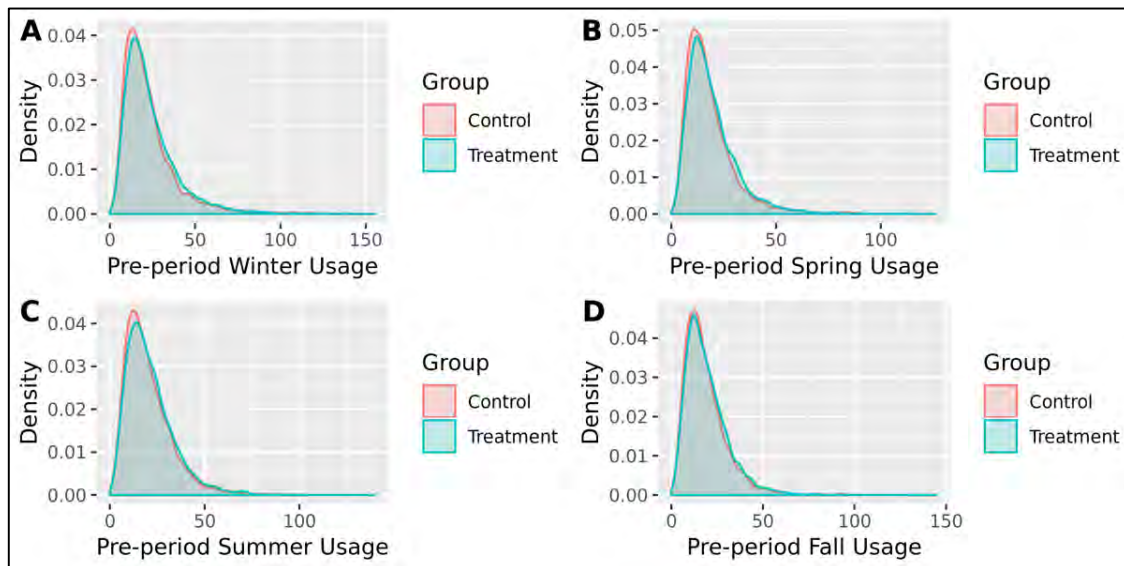
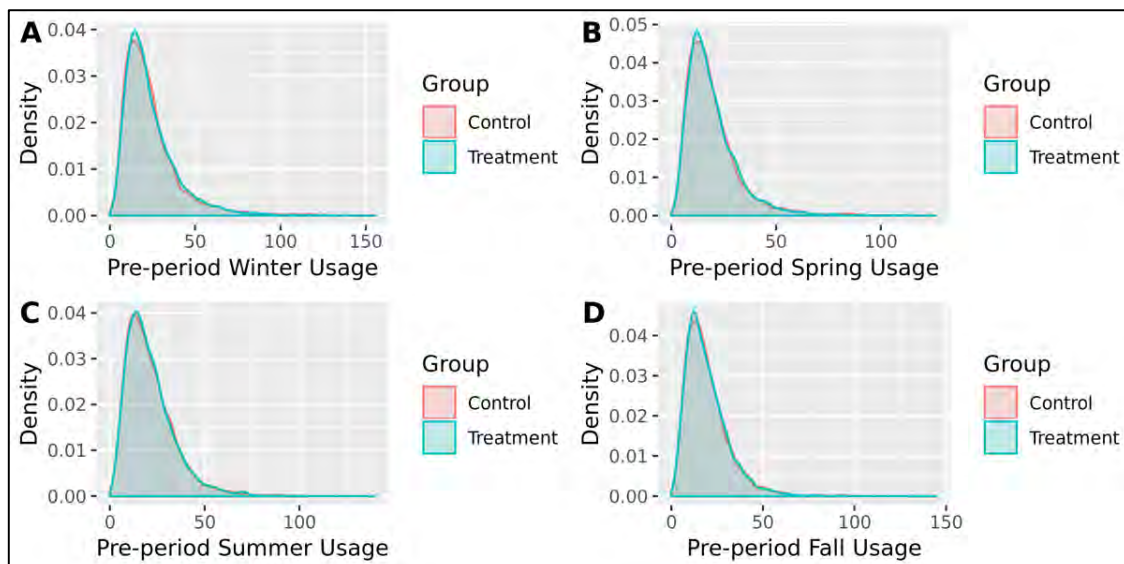


Figure 7-16 Average Daily Usage by Season for Treatment and Comparison Groups After Matching, Public Service Electric



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Figure 7-17 Average Daily Usage by Season for Treatment and Comparison Groups Before Matching, Public Service Gas

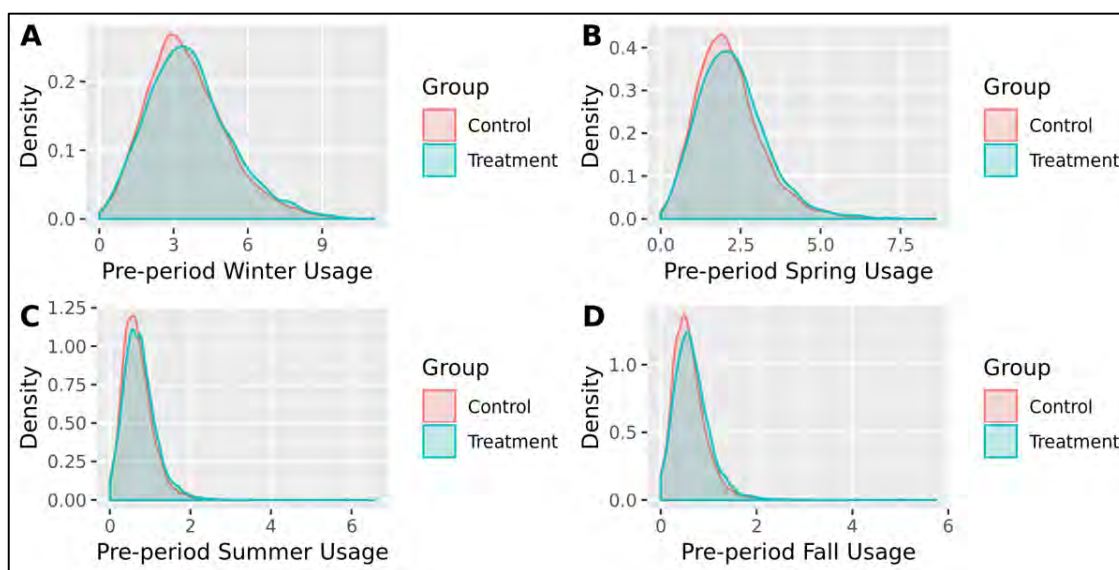
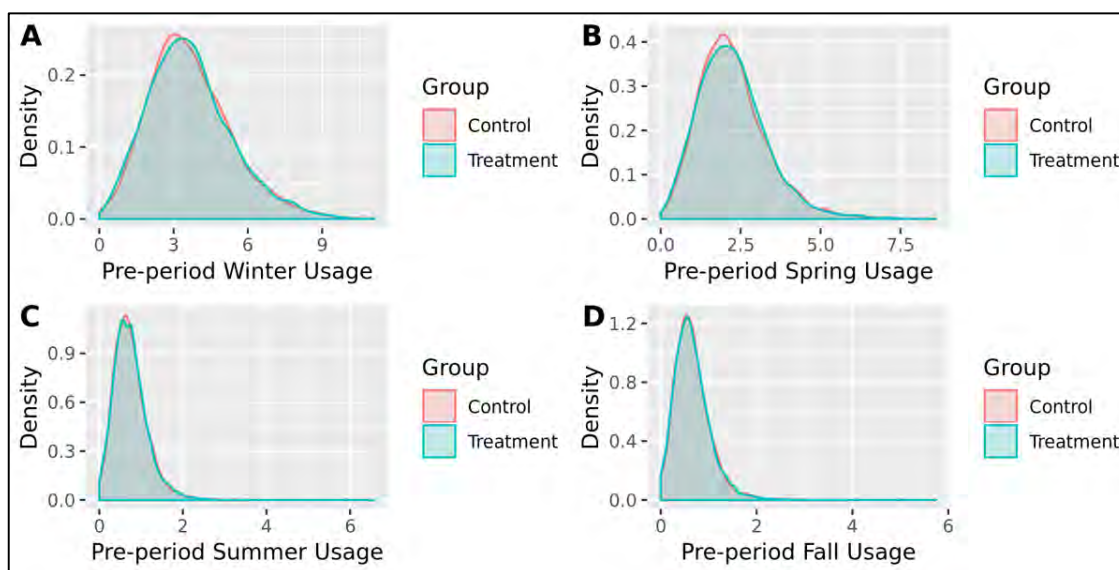


Figure 7-18 Average Daily Usage by Season for Treatment and Comparison Groups After Matching, Public Service Gas



Lastly, the joint chi-square test for covariate balance had a p-value of 0.894 and 0.880 for Public Service Electric and Public Service Gas respectively, meaning ADM failed to reject the null hypothesis of covariate imbalance (i.e., the treatment and comparison groups are similar).

7.4 Modeled Outcomes

7.4.1 Disconnects

Each utility provided information on disconnects, separate from the billing data, for each customer. Using this data, ADM flagged each invoiced bill that had a disconnect during the billing interval.

Table 7-21 provides the regression estimates for disconnects/year for each utility and fuel type. Atmos and CNG related they do not perform disconnects for PIPP customers, and the estimates show reductions in disconnects for both utilities. Black Hills Electric shows a significant reduction in disconnects while Black Hills Gas showed non-statistically significant increases in disconnects. However, the treatment cohort for Black Hills Gas is small (<100) and due to the rarity of disconnect outcomes, it is unlikely this effect is being well captured. For Public Service Gas and Public Service Electric, the change in disconnects is more difficult to interpret as only the latest recorded disconnect for each customer was provided, although a slight reduction in disconnects appears to occur. It is possible that there would be a larger effect if every disconnect occurrence were included in the regression.

Table 7-21 Disconnects Regression Results

Utility	Fuel Type	Estimate	90% CI Lower	90% CI Upper	P-Value	Adj. R2
Atmos	Gas	-0.072	-0.103	-0.041	0.000	0.012
CNG	Gas	-0.014	-0.026	-0.002	0.046	0.001
Black Hills	Electric	-0.171	-0.214	-0.128	0.000	0.037
Black Hills	Gas	0.015	-0.020	0.049	0.476	-0.003
Public Service	Electric	-0.002	-0.006	0.001	0.300	0.002
Public Service	Gas	-0.002	-0.006	0.001	0.297	0.001

Table 7-22 summarizes impacts from PIPP on customer disconnections using the regression estimates. All utilities except one (Black Hills Gas) show reductions in the number of disconnections after PIPP, with 50% showing statistically significant changes at the 95% level. Black Hills Gas had a cohort that was too small to reliably estimate disconnect impacts (<100 PIPP customers). In addition, Public Service did not provide complete histories of disconnections for customers and therefore the average number of disconnects is underestimated and the change after PIPP is not statistically significant at the 95% level.

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Table 7-22 PIPP Impacts on Disconnections

Utility	Fuel Type	Average Number of Disconnects/Year per 100 Customers	% Change After PIPP	Statistically Significant
Atmos	Gas	7.2	-100.0%	Yes
CNG	Gas	2.5	-55.6%	Yes
Black Hills	Electric	17.3	-98.8%	Yes
Black Hills	Gas	0.5	282.0%	No
Public Service	Electric	0.6	-36.7%	No
Public Service	Gas	0.6	-33.7%	No

The average shown is the average for control customers in pre-period for cohorts with controls and the average for the pre-treatment period for treatment only cohorts.

7.4.2 Disconnect Notices

Each utility provided information on disconnect notices, separate from the billing data, for each customer. Using this data, ADM flagged each invoiced bill that had a disconnect notice during the billing interval.

Table 7-23 provides the regression estimates for disconnect notices/year for each utility and fuel type. Atmos and CNG related they do not perform disconnects for PIPP customers, and the estimates show reductions in disconnect notices for both utilities. Black Hills Electric and Black Hills Gas show statistically significant reductions in disconnect notices. For Public Service Gas and Public Service Electric, the change in disconnect notices is more difficult to interpret as only the latest recorded disconnect notice for each customer was provided. A slight and statistically significant reduction in disconnect notices appears to occur for Public Service Electric, and it is possible that it would be a larger effect if every disconnect notice occurrence were included in the regression.

Table 7-23 Disconnect Notices Regression Results

Utility	Fuel Type	Estimate	90% CI Lower	90% CI Upper	P-Value	Adj. R2
Atmos	Gas	-0.141	-0.178	-0.105	0.000	0.032
CNG	Gas	-0.594	-0.720	-0.469	0.000	0.027
Black Hills	Electric	-2.258	-2.462	-2.054	0.000	0.232
Black Hills	Gas	-0.319	-0.500	-0.137	0.004	0.038
Public Service	Electric	-0.014	-0.023	-0.004	0.015	0.015
Public Service	Gas	0.000	-0.008	0.008	0.969	0.010

Table 7-24 summarizes impacts of PIPP on customer disconnection notices using the regression estimates. All utilities except one (Public Service Gas) show statistically significant reductions at

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the 95% level in the number of disconnections notices after PIPP. Public Service did not provide complete histories of disconnections for customers and therefore the average number of disconnection notices/year is underestimated.

Table 7-24 PIPP Impacts on Disconnect Notices

Utility	Fuel Type	Average Number of Disconnect Notices/Year per 100 Customers	% Change After PIPP	Statistically Significant
Atmos	Gas	14.1	-100.0%	Yes
CNG	Gas	119.4	-49.8%	Yes
Black Hills	Electric	229.9	-98.2%	Yes
Black Hills	Gas	35.9	-88.8%	Yes
Public Service	Electric	5.1	-26.5%	Yes
Public Service	Gas	3.6	-0.5%	No

The average shown is the average for control customers in pre-period for cohorts with controls and the average for the pre-treatment period for treatment only cohorts.

7.4.3 Arrears

Table 7-25 provides the regression estimates for past due/day (\$) for each utility and fuel type. ADM calculated past due for Black Hills Electric and Black Hills Gas by taking the total billed for each month and subtracting monthly customer and PIPP payments. CNG and Public Service were unable to provide a past due data field or other data fields from which past due could be calculated.²⁵

Atmos showed a slight reduction in arrears in the amount of \$0.074/day, or \$27.03 annually, but the estimate is not statistically significant. The results for Black Hills were mixed, with an increase in arrears for Black Hills Electric and a decrease in arrears for Black Hills Gas.

Table 7-25 Arrears Regression Results

Utility	Fuel Type	Estimate	90% CI Lower	90% CI Upper	P-Value	Adj. R2
Atmos	Gas	-0.074	-0.248	0.100	0.484	0.462
CNG	Gas	N/A	N/A	N/A	N/A	N/A
Black Hills	Electric	0.161	0.054	0.268	0.013	0.009
Black Hills	Gas	-0.123	-0.373	0.126	0.416	0.096
Public Service	Electric	N/A	N/A	N/A	N/A	N/A
Public Service	Gas	N/A	N/A	N/A	N/A	N/A

²⁵ This occurred because total billed was not monthly or customer payments were missing.

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Table 7-26 summarizes impacts from PIPP on customer arrears using the regression estimates. Differences in how past due amounts were provided for each utility occur, and therefore, comparisons cannot easily be made across utilities. In the case of Atmos and Black Hills Gas, arrears were reduced after PIPP, however the reduction was not statistically significant at the 95% level. For Black Hills Electric, past due amounts increased by 75% due to customers paying less than they had before enrolling in the PIPP program. However, ADM are unsure if the method of calculating past due amounts for Black Hills is appropriate given the available billing data.²⁶

Table 7-26 PIPP Impacts on Arrears

Utility	Fuel Type	Average Arrearage/Customer/Day	% Reduction After PIPP	Statistically Significant
Atmos	Gas	-1.872	4%	No
CNG	Gas	N/A	N/A	
Black Hills	Electric	0.214	-75%	Yes
Black Hills	Gas	-0.488	25%	No
Public Service	Electric	N/A	N/A	
Public Service	Gas	N/A	N/A	

The average shown is the average for control customers in pre-period for cohorts with controls and the average for the pre-treatment period for treatment only cohorts.

7.4.4 Total Billed

Table 7-27 provides the regression estimates for total billed/day (\$) for each utility and fuel type. The results of the regression estimates are mixed, with some utilities showing increases in total billed amount and others showing decreases. All the estimates are statistically significant at the 95% level. ADM noted that there were differences in how total billed was calculated across the utilities, with some utilities reporting levelized budget billing and others reporting monthly billed amounts.

²⁶ Past Due for Black Hills was calculated as Total Billed – Customer Payments – PIPP Payments for each month

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Table 7-27 Total Billed Regression Results

Utility	Fuel Type	Estimate	90% CI Lower	90% CI Upper	P-Value	Adj. R2
Atmos	Gas	-1.030	-1.202	-0.858	0.000	0.504
CNG	Gas	-5.358	-5.879	-4.838	0.000	0.545
Black Hills	Electric	0.247	0.099	0.396	0.006	0.697
Black Hills	Gas	-0.197	-0.348	-0.045	0.033	0.806
Public Service	Electric	0.093	0.079	0.107	0.000	0.634
Public Service	Gas	0.052	0.046	0.058	0.000	0.737

7.4.5 Annual Usage

The following equations were used to convert the usage/day regression estimates into annual usage estimates. In the case of treatment only cohorts (CNG and BH), the Post*Treatment interaction terms are replaced with the terms for Post due to the lack of a comparison group. The extrapolation uses the Colorado weighted averages of 959 for TMY CDD and 5,253 for TMY HDD.

Annual Usage (kWh)

$$= (\beta_3 Post_{it} * Treatment) * 365.25 \text{ (days)} + (\beta_7 Post * Treatment * CDD) * 959 + (\beta_7 Post * Treatment * HDD) * 5,253$$

Annual Usage (Therms)

$$= (\beta_3 Post_{it} * Treatment) * 365.25 \text{ (days)} + (\beta_7 Post * Treatment * HDD) * 5,253$$

The majority of utilities showed statistically significant increases in annual usage for PIPP customers. Increases in usage as a percent of annual usage ranged from 1% to 5%. Other evaluations have also found annual usage increases slightly for PIPP program customers and these estimates fall within the same range.²⁷ We note, however, that electricity usage, with the 1-5% increase associated with PIPP, was below the average household electricity usage in Colorado. Natural gas usage, with increase associated with PIPP, was below average household consumption for one utility, roughly equal to average household consumption for another, and above average household consumption for the other two utilities.

²⁷ For example, <http://www.appraiseinc.org/reports/Illinois%20PIPP%20Impact%20Report%20-%20FINAL.pdf>

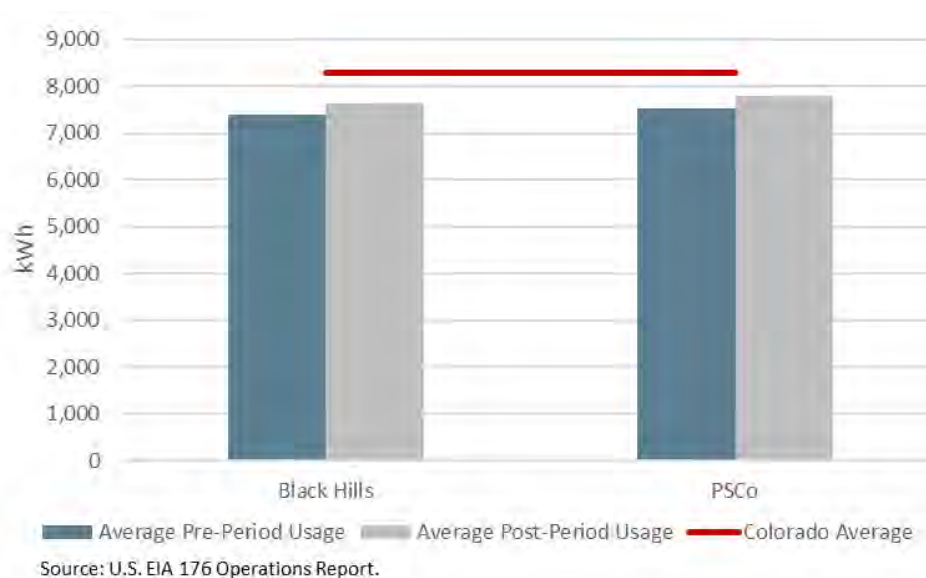
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Table 7-28 Annual Usage Regression Results

Utility	Fuel Type	Estimate	90% CI Lower	90% CI Upper	P-Value	% of Annual Usage	Adj. R2
Atmos	Gas	28.17	12.40	43.93	0.000	3.96%	0.770
CNG	Gas	41.25	31.03	51.47	0.000	5.18%	0.766
Black Hills	Electric	174.48	38.40	310.56	0.012	2.36%	0.713
Black Hills	Gas	10.34	-21.58	42.26	0.525	1.50%	0.803
Public Service	Electric	62.28	7.50	117.06	0.026	0.83%	0.647
Public Service	Gas	13.90	9.34	18.46	0.000	2.14%	0.748

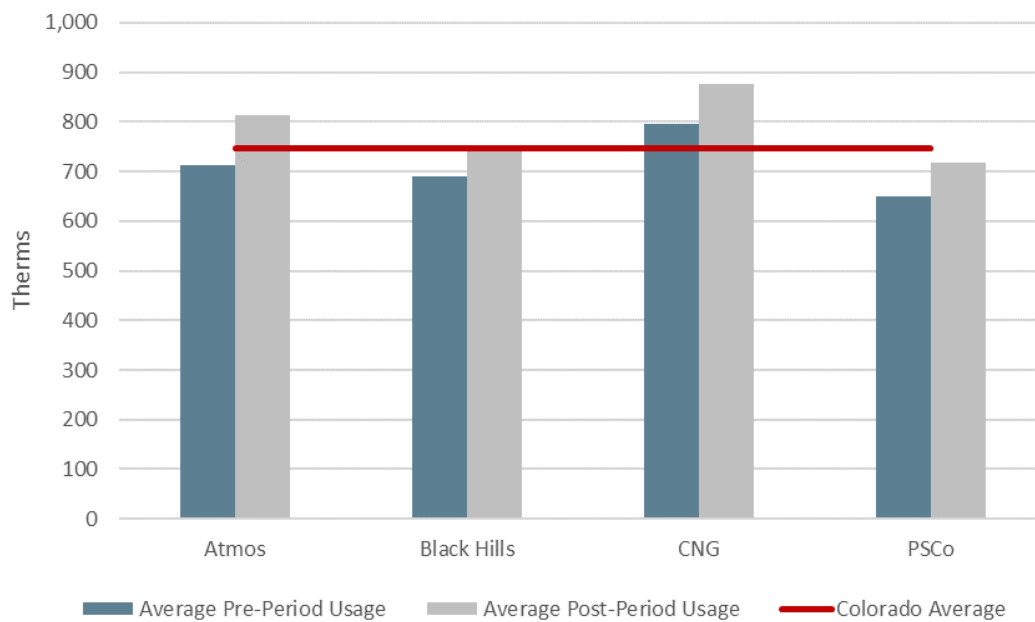
Figure 7-19 and Figure 7-20 summarize pre-post period annual usage for PIPP participants. Statewide average usage is shown as a reference line.

Figure 7-19 Comparison of PIPP Participant Pre- and Post Annual kWh Usage



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Figure 7-20 Comparison of PIPP Participant Pre- and Post Annual Therm Usage



Source: U.S. EIA Sales and Revenue Data.

The tables and figures that follow provide additional detail on the average pre- and post-period usage for treatment (PIPP) and control customers.

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Table 7-29 Average Pre- and Post-Period Usage by Cohort, Atmos

Group	Treatment		Control	
Month	Average Pre-Period Usage	Average Post-Period Usage	Average Pre-Period Usage	Average Post-Period Usage
Jan	145.3	131.9	141.6	126.3
Feb	123.1	127.8	119.8	118.6
Mar	90.8	131.0	90.3	121.5
Apr	73.8	89.8	71.0	85.3
May	52.0	57.1	51.2	55.5
June	35.4	36.2	34.2	32.9
July	22.0	21.1	21.3	20.3
Aug	14.6	15.1	14.6	14.2
Sept	16.9	15.5	15.7	15.1
Oct	20.7	16.1	19.6	20.8
Nov	38.4	69.2	39.1	59.9
Dec	79.0	102.2	78.4	90.1
Annual	712.0	813.1	696.7	760.7

Table 7-30 Average Pre- and Post-Period Usage, CNG

Group	Treatment	
Month	Average Pre-Period Usage	Average Post-Period Usage
Jan	138.9	125.0
Feb	129.9	130.1
Mar	109.6	139.4
Apr	87.5	97.5
May	77.0	77.3
June	46.6	50.7
July	26.9	29.9
Aug	17.2	17.6
Sept	18.2	17.3
Oct	26.1	23.9
Nov	42.6	69.2
Dec	76.5	98.9
Annual	796.8	876.9

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Table 7-31 Average Pre- and Post-Period Usage, Black Hills Electric

Group	Treatment	
Month	Average Pre-Period Usage	Average Post-Period Usage
Jan	691.2	701.7
Feb	563.5	621.7
Mar	555.1	605.5
Apr	514.4	498.3
May	543.6	547.7
June	664.5	658.8
July	748.6	782.3
Aug	665.7	734.1
Sept	571.3	635.0
Oct	526.7	552.2
Nov	606.7	610.5
Dec	734.0	692.7
Annual	7,385.3	7,640.6

Table 7-32 Average Pre- and Post-Period Usage, Black Hills Gas

Group	Treatment	
Month	Average Pre-Period Usage	Average Post-Period Usage
Jan	130.5	124.5
Feb	92.3	118.4
Mar	74.6	86.7
Apr	49.8	56.8
May	34.5	36.1
June	16.1	16.3
July	12.4	14.2
Aug	13.0	14.7
Sept	16.1	19.4
Oct	42.5	52.9
Nov	83.0	82.0
Dec	126.5	121.2
Annual	691.4	743.2

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Table 7-33 Average Pre- and Post-Period Usage by Cohort, Public Service Electric

Group	Treatment		Control	
Month	Average Pre-Period Usage	Average Post-Period Usage	Average Pre-Period Usage	Average Post-Period Usage
Jan	803.5	760.2	807.6	766.4
Feb	683.9	675.4	685.7	668.7
Mar	661.2	737.1	655.5	722.0
Apr	579.7	636.5	577.9	596.5
May	543.9	551.3	539.4	541.2
June	526.9	533.1	519.3	531.1
July	661.4	618.7	661.6	649.3
Aug	755.2	774.2	759.2	749.9
Sept	625.1	714.2	625.4	667.1
Oct	618.9	707.9	615.4	623.5
Nov	487.7	472.9	482.6	519.4
Dec	580.4	608.9	579.0	597.0
Annual	7,527.7	7,790.3	7,508.6	7,632.1

Table 7-34 Average Pre- and Post-Period Usage by Cohort, Public Service Gas

Group	Treatment		Control	
Month	Average Pre-Period Usage	Average Post-Period Usage	Average Pre-Period Usage	Average Post-Period Usage
Jan	129.9	114.5	129.1	114.6
Feb	112.1	106.4	112.8	107.2
Mar	90.4	121.4	91.4	116.2
Apr	66.3	85.3	65.9	78.4
May	50.8	51.9	49.9	49.8
June	35.0	36.3	34.5	29.3
July	19.3	21.1	19.4	18.7
Aug	15.8	15.6	15.9	15.0
Sept	15.0	14.3	15.0	14.2
Oct	20.4	17.4	20.1	21.5
Nov	29.5	51.3	29.5	50.9
Dec	65.0	82.4	64.2	75.4
Annual	649.3	718.0	647.7	691.4

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Figure 7-21 Atmos PIPP Customer Usage by Period

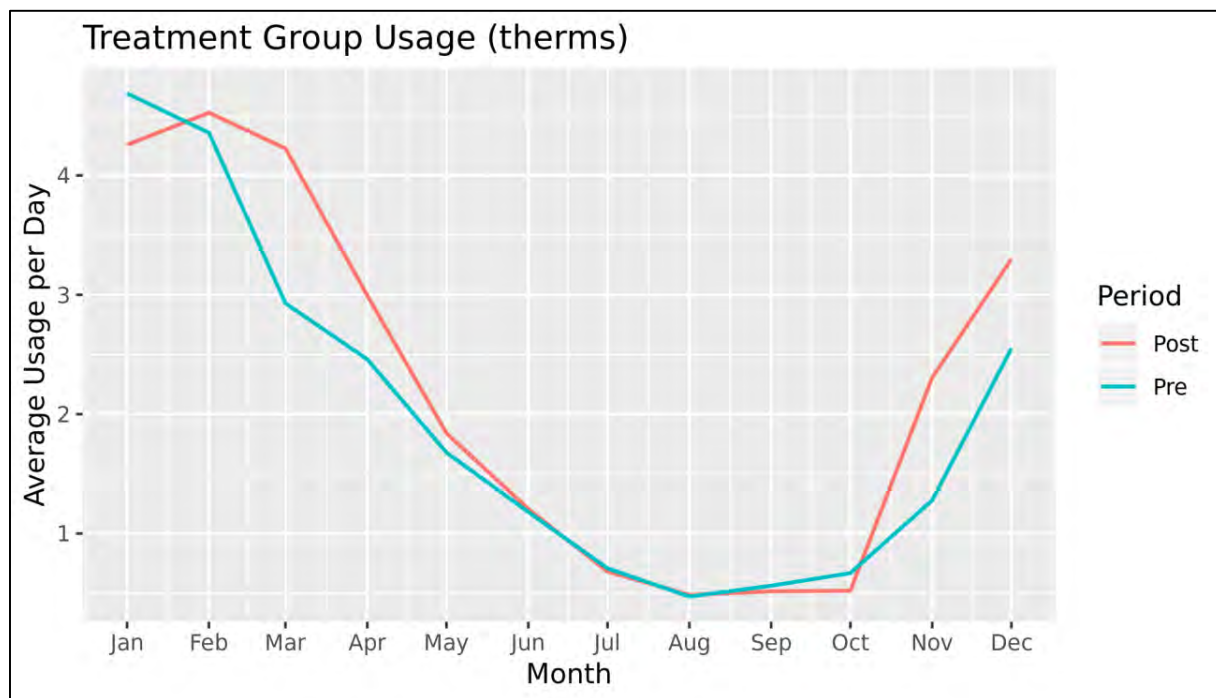
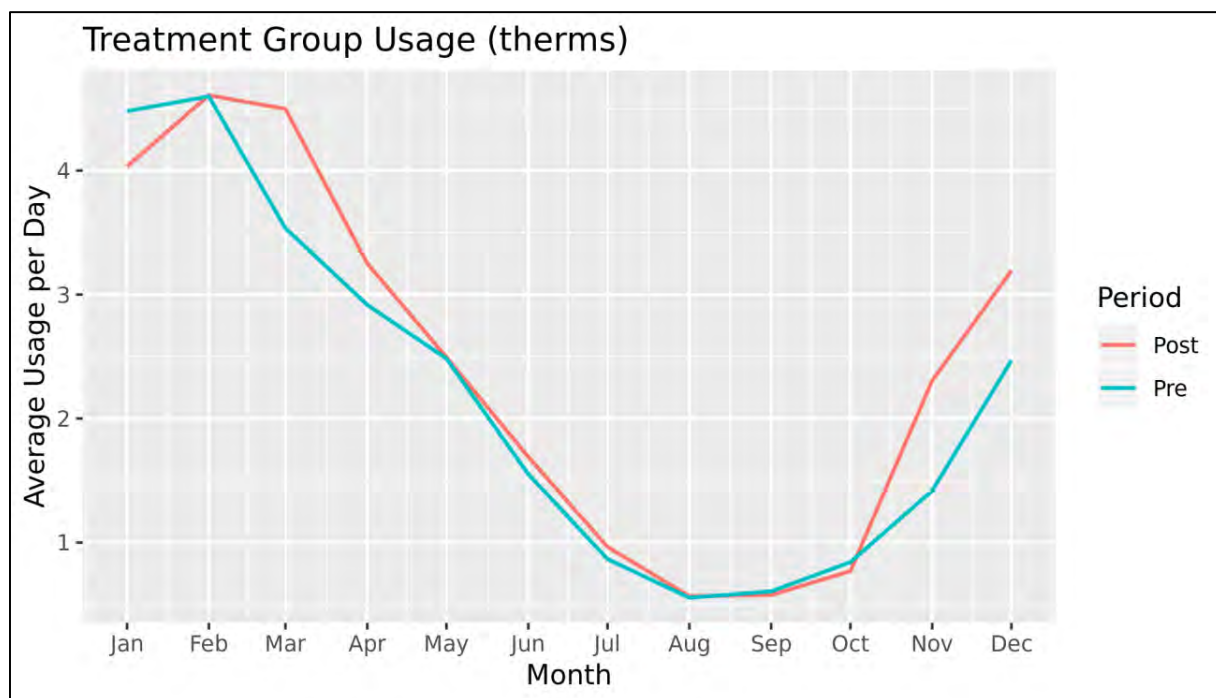


Figure 7-22 CNG PIPP Customer Usage by Period



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Figure 7-23 Black Hills Electric PIPP Customer Usage by Period

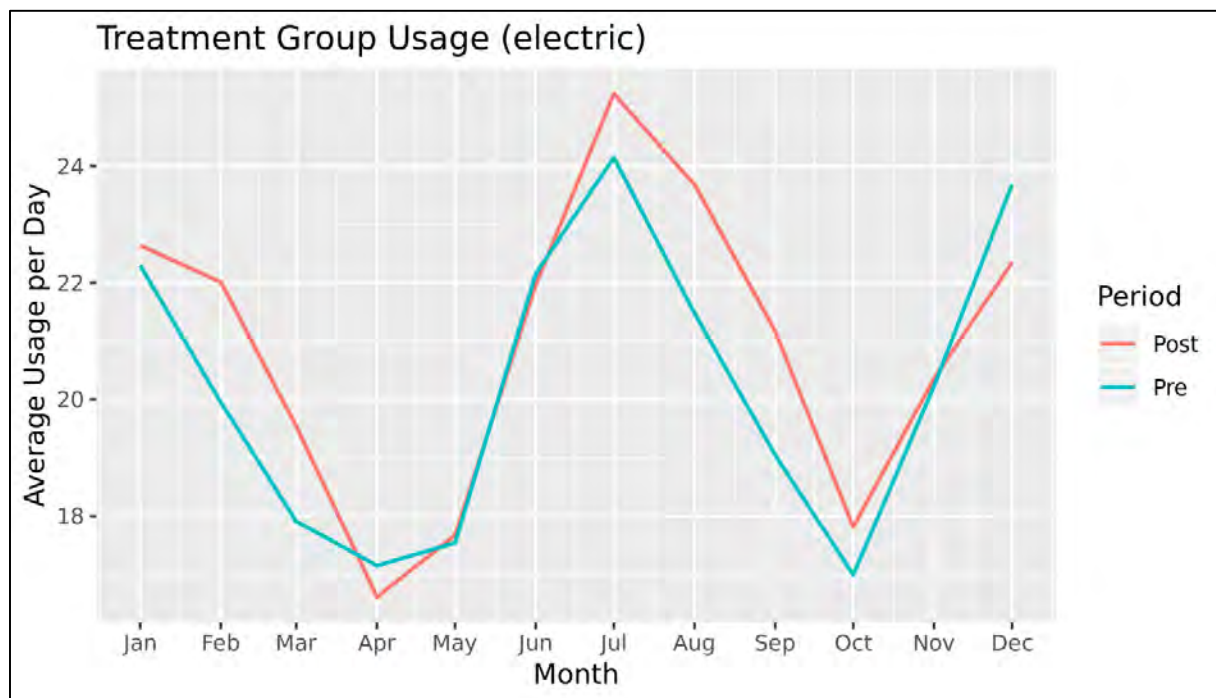
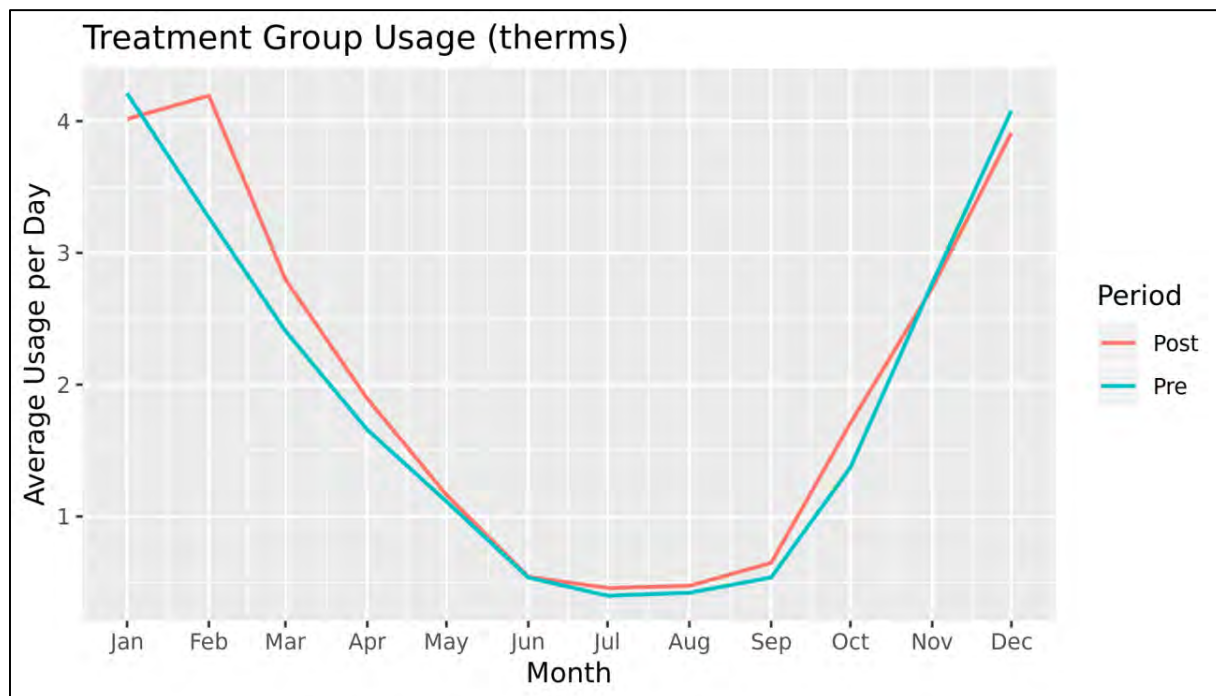


Figure 7-24 Black Hills Gas PIPP Customer Usage by Period



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Figure 7-25 Public Service Electric PIPP Customer Usage by Period

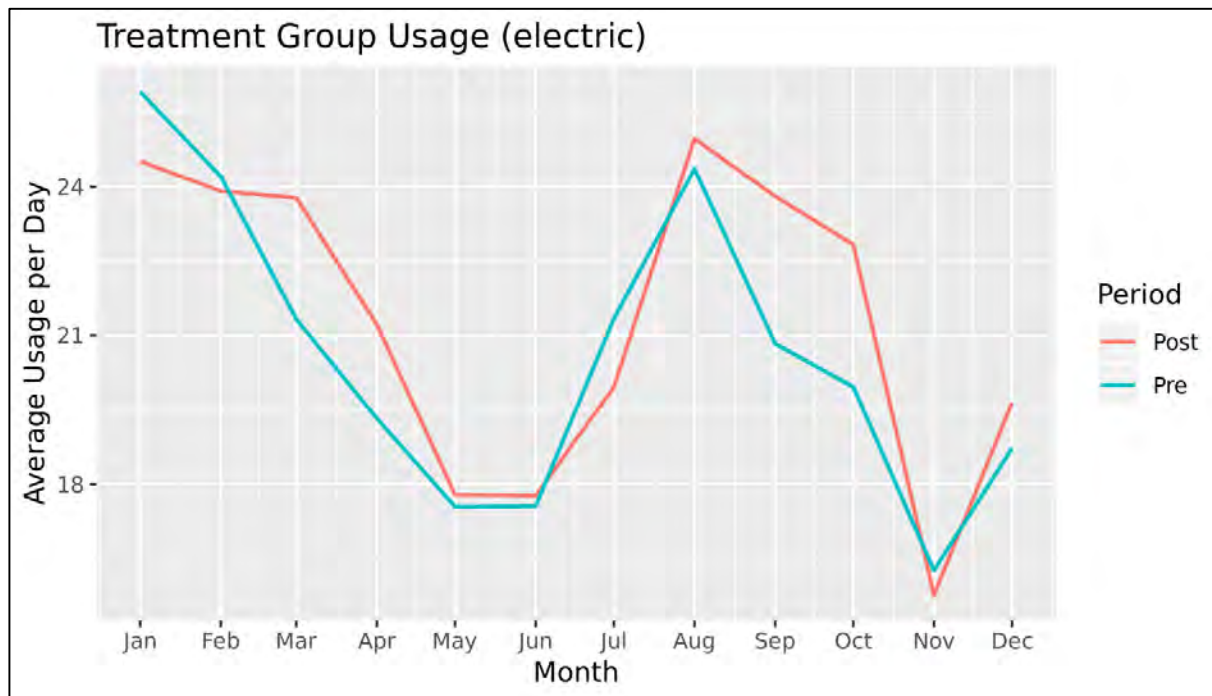
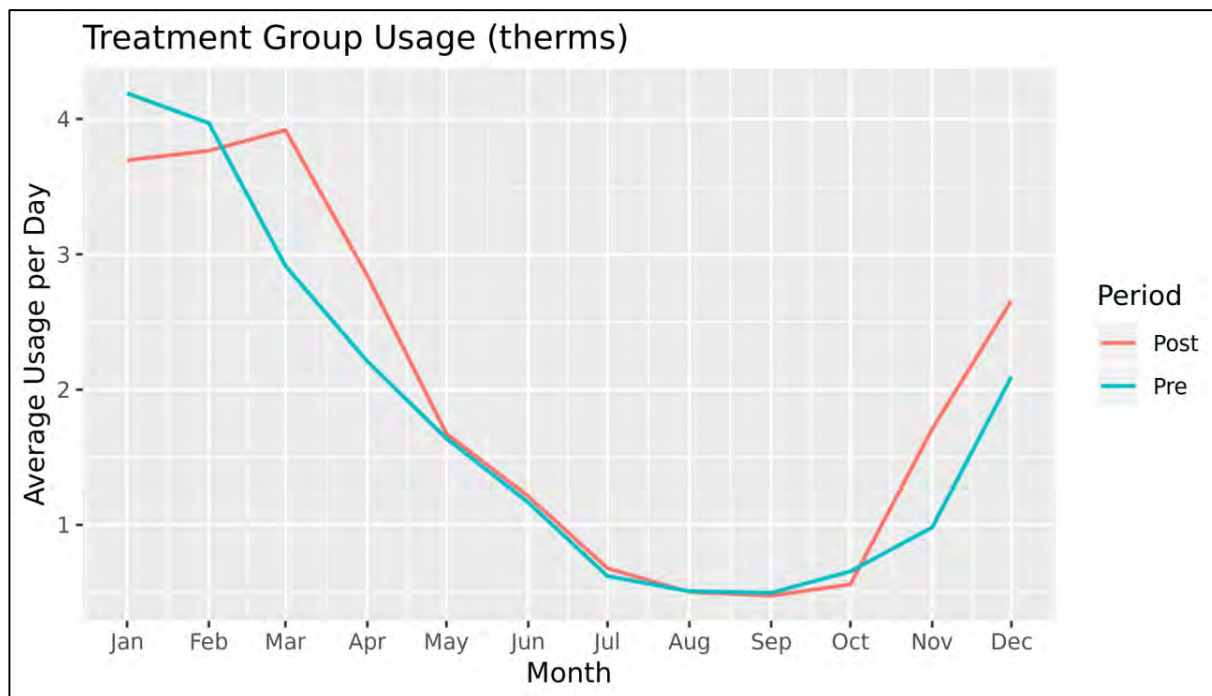


Figure 7-26 Public Service Gas PIPP Customer Usage by Period



8 Benefit Analysis

This Chapter presents findings on the analysis of utility and participant benefits for the PIPP programs. The methodology and data sources used to monetize the benefits are discussed in Section 3.6.

8.1 Monetized Utility Benefits

ADM estimated the utility benefits resulting from the impacts of PIPP on arrearages, disconnects, and disconnect notices. The analysis of utility benefits was based on results from the evaluation of program impacts. ADM only monetized benefits for a program outcome if the impact analyses found that the program had a statistically significant effect on the outcome. Thus, the zero-dollar amounts shown in the table below reflect impacts that could not be estimated with the data or for which there was not a statistically significant effect.

Table 8-1 summarizes the monetized values of the benefits realized for each utility and fuel type. The value of the Public Service benefits is considerably lower than what would be expected based on the value realized for the other utility programs. The primary reasons for this were that data limitations prevented analysis of arrearage impacts, and data on disconnects and notices was limited to the most recent disconnection or notice. As such, the average number of disconnects and notices sent found for Public Service was much lower than what was found for other utilities.

Table 8-1 Summary of Monetized Utility Benefits

Utility Program	Arrearages	Disconnects	Fewer Notices	Total Utility Benefits
Atmos	\$0.00	\$481.09	\$625.05	\$1,106.14
Black Hills Electric	\$5,280.57	\$1,567.16	\$13,733.09	\$20,580.82
Black Hills Gas	\$0.00	\$0.00	\$366.45	\$366.45
CNG	\$0.00	\$40.10	\$1,138.09	\$1,178.19
Public Service Electric	\$0.00	\$0.00	\$748.01	\$748.01
Public Service Gas	\$0.00	\$0.00	\$0.00	\$0.00

8.2 Monetized Participant Benefits

Table 8-2 summarizes the value of the monetized benefits for the sample of survey respondents by the utility and the participant benefit fuel type.

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Table 8-2 Summary of Survey Respondent Monetized Participant Benefits

Utility	Participant Benefit Fuel Type	Home Comfort		Ease of Paying Other Bills		Reduced Worry		Fewer Disconnect Notices		Fewer Disconnects		Improved Health	
		n	\$	n	\$	n	\$	n	\$	n	\$	n	\$
Atmos	Natural Gas	50	\$9	46	\$15	47	\$10	47	\$4	48	\$5	50	\$0
Black Hills	Natural Gas	11	\$44	12	\$32	12	\$22	13	\$16	13	\$16	13	\$17
	Electricity	93	\$72	91	\$62	89	\$45	85	\$43	86	\$41	101	\$20
	Natural Gas and Electricity	2	\$35	2	\$25	2	\$25	2	\$0	2	\$0	2	\$25
CNG	Natural Gas	19	\$39	19	\$63	18	\$33	19	\$37	18	\$8	21	\$5
Public Service	Natural Gas	18	\$34	20	\$52	20	\$89	18	\$44	21	\$40	25	\$24
	Electricity	6	\$67	6	\$100	6	\$183	5	\$60	6	\$147	9	\$67
	Natural Gas and Electricity	61	\$70	67	\$84	72	\$70	64	\$34	59	\$30	77	\$21

Table 8-3 summarizes the benefits for PY2018/19 extrapolated to the population of PIPP participants.

Table 8-3 Summary of Monetized Participant Benefits

Utility	Participant Benefit Fuel Type	PY2018/19 Participant Count	Home Comfort	Ease of Paying Other Bills	Reduced Worry	Fewer Disconnect Notices	Fewer Disconnects	Improved Health
Atmos	Natural Gas	806	\$7,335	\$12,353	\$7,803	\$3,173	\$4,114	\$0
Black Hills	Natural Gas	134	\$5,872	\$4,322	\$2,926	\$2,185	\$2,185	\$2,237
Black Hills	Electricity	1,040	\$75,283	\$63,989	\$47,151	\$44,536	\$42,616	\$21,140
Black Hills	Natural Gas and Electricity	20	\$700	\$500	\$500	\$0	\$0	\$500
CNG	Natural Gas	348	\$13,737	\$21,979	\$11,600	\$12,821	\$2,900	\$1,657
Public Service	Natural Gas	1,985	\$68,372	\$103,716	\$177,161	\$86,568	\$78,927	\$47,640
Public Service	Electricity	545	\$36,333	\$54,500	\$99,917	\$32,700	\$79,933	\$36,333
Public Service	Natural Gas and Electricity	12,470	\$878,215	\$1,048,038	\$867,011	\$423,785	\$370,084	\$263,975

Table 8-4 presents a summary of the total value of the monetized participant benefits for PIPP by utility. As shown, the total value was estimated to be equal to \$5,169,000.

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Table 8-4 Total Value of Monetized Participant Benefits

Utility	Total Value of Participant Benefits	Per Participant Value of Benefits
Atmos	\$34,777	\$43
Black Hills	\$316,640	\$265
CNG	\$64,694	\$186
Public Service	\$4,753,211	\$317
Total	\$5,169,322	\$298

8.3 Summary of Benefits and Costs

Table 8-5 summarizes the program administration and benefit costs, as well as the utility benefits and participant benefits.

Table 8-5 PY2018/19 Benefits and Costs

Cost or Benefit	Atmos	Black Hills	CNG	Public Service	Total
Administration cost	\$18,749	\$32,111	\$7,202	\$218,369	\$276,431
Benefit cost (bill credits + arrearage credits)	\$128,715	\$857,635	\$83,744	\$9,716,738	\$10,786,832
Utility benefits	\$1,106	\$20,947	\$1,178	\$748	\$23,980
Participant benefits	\$34,777	\$316,640	\$64,694	\$4,753,211	\$5,169,322

9 Appendix A: Utility and Stakeholder Interview Guides

9.1 Utility Staff Interview Guide

Introduction

Thank you for taking the time to speak with me today. The purpose of this discussion is to help us understand some of the specific aspects of the implementation and administration of the Percentage of Income Payment Plans.

I have several questions to ask and I want to hear all that you have to say on these topics, but I realize you have a limited amount of time. For that reason, it might seem as though I am rushing at some points but that is only because I want to be respectful of your time.

Do you have any questions for me before we begin?

Overview of Responsibilities

1. What is your job title? What are your responsibilities for the Percentage of Income Payment Plans?
2. Do you have responsibilities for other programs or services directed at low income customers?
3. Do you have a 3rd party implementer for the PIPP program or is everything handled in-house?

History of PIPP

4. I would like to know if and how the PIPP that you currently offer changed in 2016 when the triennial period began. How does the plan that you offer now differ, if at all, from what you offered prior to 2016?
5. In your view, what brought about the change in rulemaking that lead the current PIPPs?
6. Overall, do you think the current regulatory framework is an improvement?

Program Processes

7. How is information about the PIPP program made available to potential qualifying customers and how are customers recruited or identified for enrollment?
 - a. LEAP enrollments
 - b. Missed payments/arrearage
 - c. Marketing activities
 - d. Partner organizations (EOC, community action agencies, nonprofits)

PIPP Evaluation Report

8. How does a customer become enrolled in the PIPP?
 - a. Application forms/other materials
 - b. Opt-out option
 - c. How long have you done auto-enrollment (All but Black Hills auto enroll)? What triggers auto enrollment?
9. What data or documentation sources do you use, if any, in the process of enrolling a customer? (IF NEEDED: For example, what data do you use from LEAP?)
10. Do you have any other access to information about the income levels of your customers, or does it all come from LEAP enrollment?
11. Other than CDHS and the LEAP program, do you interact with other government social service programs (e.g. TANF, WIC), and if so could those programs and providers be leveraged to increase PIPP enrollment?
12. During the 2016-19 triennial, did you have a wait list for PIPP? (If needed, clarify that speaking of the pre-Covid)
 - a. For times when you had a waitlist, was your utility able to enroll customers in PIPP eventually to eliminate the waitlist? How so?
13. Once a customer is enrolled, how often is the customer re-certified as qualifying for the program? How often is their income checked for calculation of the program credit? What is the process for doing these things?
14. I would like to hear about the program credits that customers receive. The code of regulations provides a minimum and maximum percentage of income that a participant should pay for their utilities. For example, for electricity, customers with electric heat pay between 3 and 6% of income for electricity. [For customers with gas heat, gas bills are between limited to 2-3% and 2-3% for electricity] How is the benefit for a customer of your utility calculated?
15. Does your utility have a levelized billing program? How are PIPP participants enrolled in it? What triggers a customer's removal from the levelized billing program (NOTE, customers may be removed if they fail to meet their obligations).
16. One of the regulatory requirements is that the utility is responsible for estimating the participants' annual utility bill. How is the annual bill estimated? When do you estimate the annual bill (e.g., at enrollment, annually)?
17. Is the maximum PIPP amount of 31 cents for residential customers an appropriate amount (i.e. should it be higher, or lower)? Why or why not?
18. What is the current amount of the customer budget rider?

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Data Management and Tracking

19. What data is tracked for enrolled participants?
20. What is the data that you track used for?
21. What quality control measures does the utility use for data management and data collection?
22. What are some of the challenges you face in tracking participant data?
23. Is there data that you cannot or do not currently track that would be valuable to include? What would need to change to collect that data?

Program Impacts

24. Have you undertaken analysis of the program impacts on customers such as effects on disconnections or arrearages?
25. Have you assessed the financial impacts on [UTILITY] such as savings from reduced connections, collection costs, and arrearage carrying costs?

Additional Programs

26. What other programs do you offer to support low-income customers?
 - a. Do the qualification requirements align with PIPP?
 - b. What are the benefits to customers of the programs (payment assistance, energy use reductions/efficiency)?
27. What information is provided to PIPP participants on the energy efficiency programs offered by you or by the state of Colorado? How is that information conveyed?
28. [If single fuel type utility] Is information provided to customers on programs provided by other fuel type utilities? Is information provided to these utilities about the customers and their eligibility for their programs?

Low Income Customer Needs

29. I would like to talk about how well the state of Colorado is meeting low-income customers need for affordable energy and the role that the PIPPs play in that. In this discussion, I would like to hear about your perspective on these questions prior to the onset of Covid-19.

To begin with how well do you think the state is meeting needs for affordable energy? Are there specific gaps in terms of the amount of support provided generally, or in supporting specific

PIPP Evaluation Report

customer groups? (If needed, groups could be related to specific housing types, regions of the state, or other factors).

- 30. How would you say PIPP participant energy usage compare to other customers? Have you noticed changes in PIPP participant energy use after they begin their participation?
- 31. The country is experience significant economic hardship with the onset of Covid-19. Have you seen an impact on your PIPP enrollments or applications yet?
- 32. Have you increased outreach to customers about the PIPP program?
- 33. Given the current structure and funding of the PIPPs, how well do you think they will be able to meet the need for affordable energy?

Stakeholder Engagement

- 34. What is the process for engaging with these stakeholders?
- 35. Are there any stakeholder advisory groups that provide guidance on the PIPPs?
- 36. Overall, how effective do you the think the stakeholder engagement process is?

Conclusion

- 37. What would you like to change about the PIPP that you run? How would you make that change? What would prevent that change from happening?
- 38. Are there any regulatory requirements that you would like to see changed to improve the effectiveness or efficiency of the PIPP?
- 39. What do you think works best about the PIPP?
- 40. What are you hoping to learn from the evaluation?

9.2 CEO Staff Interview Guide

Overview of Responsibilities:

1. What is your job title? What are your responsibilities regarding the PIPPs?
2. What is CEO's role regarding the PIPPs?

History and Current Structure of PIPPs

3. I would like to hear your perspective on the rules that govern the current PIPPs. My understanding of the history is that Colorado began offering PIPPs in 2012 and that the rules were revised in 2016. Is that correct?
4. What was the objective of the 2016 rule changes?
5. What brought about that the rulemaking? Had concerns been raised about how the plans were operating under the prior rules?
6. Do you think the objectives of the changes have been achieved? Why or why not?

Stakeholder Engagement

7. Can you give me an overview of the processes for engaging stakeholders in these programs?
8. Are there any stakeholder advisory groups that provide guidance on the PIPPs?
9. Do you think that there are improvements that could be made in how stakeholders are engaged?

Low Income Customer Needs and PIPPs

10. I would like to talk about how well the state of Colorado is meeting low-income customers' need for affordable energy and the role that the PIPPs play in that. In this discussion, I would like to hear about your perspective on these questions prior to the onset of Covid-19.

To begin with how well do you think the state is meeting needs for affordable energy? Are there specific gaps in terms of the amount of support provided generally, or in supporting specific customer groups?

11. In your view, do you think the percentage of income paid for utilities set in the regulations is appropriate or do you think a different share would be better?
12. Do you think the residential fee of 31 cents per monthly bill is a proper amount? Should it be higher or lower, and why?

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13. Do you think that the current regulatory framework strikes the right balance between providing funding for the PIPPs and the costs recovered from other ratepayers?
14. The country is experience significant economic hardship with the onset of Covid-19. Given the current structure and funding of the PIPPs, how well do you think they will meet the increased need for affordable energy?
15. Has the current situation caused you to identify any new issues with how the state meets the need for affordable energy?

Conclusion

16. What would you like to change about how the state meets affordable energy needs? Is there anything you would like to see changed about the PIPPs?
17. Are there any regulatory requirements that you would like to see changed to improve the effectiveness or efficiency of the PIPP?
18. What do you think works best about the PIPP?
19. What are you hoping to learn from the evaluation?
20. Is there anything about the PIPPs that I have not asked about that you think I should know?

9.3 Energy Outreach Colorado

Introduction

Thank you for taking the time to speak with me today. The purpose of this discussion is to understand your perspectives on the state's efforts to meet the need for affordable energy and on the Percentage of Income Payment Plans offered by the Colorado utilities specifically.

I have several questions to ask and I want to hear all that you have to say on these topics, but I realize you have a limited amount of time. For that reason, it might seem as though I am rushing at some points but that is only because I want to be respectful of your time.

Do you have any questions for me before we begin?

Background

1. What is your job title and role?
2. I would like to hear about Energy Outreach Colorado's role in advocacy and delivery of services and support to help low income customers afford their energy needs. What types of advocacy activities does Energy Outreach Colorado engage in?
3. Can you tell me about the program and services that Energy Outreach Colorado offers to low income customers?
 - a. Does Energy Outreach Colorado have a role in administering or delivering the states LEAP or Weatherization programs?
 - b. What is Energy Outreach Colorado's role in providing utility payment assistance? What are the funding sources of that assistance?
4. What role does EOC play with local county level partners with regard to LEAP enrollment and outreach?
 - a. Are there particular metrics that are used to track year over year enrollment at a county level?
 - b. Are best practices for outreach discussed and refined?
5. What role does Energy Outreach Colorado have in regard to the PIPPs offered by the Colorado utilities?

History and Current Structure of PIPPs

6. I would like to hear your perspective on the rules that govern the current PIPPs. My understanding of the history is that Colorado began offering PIPPs in 2012 and that the rules were revised in 2016. Is that correct?
7. What was the objective of the 2016 rule changes?

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8. Did Energy Outreach Colorado play a role in the statewide rulemaking for the current structure of the PIPPs? What was that role (e.g., informational/advocacy)?
9. What brought about that the rulemaking? Had concerns been raised about how the plans were operating under the prior rules?
10. Do you think the objectives of the changes have been achieved? Why or why not?

Low Income Customer Needs and PIPPs

11. I would like to talk about how well the state of Colorado is meeting low-income customers' need for affordable energy and the role that the PIPPs play in that. In this discussion, I would like to hear about your perspective on these questions prior to the onset of Covid-19.

To begin with how well do you think the state is meeting needs for affordable energy? Are there specific gaps in terms of the amount of support provided generally, or in supporting specific customer groups?

12. Now I would like to focus in on the role that the PIPPs play in meeting affordable energy needs. To begin with, one of the key qualification criteria is that it is limited to customers with a household income at or below 185% of the current federal poverty level. Is that an appropriate threshold? Why or why not?

13. In your view, what percentage of income paid for utilities constitutes affordable energy? Do you think the percentages set in the Code of Regulations are appropriate?

14. How well do you think the utilities are doing at getting low income customers enrolled in PIPP? Are some doing a better job of it than others?

- a. If any issues noted, do you have any suggestions for how the utilities could more effectively inform customers of PIPP and get them enrolled?

15. The country is experience significant economic hardship with the onset of Covid-19. Given the current structure and funding of the PIPPs, how well do you think they will meet the increased need for affordable energy?

- a. What should change, in your view, to meet growing needs for affordable energy?

16. Has the current situation caused you to identify any new issues with how the state meets the need for affordable energy?

17. Is the maximum PIPP amount of 31 cents for residential customers an appropriate amount (i.e. should it be higher, or lower)? Why or why not?

Coordination with Other Low-Income Programs

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18. My understanding of the code of regulations is that the PIPP credits are applied after any applicable LEAP assistance is applied to the utility bill. Is that your understanding?

a. Do you have any concerns about how LEAP and PIPP credits are integrated to reduce customer energy costs?

19. A part of the rulemaking is that utilities are to provide program participants information on energy efficiency and weatherization to PIPP participants. How well do you think that process is working? Do you think the utilities are performing equally as well?

Stakeholder Engagement Process

20. I would like to hear about the process for engaging stakeholders on the PIPPs. First, what types of engagement by the utilities occur with stakeholders such as Energy Outreach Colorado?

21. Are there any stakeholder advisory groups that provide guidance on the PIPPs?

22. What role, if any, does Energy Outreach Colorado have in the Colorado Commission on Low-Income Energy Assistance?

a. My understanding is that the Colorado Commission on Low-Income Energy Assistance does not have much involvement with PIPP? Should it? What would the benefit be?

23. Overall, how effective do you think the stakeholder engagement process is?

24. What do you think could be improved about the stakeholder engagement process?

Conclusion

25. What would you like to change about how the state meets affordable energy needs? Is there anything you would like to see changed about the PIPPs?

d. How would you make that change? What would prevent that change from happening?

26. Are there any regulatory requirements that you would like to see changed to improve the effectiveness or efficiency of the PIPP?

27. What do you think works best about the PIPP?

28. What are you hoping to learn from the evaluation?

29. Is there anything else about the PIPPs or the affordable energy needs of low-income customers that we haven't talked about that you think I should understand?

9.4 LEAP

Introduction

Thank you for taking the time to speak with me today. The purpose of this discussion is to understand your perspectives on the Percentage of Income Payment Plans and how those are coordinated with LEAP.

I have several questions to ask and I want to hear all that you have to say on these topics, but I realize you have a limited amount of time. For that reason, it might seem as though I am rushing at some points but that is only because I want to be respectful of your time.

Do you have any questions for me before we begin?

Background

1. What is your job title and role in administering LEAP?

LEAP Operations

2. The next few questions are about how the LEAP program operates. These questions are focused on non-emergency circumstances and not any temporary rules that may be in place because of COVID 19. To begin with, can you tell me about the ways in which Coloradans may learn about LEAP?
3. After someone is enrolled in LEAP, how often do they need to provide updated income, heating type, and other information to remain enrolled?
 - a. What entity is responsible for getting that updated information?
 - b. What is the process for getting the information updated?
4. Currently, the income requirement for LEAP is 60% of state median income for a given number of household members, correct? Previously the criteria was 185% of FPL.
 - a. Has the change in income requirement created challenges in terms of coordinating with PIPP for which the income requirement is 185% of FPL?
 - b. Has the change caused the average LEAP grant to increase or decrease?
 - c. Has LEAP enrollment changed as a result?
5. Does LEAP (or Colorado Department of Human Services) coordinate with other programs such as TANF or WIC to ensure that people who are applying for one program are applying for all the programs they are eligible for? Is there any sort of common application that people can fill out?
6. My understanding is that those who receive a LEAP benefit must agree to have their dwelling weatherized if contacted by a state-authorized weatherization agency. What is the

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process for referring customers to weatherization services? Who determines if they comply with this requirement?

7. Are there other program or services that LEAP participants are required to enroll in?

Coordination with PIPP

8. I would like to discuss coordination efforts with the PIPPs offered by the utilities.

Can you tell me out the process for coordinating on data sharing such as providing income and heating type for?

9. Is there a process for cross-referral of LEAP participants to the utility PIPPs or vice versa?

10. Are there other ways in which LEAP coordinates with the utility PIPPs?

- a. Periodic meetings / conference calls
- b. Connecting customers to other services

11. Are there other ways in which LEAP should coordinate with the PIPPs?

Low Income Customer Needs and PIPPs

12. I would like to talk about how well the state of Colorado is meeting low-income customers need for affordable energy and the role that the PIPPs play in that. I would like to first hear about your perspective on these questions prior to the onset of Covid-19.

To begin with how well do you think the state is meeting needs for affordable energy? Are there specific gaps in terms of the amount of support provided generally, or in supporting specific customer groups?

13. The country is experience significant economic hardship with the onset of Covid-19. Given the current structure and funding of LEAP and the PIPPs, how well do you think the state will be able to meet the need for affordable energy?

14. Are there outreach strategies in place to reach the large number of people who are unemployed as a result of Covid-19?

15. Has the current situation caused you to identify any new issues with how the state meets the need for affordable energy?

16. Is the maximum PIPP amount of 31 cents for residential customers an appropriate amount (i.e., should it be higher, or lower)? Why or why not?

17. What temporary or emergency rules are currently in place, if any? Would there be a benefit of extending those rules?

Conclusion

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18. What would you like to change about how the PIPPs operate or coordinate with LEAP? How would you make that change? What would prevent that change from happening?
19. What do you think works best about the PIPPs or the process of coordinating with LEAP?
20. What are you hoping to learn from the evaluation?
21. Is there anything else about energy assistance in Colorado that I have not asked about that you think I should know?

9.5 Office of Consumer Counsel

Introduction

Thank you for taking the time to speak with me today. The purpose of this discussion is to understand your perspectives on the state's efforts to meet the need for affordable energy and on the Percentage of Income Payment Plans offered by the Colorado utilities specifically.

I have several questions to ask and I want to hear all that you have to say on these topics, but I realize you have a limited amount of time. For that reason, it might seem as though I am rushing at some points but that is only because I want to be respectful of your time.

Do you have any questions for me before we begin?

Background

1. What is your job title and role?
2. Can you tell me about the OCC's role in relation to the PIPPs?

History and Current Structure of PIPPs

3. I would like to hear your perspective on the rules that govern the current PIPPs. My understanding of the history is that Colorado began offering PIPPs in 2012 and that the rules were revised in 2016. Is that correct?
4. What was the objective of the 2016 rule changes?
5. What brought about that the rulemaking? Had concerns been raised about how the plans were operating under the prior rules?
6. Do you think the objectives of the changes have been achieved? Why or why not?

Stakeholder Engagement

7. Can you give me an overview of the processes for engaging stakeholders in these programs?
8. Are there any stakeholder advisory groups that provide guidance on the PIPPs?
9. Do you think that there are improvements that could be made in how stakeholders are engaged?

Oversight Function

10. Do you have any concerns about the utility reporting process or the oversight of the PIPPs?
 - a. What could be done to address those concerns?

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Low Income Customer Needs and PIPPs

11. I would like to talk about how well the state of Colorado is meeting low-income customers need for affordable energy and the role that the PIPPs play in that. In this discussion, I would like to hear about your perspective on these questions prior to the onset of Covid-19.

To begin with how well do you think the state is meeting needs for affordable energy? Are there specific gaps in terms of the amount of support provided generally, or in supporting specific customer groups?

12. In your view, do you think the percentage of income paid for utilities by PIPP participants set in the regulations is appropriate or do you think a different share would be better?

13. Do you think that the current regulatory framework strikes the right balance between providing funding for the PIPPs and the costs recovered from other ratepayers?

14. Is the 31 cent residential maximum residential funding fee an appropriate maximum? Why or why not?

15. The country is experiencing significant economic hardship with the onset of Covid-19. Given the current structure and funding of the PIPPs, how well do you think they will meet the increased need for affordable energy?

a. What should change, in your view, to meet growing needs for affordable energy?

16. Has the current situation caused you to identify any new issues with how the state meets the need for affordable energy?

Conclusion

17. What would you like to change about how the state meets affordable energy needs? Is there anything you would like to see changed about the PIPPs?

18. Are there any regulatory requirements that you would like to see changed to improve the effectiveness or efficiency of the PIPP?

19. Are there aspects of how the PIPPs are implemented that you think should be changed?

20. What do you think works best about the PIPP?

21. What are you hoping to learn from the evaluation?

22. Is there anything about the PIPPs that I have not asked about that you think I should know?

9.6 Public Utilities Commission

Introduction

Thank you for taking the time to speak with me today. The purpose of this discussion is to understand your perspectives on the state's efforts to meet the need for affordable energy and on the Percentage of Income Payment Plans offered by the Colorado utilities specifically.

I have several questions to ask and I want to hear all that you have to say on these topics, but I realize you have a limited amount of time. For that reason, it might seem as though I am rushing at some points but that is only because I want to be respectful of your time.

Do you have any questions for me before we begin?

Background

1. What is your job title and role?

History and Current Structure of PIPPs

2. I would like to hear your perspective on the rules that govern the current PIPPs. My understanding of the history is that Colorado began offering PIPPs in 2012 and that the rules were revised in 2016. Is that correct?
3. What was the objective of the 2016 rule changes?
4. What brought about that the rulemaking? Had concerns been raised about how the plans were operating under the prior rules?
5. Do you think the objectives of the changes have been achieved? Why or why not?

Stakeholder Engagement

6. Can you give me an overview of the processes for engaging stakeholders in these programs?
7. Who are the key stakeholders in regard to the PIPPs?
8. Are there any stakeholder advisory groups that provide guidance on the PIPPs?

Oversight Function

9. Have the utilities generally complied with the annual reporting requirements set in the rules?
10. Are there any requirements regarding the content of the reports that is not outlined in the rules?
11. Is there reporting to the PUC other than the annual report filed by the utilities on the PIPP?

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- a. Aside from the utility annual reports on program operations, is there any additional publicly available reporting related to the PIPPs such as reporting on disconnects or additional PIPP reports?
12. Does the reporting provided meet your needs?
13. What meetings are there to discuss the PIPPs, internally and externally? What is the goal of these meetings?
14. Has the commission requested additional documentation or data on the PIPPs from the utilities? What types of requests have been made and for what purpose?
15. Do you have any concerns about the delivery of the PIPPs?
 - a. Customer enrollment in PIPPs?
 - b. How arrearage credits are being applied?
 - c. The application of LEAP benefits in conjunction with PIPP credits?
 - d. Program administrative costs?
 - e. Coordination with Weatherization services?
 - f. Enrollments in levelized billing plans?
16. Do you have any concerns about the cost recovery mechanism or process in terms of potential impacts on other rate payers or low-income customers?

Low Income Customer Needs and PIPPs

17. I would like to talk about how well the state of Colorado is meeting low-income customers need for affordable energy and the role that the PIPPs play in that. In this discussion, I would like to hear about your perspective on these questions prior to the onset of Covid-19.

To begin with how well do you think the state is meeting needs for affordable energy? Are there specific gaps in terms of the amount of support provided generally, or in supporting specific customer groups?

18. Now I would like to focus in on the role that the PIPPs play in meeting affordable energy needs. To begin with, one of the key qualification criteria is that eligible customers are those with a household income at or below 185% of the current federal poverty level. Is that an appropriate threshold? Why or why not?

19. In your view, what percentage of income paid for utilities constitutes affordable energy? Do you think the percentages set in the Code of Regulations are appropriate?

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20. The country is experience significant economic hardship with the onset of Covid-19. Given the current structure and funding of the PIPPs, how well do you think they will meet the increased need for affordable energy?

21. Has the current situation caused you to identify any new issues with how the state meets the need for affordable energy?

Conclusion

22. What would you like to change about how the state meets affordable energy needs? Is there anything you would like to see changed about the PIPPs?

a. How would you make that change? What would prevent that change from happening?

23. Are there any regulatory requirements that you would like to see changed to improve the effectiveness or efficiency of the PIPP?

24. What do you think works best about the PIPP?

25. What are you hoping to learn from the evaluation?

26. Is there anything about the PIPPs or the PUCs role that I have not asked about that you think I should know?

9.7 Weatherization Assistance Program

Introduction

Thank you for taking the time to speak with me today. The purpose of this discussion is to understand your perspectives on the Percentage of Income Payment Plans and how those are coordinated with the Weatherization Assistance Program.

I have several questions to ask and I want to hear all that you have to say on these topics, but I realize you have a limited amount of time. For that reason, it might seem as though I am rushing at some points but that is only because I want to be respectful of your time.

Do you have any questions for me before we begin?

Background

1. What is your job title and role in administering the Weatherization Assistance Program?

WAP Operations

2. The next few questions are about how the WAP program operates. To begin with, can you tell me about the ways in which customers may learn about WAP?
3. How is WAP funded? Does it come from the same source as LEAP or does it have its own funding source?
4. My understanding is that the income requirement for the WAP is 200% of federal poverty level. Is that correct?
 - a. In contrast, to qualify for a LEAP benefit a customer should have an income equal to 60% of the state median income. However, receiving LEAP qualifies a customer to receive weatherization services. Do you have any thoughts on that difference?
5. My understanding is that customers that receive a LEAP benefit must agree to have their dwelling weatherized if contacted by a state-authorized weatherization agency. How does this process work?
 - a. Once LEAP provides data, how does WAP select or prioritize customers to receive services?
 - b. How does WAP inform customers about their selection for services? How does a customer communicate acceptance or refusal of services? How does the process differ for owner-occupied and rented homes?
 - c. What are some of the reasons for refusal? Is non-response to the request to perform services an issue? Are there different factors for owner occupied and rented homes?

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- d. Once a customer refuses services, how does that information get communicated to WAP?
- 6. Does WAP typically have a wait list? How long does it take to receive services? Does that vary by region in the state?
- 7. How long does a LEAP participant have to comply with the Weatherization requirement before notice of noncompliance is sent?
- 8. Are there other programs or services that Weatherization participants are required to enroll in?

Coordination with PIPP

- 9. I would like to discuss coordination efforts with the PIPPs offered by the utilities. One of the requirements of the PIPPs is that participating customers are to be referred to weatherization services. Does your office receive referrals directly from the utility PIPP programs?
- 10. The regulations require utilities to send lists of PIPP participants that use more than 10,000 kWh or 600 therms a year to the weatherization program. How do those consumption thresholds align with your system for prioritizing weatherization clients? When considering the broader pool of clients seeking weatherization services, are those consumption levels pretty typical or are they at the high or low end?
- 11. Does the WAP refer program participants to PIPP programs? If so, what is the process for doing that?
- 12. Are there other ways in which WAP coordinates with the utility PIPPs?
 - a. Periodic meetings / conference calls
 - b. Connecting customers to other services
- 13. Are there other ways in which WAP should coordinate with the PIPPs?

Low Income Customer Needs and PIPPs

- 14. I would like to talk about how well the state of Colorado is meeting low-income customers' need for affordable energy and the role that the PIPPs play in that. First, I would like to hear about your perspective on these questions prior to the onset of Covid-19.

How well do you think the state is meeting needs for affordable energy? Are there specific gaps in terms of the amount of support provided generally, or in supporting specific customer groups?

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15. The country is experience significant economic hardship with the onset of Covid-19. Given the current structure and funding of WAP and the PIPPs, how well do you think the state will be able to meet the need for affordable energy?
16. Has the current situation caused you to identify any new issues with how the state meets the need for affordable energy?
17. Given the current situation has there been increased resistance to weatherization from LEAP and PIPP recipients?

Conclusion

18. What would you like to change about how the PIPPs operate or coordinate with WAP? How would you make that change? What would prevent that change from happening?
19. What do you think works best about how the state provides utility cost assistance to low-income customers?
20. Is there anything else about energy assistance and weatherization services in Colorado that I have not asked about that you think I should know?

I0 Appendix B: Participant and Nonparticipant Survey Instrument

Introduction

Screening [Do not display title]

1. To begin with, do you pay the [FUEL_TYPE] bills for your household?
 1. Yes
 2. No

[Display if Q1 = 2]

2. Do you know about how much your [FUEL_TYPE] bills are?
 1. Yes
 2. No

[IF ONLINE = 1 and Q1 = 2 and Q2 = 2: Terminate: Based on your response, you do not qualify for this survey. Thank you for your time.]

3. **[IF PHONE = 1 and Q1 = 2 and Q2 = 2]** Many of our questions are about how affordable your utility bills are. May I speak with someone in your household who pays the [FUEL_TYPE] bills?
 1. Yes (Continue survey or reschedule a call back)
 2. No **[Terminate: You do not qualify for this survey. Thank you for your time]**

PIPP Awareness [Do not display title]

4. [UTILITY] offers a program called [PROGRAM_NAME]. Have you heard of this program?
 1. Yes
 2. No

PIPP Participation [Do not display title]

5. Through [UTILITY]'s [PROGRAM_NAME] Program, your [FUEL_TYPE] costs were lowered and your monthly bills were changed so that they remained about the same each month.

Were you aware that you participated and received this benefit in [YEAR]?

1. Yes
2. No

[Display if OPT_OUT = 0]

6. Are you currently enrolled in [UTILITY]'s [PROGRAM_NAME] Program?
 1. Yes
 2. No
 98. Not sure

[Display if OPT_OUT = 2]

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7. Based on our records you were not enrolled in [UTILITY]'s [PROGRAM_NAME] Program in 2019.
Why were you not enrolled in 2019? (Please select all that apply)

[Multiselect]

1. I was not qualified for the [PROGRAM_NAME] Program **[Terminate: Based on your response, you do not qualify for this survey. Thank you for your time.]**
2. I was not qualified for LEAP **[Terminate: Based on your response, you do not qualify for this survey. Thank you for your time.]**
3. I did not want to be enrolled in [PROGRAM_NAME] Program
4. I did not want to be enrolled in LEAP
5. I thought I was enrolled in [PROGRAM_NAME] Program
6. For some other reason (Please explain)
7. [Did not get application in on time]
8. [Moved]
9. [Financial Reasons]
10. [Did not get assistance from the utility]
11. [Lack of awareness]
12. [Missed LEAP deadline]

98. [Don't know]

[IF Q7 = 4 AND Q7 <> 3, ASSISTANCE = "LEAP", ELSE ASSISTANCE = "[PROGRAM_NAME]"]

[Display if OPT_OUT = 1]

8. Based on our records you opted out of [UTILITY]'s [PROGRAM_NAME] Program in [YEAR]. Is that correct?
1. Yes
 2. No **[TERMINATE SURVEY: Thank you for providing that information. Based on your responses you are not qualified for this survey.]**

[Display if Q7 = 3 or 4 or Q8 =1]

9. Why did you not want to be enrolled in [ASSISTANCE]? (Please select all that apply.)

[Multiselect] [Randomize 1 - 7]

1. I didn't want assistance
2. I didn't understand what the benefit was
3. I didn't like that I was required to have my utility bill adjusted so that it didn't change from month-to-month
4. **[Display if OPT_OUT = 2]** I didn't want to enroll in LEAP
5. **[Display if OPT_OUT = 2]** I didn't have the documentation necessary to enroll in LEAP
6. **[Display if OPT_OUT = 2]** The application was too much effort
8. [I got LEAP payments]
9. [I moved]
10. [I didn't know how to apply]
11. [I didn't understand the billing or payments under the program]
12. [I didn't need the benefit]

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- 13. [I didn't like the change/confused]
- 14. [The benefit is lower in the warmer weather]
- 7. For some other reason (Please explain)
- 98. [Don't know]

[Display if more than one is selected in Q9]

- 10. Of those reasons you mentioned, what was the most important reason why you did not want to be enrolled in [ASSISTANCE]?
 - 1. [Display if Q9 = 1] I didn't want assistance
 - 2. [Display if Q9 = 2] I didn't understand what the benefit was
 - 3. [Display if Q9 = 3] I didn't like the that I was required to have my utility bill adjusted so that it didn't change from month-to-month (also known as budget billing)
 - 4. [Display if Q9 = 4] I didn't want to enroll in LEAP
 - 5. [Display if Q9 = 5] I didn't have the documentation necessary to enroll in LEAP
 - 6. [Display if Q9 = 6] The application was too much effort
 - 7. For some other reason (Please explain)
 - 8. [I got LEAP payments]
 - 9. [I moved]
 - 10. [I didn't know how to apply]
 - 11. [I didn't understand the billing or payments under the program]
 - 12. [I didn't need the benefit]
 - 13. [I didn't like the change/confused]
 - 14. [The benefit is lower in the warmer weather]

[Display if Q4 = 1]

- 11. How did you first become aware of [UTILITY]'s [PROGRAM_NAME] Program?

[Randomize 1 – 8]

- 1. Through a notification or letter from [UTILITY] telling me that I was enrolled
- 2. Through a bill notice or mailing from [UTILITY] telling me that they offered the program
- 3. A charity or nonprofit organization
- 4. Utility website or customer service
- 5. Social media
- 6. Radio, television, or newspaper advertisement
- 7. From my local government
- 8. From a friend, family member or neighbor
- 9. In some other way (Please describe)
- 10. [LEAP]
- 98. Do not recall

LEAP Enrollment [Do not display title]

- 12. According to our records you received utility bill payment assistance through the Colorado Low-income Energy Assistance Program or LEAP in [YEAR].
Are you currently receiving LEAP assistance?
 - 1. Yes

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- 2. No
- 3. No, I don't think I ever received LEAP assistance
- 98. Do not recall

[Display if Q12 <> 3]

13. How did you first learn of LEAP?

[Randomize 1 – 12]

- 1. The Colorado Department of Human Services website
- 2. By calling the Colorado Department of Human Services toll-free number
- 3. Through a bill notice or mailing from my [UTILITY]
- 4. A charity or nonprofit organization such as Discover Goodwill
- 5. The [UTILITY] website or customer service
- 6. Social media
- 7. Radio, television, or newspaper advertisement
- 8. A news story
- 9. From my local or state government
- 10. Internet search (google, etc.)
- 11. From a social worker
- 12. From a friend, family member or neighbor
- 13. In some other way (Please describe)
- 14. [Had LEAP previously or known for a long time]
- 15. [Welfare]
- 16. [Case Worker]
- 98. Do not recall
- 99. I don't know what LEAP is

[Display if Q12 <> 3]

14. Thinking back to when you most recently enrolled in LEAP, did you have any difficulty or challenges with the enrollment process?

- 1. Yes
- 2. No
- 98. Do not recall

[Display if Q14= 1]

15. What kinds of difficulty did you have? (Please select all that apply)

[Multiselect] [Randomize 1 – 4]

- 1. Completing the application
- 2. Providing documentation such as proof of income
- 3. My application was initially denied
- 4. The enrollment period had closed
- 5. I didn't know how to apply
- 6. Some other reason (Please explain)

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16. Were there any years when you think you qualified for LEAP but did not receive the LEAP benefit?
1. Yes
 2. No
 98. Not sure

[Display if Q16 = 1]

17. Why did you not receive the LEAP benefit? (Select all that apply)

[Multiselect] [Randomize 1 – 4]

1. I was not aware of the LEAP benefit and did not apply
 2. I missed the application period
 3. I was not able to complete the application
 4. I was not interested in getting the benefit
 5. For some other reason (Please explain)
 6. [Covid 19]
 7. [Did not qualify]
 8. [I did not have all the information to apply].
 98. Don't know
18. Do you have any suggestions for how the LEAP enrollment process could be improved?

Additional Utility Assistance [Do not display title]

19. Have you applied for bill payment assistance from Energy Outreach Colorado?
1. Yes
 2. No
 98. Not sure

[Display if Q19 = 1]

20. Did you receive assistance from Energy Outreach Colorado?
1. Yes
 2. No
 98. Not sure

[Display if Q19 = 1]

21. How did you learn of the assistance that Energy Outreach Colorado provides?
1. From [UTILITY]
 2. From the Energy Outreach Colorado website
 3. From an internet search (google, etc.)
 4. Social media
 5. Radio, television, or newspaper advertisement
 6. From a friend, family member or neighbor
 7. In some other way (Please describe)
 8. [Human Resources]

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- 9. [Church]
- 98. Do not recall

Affordability [Do not display title]

The next few questions are about the affordability of your utility bills. Although Covid-19 may have impacted your ability to pay your bills, we would like you to think about how affordable your bills were before Covid-19 began.

As a reminder, we will keep your responses confidential. We will not share them with your utility or others.

- 22. How affordable is your natural gas bill? Would you say:
 - 1. Very affordable
 - 2. Somewhat affordable
 - 3. Somewhat unaffordable
 - 4. Very unaffordable
 - 5. Do not have natural gas service at my home
- 23. How affordable is your electricity bill? Would you say:
 - 1. Very affordable
 - 2. Somewhat affordable
 - 3. Somewhat unaffordable
 - 4. Very unaffordable

[Display if Q5 = 1 OR Q6 = 1]

- 24. Prior to your enrollment in [UTILITY]'s [PROGRAM_NAME] Program assistance, did you have difficulty paying your [FUEL_TYPE] bills?
 - 1. Yes
 - 2. No
 - 98. Not sure

[Display if Q5 = 1 OR Q6 = 1]

- 25. Would you say that your participation in [UTILITY]'s [PROGRAM_NAME] Program and receiving made paying your [FUEL_TYPE] bills: **[IF PHONE: (Read list)]**
 - 1. A lot easier
 - 2. Somewhat easier
 - 3. About the same
 - 4. Somewhat more difficult
 - 5. A lot more difficult

[Display if Q25= 4 or 5]

- 26. Why did the [PROGRAM_NAME] Program make paying your [FUEL_TYPE] bills more difficult?
[LARGE TEXT BOX]

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27. Before you were enrolled in [UTILITY]'s [PROGRAM_NAME] Program, were you enrolled in a budget billing plan that kept your utility bills about the same each month instead of going up and down from month-to-month?

1. Yes
2. No

[Display if Q27 = 2]

28. As part of your enrollment in [UTILITY]'s [PROGRAM_NAME] Program you were enrolled in a budget billing plan that kept your utility bills about the same each month instead of going up and down from month-to-month.

Were you aware that you were enrolled in this type of billing plan?

1. Yes
2. No

[Display if Q27 = 1 or Q28 = 1]

29. How much does having a monthly bill that stays about the same each month help you to pay your utility bills? Would you say:
1. It helps a lot
 2. It helps a some
 3. It helps a little bit
 4. It doesn't help at all
30. We would like to understand the benefits you might have had because the [PROGRAM_NAME] Program lowered your utility costs.

How much do you agree with the following statements. **[IF PHONE: Please answer on a scale where 0 means you "do not agree at all" and 4 means you "completely agree."]**

[Randomize order of 1 – 6; fix 7]

[SCALE: 1= 0 (Do not agree at all), 1 = 1, 2 = 2, 3 = 3, 4 = 4 (Completely agree), 98 = Don't know]

1. The [PROGRAM_NAME] Program helped you to keep your home at a more comfortable temperature
2. The [PROGRAM_NAME] Program made it easier for you to pay other expenses like housing and food costs
3. The [PROGRAM_NAME] Program made you less worried about being able to pay your utility bills
4. The [PROGRAM_NAME] Program helped you to receive fewer shutoff notices
5. The [PROGRAM_NAME] Program helped you to have fewer actual utility shutoffs
6. The [PROGRAM_NAME] Program improved your health

[Display if any in Q30 > 2]

31. We would like you to estimate how much the benefits you mentioned above are worth to you. To understand that, we would like you to estimate how much money you would pay each year to get the kinds of benefits you received through the program.

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For each of the benefits you mentioned, please estimate how much you would be willing to pay for that benefit in **dollars per year**.

How much would you be willing to pay for each of the following benefits?

- a. [Display if Q30a >2] [TEXT BOX] Improved home comfort (dollars per year)
- b. [Display if Q30b >2] [TEXT BOX] Having an easier time paying other expenses (dollars per year)
- c. [Display if Q30c >2] [TEXT BOX] Having less worry about paying utility bills (dollars per year)
- d. [Display if Q30d >2] [TEXT BOX] Receiving fewer shutoff notices (dollars per year)
- e. [Display if Q30e >2] [TEXT BOX] Having fewer utility shutoffs (dollars per year)
- f. [Display if Q30f >2] [TEXT BOX] Experiencing improved health (dollars per year)

32. Have you experienced any other benefits from your participation in [UTILITY]'s [PROGRAM_NAME] Program? Please describe those benefits.

[LARGE TEXT BOX]

Energy Efficiency Program Awareness [Do not display title]

33. Did you receive any information from LEAP or [UTILITY] on the Colorado Weatherization Assistance Program?
- 1. Yes, from LEAP
 - 2. Yes, from [UTILITY]
 - 3. Yes, from both [UTILITY] and LEAP
 - 4.. No, did not receive information on the weatherization program
 - 98. Do not recall
34. Has your home received services through the Colorado Weatherization Assistance Program? Through this program your home may have received improvements to help you save energy.
- 1. Yes
 - 2. No
 - 98. Not sure

[Display if Q34 = 2]

35. Are you currently on a waitlist to receive services through the Colorado Weatherization Assistance Program?
- 1. Yes
 - 2. No
 - 98. Not sure
36. Did you know that [UTILITY] offered energy efficiency programs to help customers save energy?
- 1. Yes
 - 2. No

[Display if Q36 = 1]

37. How did you first learn of your [UTILITY]'s energy efficiency programs?

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1. A(n) [UTILITY] customer service representative
2. The [UTILITY] website
3. My [UTILITY] mailed information to me
4. Internet search (google, etc).
5. Through a contractor
6. Through social media (facebook, twitter etc).
7. Through friends, family, or colleagues
8. In some other way (Please describe)
9. [News report / media]
10. [LEAP]
11. [DHS]
12. [Social / human services]
13. [Retailer associate]
14. [From a school]
15. [TANF]
16. [WIC]
17. [Advertisement]
- 98 Do not recall

[Display if Q36 = 1]

38. Did [UTILITY] give you information about their energy efficiency programs when you were enrolled in the [PROGRAM_NAME] Program?
1. Yes
 2. No
39. Has [UTILITY] given you any tips or information to help you use less energy in your home?
1. Yes
 2. No
 98. Not sure
40. Have you participated in any energy efficiency programs offered by [UTILITY]?
1. Yes
 2. No
 98. Not sure

[Display if Q40 = 1]

41. What type of program did you participate in?
1. A program that makes energy improvements to my home such as adding insulation and sealing off air leaks.
 2. A program that provides rebates for energy efficient appliances
 3. A program that provides free or discounted LED light bulbs
 4. Another type of program (Please describe)
 98. Do not recall
 6. [Weatherization]

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- 7. [Time of use pricing]
- 8. [A program that provides a water usage kit or discounted LED light bulbs]

Covid-19 Impacts [Do not display title]

42. The next few questions are about the impact of Covid-19 and your household's ability to pay its energy bills.
Have you or another member of your household experienced one of the following employment changes? (Select all that apply)

[Multiselect]

- 1. Lost a job due to layoff
 - 2. Lost a job due to a furlough or temporary layoff
 - 3. Had a reduction in hours of work or salary
 - 4. Transitioned to working from home
 - 5. None of the above
 - 99. Prefer not to state
43. Have you seen an increase in your utility costs or energy usage since Covid-19 began?
- 1. Yes
 - 2. No
44. Are you aware that the LEAP/[PROGRAM_NAME] enrollment season has been extended this year?
- 1. Yes
 - 2. No

Demographics and Home Characteristics [Do not display title]

The next few questions are about you and your home. Like all of your responses, we will keep your answers confidential. However, you do not need to answer these questions if you do not want to.

45. Do you rent or own your home?
- 1. Own
 - 2. Rent
 - 98. Don't know
 - 99. Prefer not to answer
46. What is the primary fuel type used to heat your home?
- 1. Natural gas
 - 2. Electricity
 - 3. Other [text box]
 - 98. Don't know
 - 99. Prefer not to answer
47. What is the primary fuel type to heat your hot water heater?
- 1. Natural gas
 - 2. Electricity
 - 3. Other [text box]

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- 98. Don't know
- 99. Prefer not to answer

48. Including yourself, how many people lived in your home in 2019?

- 1. 1 person
- 2. 2 people
- 3. 3 people
- 4. 4 people
- 5. 5 people
- 6. 6 people
- 7. 7 people
- 8. 8 or more people
- 98. Don't know
- 99. Prefer not to answer

49. Are any members of your household 18 or younger?

- 1. Yes
- 2. No
- 99. Prefer not to answer

[Display if Q49 = 1]

50. How many children are in there in your household for each of the following age ranges?

- 1. Age 5 or under **[TEXT BOX]**
- 2. Age 6 – 10 **[TEXT BOX]**
- 3. Age 11 – 18 **[TEXT BOX]**
- 99. Prefer not to answer

51. Has any member of your household been diagnosed with a disability of impairment?

- 1. Yes
- 2. No
- 99. Prefer not to answer

52. Are you or another member of your household age 65 or older?

- 1. Yes
- 2. No
- 99. Prefer not to answer

53. What was your total annual household income in 2019?

- 1. _____
- 98. Don't know
- 99. Prefer not to answer

54. Are you of Hispanic, Latino, or Spanish origin?

- 1. Yes
- 2. No
- 99. Prefer not to answer

55. What is your race? (Select all that apply)

[Multiselect]

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1. White
2. Black or African American
3. American Indian or Alaskan Native
4. Chinese
5. Vietnamese
6. Native Hawaiian
7. Filipino
8. Korean
9. Samoan
10. Asian Indian
11. Japanese
12. Chamorro
13. Other Asian
14. Other Pacific Islander
15. Other
99. Prefer not to answer

Interview recruitment [Do not display]

56. We are interested in speaking with a few customers by telephone to get more information on their experiences with paying their utility bills and the Percentage of Income Payment Program. We will be selecting approximately 20 people to complete an interview at random. If you are selected, we are offering an additional \$50 gift card in exchange for your time. The interviews should take about 20 to 30 minutes.
- Would you be interested in speaking with us if you were selected?
1. Yes
 2. No

[Display if Q56 =1]

57. Please provide your name, email, and telephone number where we can reach you. We will contact you to schedule a time if you are selected.

Name:

Telephone number:

Email address:

[Display if Q56 =1]

58. Do you prefer to be contacted by telephone or email?
1. Telephone
 2. Email
59. Do you have an email address that we can use to send you the \$10 [GIFT CARD] for completing the survey?
1. Yes
 2. No

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[Display if Q59 =1]

60. Please provide your email address:

[Display if Q59 =2]

61. Please provide your mailing address so that we can mail you the gift card.

1. Name
2. Street Address
3. Unit/Apartment number:
4. City
5. State
6. Zip

Thank You! That completes the survey.

II Appendix C: Tabulated Survey Responses

To begin with, do you pay the [FUEL_TYPE] bills for your household?		Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 71)	Non-Participant (n = 56)	Participant (n = 148)	Non-Participant (n = 68)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 142)	Non-Participant (n = 79)
	Yes	99%	96%	99%	99%	100%	100%	100%	100%
	No	1%	4%	1%	1%	0%	0%	0%	0%

Do you know about how much your [FUEL_TYPE] bills are?		Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 1)	Non-Participant (n = 2)	Participant (n = 1)	Non-Participant (n = 1)	Participant (n = 0)	Non-Participant (n = 0)	Participant (n = 0)	Non-Participant (n = 0)
	Yes	100%	100%	100%	100%				
	No	0%	0%	0%	0%				

[UTILITY] offers a program called [PROGRAM_NAME]. Have you heard of this program?		Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 71)	Non-Participant (n = 56)	Participant (n = 147)	Non-Participant (n = 68)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 141)	Non-Participant (n = 79)
	Yes	54%	36%	96%	74%	53%	50%	62%	65%
	No	46%	64%	4%	26%	47%	50%	38%	35%

Through [UTILITY]'s [PROGRAM_NAME] Program, your [FUEL_TYPE] costs were lowered and your monthly bills were changed so that they remained about the same each month. Were you aware that you participated and received this benefit in [YEAR]?		Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 71)	Non-Participant (n = 56)	Participant (n = 147)	Non-Participant (n = 68)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 142)	Non-Participant (n = 79)
	Yes	66%	79%	97%	74%	50%	50%	54%	57%
	No	34%	21%	3%	26%	50%	50%	46%	43%

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Are you currently enrolled in [UTILITY]'s [PROGRAM_NAME] Program?		Atmos		Black Hills		CNG		Public Service	
		Particip ant (n = 71)	Non- Particip ant (n = 0)	Particip ant (n = 148)	Non- Particip ant (n = 0)	Particip ant (n = 30)	Non- Particip ant (n = 0)	Particip ant (n = 142)	Non- Particip ant (n = 0)
	Response								
	Yes	45%		70%		37%		27%	
	No	21%		18%		20%		16%	

Based on our records you were not enrolled in [UTILITY]'s [PROGRAM_NAME] Program in 2019. Why were you not enrolled in 2019?		Atmos		Black Hills		CNG		Public Service	
		Particip ant (n = 0)	Non- Particip ant (n = 0)	Particip ant (n = 0)	Non- Particip ant (n = 65)	Particip ant (n = 0)	Non- Particip ant (n = 4)	Particip ant (n = 0)	Non- Particip ant (n = 79)
	Response								
	I was not qualified for the [PROGRAM_NAME] Program				0%		0%		0%
	I was not qualified for LEAP				0%		0%		0%
	I did not want to be enrolled in [PROGRAM_NAME]				2%		0%		5%
	I did not want to be enrolled in LEAP				0%		0%		4%
	I thought I was enrolled in [PROGRAM_NAME] Program				40%		25%		68%
	Other				9%		0%		8%
	[Did not get application in on time]				2%		0%		1%
	[Moved]				3%		0%		0%
	[Financial Reasons]				5%		0%		0%
	[Did not get assistance from the utility]				3%		0%		0%
	[Lack of awareness]				2%		0%		1%
	[Missed LEAP deadline]				2%		0%		4%
	[Don't know]				34%		75%		9%

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Based on our records you opted out of [UTILITY]'s [PROGRAM_NAME] Program in [YEAR]. Is that correct?		Atmos		Black Hills		CNG		Public Service	
		Particip ant (n = 0)	Non- Particip ant (n = 56)	Particip ant (n = 0)	Non- Particip ant (n = 3)	Particip ant (n = 0)	Non- Particip ant (n = 0)	Particip ant (n = 0)	Non- Particip ant (n = 0)
	Response								
	Yes		100%		100%				
	No		0%		0%				

		Atmos		Black Hills		CNG		Public Service	
		Particip ant (n = 0)	Non- Particip ant (n = 55)	Particip ant (n = 0)	Non- Particip ant (n = 4)	Particip ant (n = 0)	Non- Particip ant (n = 0)	Particip ant (n = 0)	Non- Particip ant (n = 7)
Why did you not want to be enrolled in [ASSISTANCE]? (Please select all that apply.)	Response								
	I didn't want assistance		2%		0%				0%
	I didn't understand what the benefit was		16%		25%				0%
	I didn't like that I was required to have my utility bill adjusted so that it didn't change from month-to-month		22%		50%				29%
	I didn't want to enroll in LEAP		0%		0%				14%
	I didn't have the documentation necessary to enroll in LEAP		0%		0%				14%
	The application was too much effort		0%		0%				0%
	[I got LEAP payments]		15%		0%				0%
	[I moved]		15%		0%				0%
	[I didn't know how to apply]		0%		0%				14%
	[I didn't understand the billing or payments under the program]		4%		25%				0%
	[I didn't need the benefit]		2%		0%				0%
	Other		9%		25%				14%
	Don't know		20%		0%				14%

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	2	Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 0)	Non-Participant (n = 5)	Participant (n = 0)	Non-Participant (n = 1)	Participant (n = 0)	Non-Participant (n = 0)	Participant (n = 0)	Non-Participant (n = 0)
Of those reasons you mentioned, what was the most important reason why you did not want to be enrolled in [ASSISTANCE]?	I didn't want assistance		0%		0%				
	I didn't understand what the benefit was		20%		0%				
	I didn't like the that I was required to have my utility bill adjusted so that it didn't change from month-to-month (also known as budget billing)		40%		100%				
	I didn't want to enroll in LEAP		0%		0%				
	I didn't have the documentation necessary to enroll in LEAP		0%		0%				
	The application was too much effort		0%		0%				
	[I didn't like the change / found it confusing]		0%		0%				
	[The benefit is lower in the warmer weather]		20%		0%				
	Other		0%		0%				

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	Response	Atmos		Black Hills		CNG		Public Service	
		Participant (n = 0)	Non-Participant (n = 55)	Participant (n = 0)	Non-Participant (n = 4)	Participant (n = 0)	Non-Participant (n = 0)	Participant (n = 0)	Non-Participant (n = 7)
Of those reasons you mentioned, what was the most important reason why you did not want to be enrolled in [ASSISTANCE]?	I didn't want assistance		4%		0%				0%
	I didn't understand what the benefit was		16%		0%				0%
	I didn't like the that I was required to have my utility bill adjusted so that it didn't change from month-to-month (also known as budget billing)		16%		50%				29%
	I didn't want to enroll in LEAP		0%		0%				14%
	I didn't have the documentation necessary to enroll in LEAP		0%		0%				14%
	The application was too much effort		0%		0%				0%
	[I got LEAP payments]		13%		0%				0%
	[I moved]		16%		0%				0%
	[I didn't know how to apply]		0%		0%				14%
	[I didn't understand the billing or payments under the program]		2%		25%				0%
	[I didn't need the benefit]		2%		0%				0%
	[I didn't like the change/confused]		2%		0%				0%
	[The benefit is lower in the warmer weather]		0%		0%				0%
	Other		9%		25%				14%
	Don't know		20%		0%				14%

*Recoded to combine responses from those who provided a single response to the multiselect question and those who provided the response to the question about the most important reason of the multiple reasons provided.

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	Response	Atmos		Black Hills		CNG		Public Service	
		Participant (n = 38)	Non-Participant (n = 20)	Participant (n = 0)	Non-Participant (n = 3)	Participant (n = 16)	Non-Participant (n = 2)	Participant (n = 0)	Non-Participant (n = 4)
How did you first become aware of [UTILITY]'s [PROGRAM_NAME] Program?	Through a notification or letter from [UTILITY] telling me that I was enrolled	21%	25%		67%	6%	0%		0%
	Through a bill notice or mailing from [UTILITY] telling me that they offered the program	24%	20%		0%	50%	0%		50%
	A charity or nonprofit organization	5%	0%		0%	6%	0%		25%
	Utility website or customer service	8%	0%		0%	0%	0%		0%
	Social media	0%	0%		0%	0%	0%		0%
	Radio, television, or newspaper advertisement	0%	0%		0%	0%	0%		0%
	From my local government	8%	0%		0%	19%	50%		0%
	From a friend, family member or neighbor	3%	30%		0%	0%	0%		0%
	In some other way	0%	10%		0%	0%	0%		0%
	[LEAP]	8%	5%		0%	0%	0%		0%
	Do not recall	24%	10%		33%	19%	50%		25%

PIPP Evaluation Report

According to our records you received utility bill payment assistance through the Colorado Low-income Energy Assistance Program or LEAP in [YEAR]. Are you currently receiving LEAP assistance?		Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 71)	Non-Participant (n = 56)	Participant (n = 148)	Non-Participant (n = 68)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 142)	Non-Participant (n = 78)
	Yes	92%	73%	89%	71%	87%	50%	85%	53%
	No	8%	25%	11%	26%	13%	50%	13%	36%
	No, I don't think I ever received LEAP assistance	0%	2%	0%	1%	0%	0%	0%	0%
	Do not recall	0%	0%	0%	1%	0%	0%	2%	12%

PIPP Evaluation Report

	Response	Atmos		Black Hills		CNG		Public Service	
		Participant (n = 71)	Non-Participant (n = 55)	Participant (n = 148)	Non-Participant (n = 67)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 142)	Non-Participant (n = 78)
How did you first learn of LEAP?	The Colorado Department of Human Services website	20%	7%	11%	13%	20%	0%	21%	19%
	By calling the Colorado Department of Human Services toll-free number	6%	5%	7%	12%	20%	0%	4%	6%
	Through a bill notice or mailing from my [UTILITY]	8%	7%	9%	4%	13%	0%	12%	4%
	A charity or nonprofit organization such as Discover Goodwill	1%	0%	1%	1%	0%	0%	4%	6%
	The [UTILITY] website or customer service	1%	0%	3%	0%	0%	0%	4%	12%
	Social media	0%	0%	0%	1%	0%	0%	1%	3%
	Radio, television, or newspaper advertisement	0%	4%	1%	3%	0%	0%	1%	4%
	A news story	0%	4%	0%	0%	0%	0%	0%	0%
	From my local or state government	7%	5%	12%	7%	13%	0%	14%	12%
	Internet search (google, etc.)	0%	0%	0%	0%	0%	0%	1%	1%
	From a social worker	13%	27%	22%	15%	7%	50%	9%	9%
	From a friend, family member or neighbor	24%	24%	20%	18%	13%	50%	22%	15%
	Other	3%	4%	1%	4%	3%	0%	2%	1%
	[Had LEAP previously or known for a long time]	3%	2%	1%	4%	0%	0%	0%	0%
	[Welfare]	1%	2%	0%	0%	0%	0%	0%	0%
	[Case Worker]	1%	2%	1%	0%	0%	0%	0%	0%
	Do not recall	11%	5%	9%	13%	10%	0%	6%	4%
	I don't know what LEAP is	0%	2%	0%	1%	0%	0%	0%	4%

PIPP Evaluation Report

Thinking back to when you most recently enrolled in LEAP, did you have any difficulty or challenges with the enrollment process?		Atmos		Black Hills		CNG		Public Service	
		Particip ant (n = 71)	Non- Particip ant (n = 54)	Particip ant (n = 148)	Non- Particip ant (n = 66)	Particip ant (n = 30)	Non- Particip ant (n = 4)	Particip ant (n = 142)	Non- Particip ant (n = 78)
	Response								
	Yes	13%	4%	3%	6%	0%	25%	6%	19%
	No	86%	94%	94%	89%	97%	75%	92%	73%
	Do not Recall	1%	2%	3%	5%	3%	0%	2%	8%

What kinds of difficulty did you have? (Please select all that apply)		Atmos		Black Hills		CNG		Public Service	
		Particip ant (n = 9)	Non- Particip ant (n = 2)	Particip ant (n = 4)	Non- Particip ant (n = 4)	Particip ant (n = 0)	Non- Particip ant (n = 1)	Particip ant (n = 9)	Non- Particip ant (n = 15)
	Response								
	Completing the application	44%	50%	50%	0%		0%	33%	13%
	Providing documentation such as proof of income	44%	0%	25%	0%		0%	11%	27%
	My application was initially denied	22%	0%	25%	50%		100%	22%	40%
	The enrollment period had closed	11%	0%	0%	25%		0%	11%	27%
	I didn't know how to apply	11%	0%	0%	25%		0%	0%	13%
	Some other reason	0%	50%	25%	0%		0%	33%	13%

Were there any years when you think you qualified for LEAP but did not receive the LEAP benefit?		Atmos		Black Hills		CNG		Public Service	
		Particip ant (n = 71)	Non- Particip ant (n = 56)	Particip ant (n = 146)	Non- Particip ant (n = 67)	Particip ant (n = 30)	Non- Particip ant (n = 4)	Particip ant (n = 142)	Non- Particip ant (n = 79)
	Response								
	Yes	20%	5%	10%	22%	17%	50%	27%	43%
	No	66%	73%	75%	63%	70%	50%	54%	35%
	Not sure	14%	21%	15%	15%	13%	0%	19%	22%

PIPP Evaluation Report

Why did you not receive the LEAP benefit		Atmos		Black Hills		CNG		Public Service	
		Particip ant (n = 13)	Non- Particip ant (n = 3)	Particip ant (n = 13)	Non- Particip ant (n = 15)	Particip ant (n = 5)	Non- Particip ant (n = 2)	Particip ant (n = 38)	Non- Particip ant (n = 34)
	Response								
	I was not aware of the LEAP benefit and did not apply	54%	33%	62%	13%	0%	0%	50%	29%
	I missed the application period	23%	0%	8%	53%	40%	0%	26%	53%
	I was not able to complete the application	0%	33%	15%	27%	20%	50%	13%	18%
	I was not interested in getting the benefit	15%	0%	0%	0%	0%	0%	3%	3%
	[Covid 19]	0%	0%	8%	0%	0%	0%	0%	3%
	[Did not qualify]	0%	0%	0%	0%	0%	50%	0%	6%
	[I did not have all the information to apply]	0%	0%	0%	0%	0%	0%	3%	6%
	Other	8%	0%	15%	20%	40%	0%	16%	0%
	Don't know	0%	33%	0%	7%	0%	0%	0%	0%

Have you applied for bill payment assistance from Energy Outreach Colorado?		Atmos		Black Hills		CNG		Public Service	
		Particip ant (n = 71)	Non- Particip ant (n = 56)	Particip ant (n = 148)	Non- Particip ant (n = 67)	Particip ant (n = 30)	Non- Particip ant (n = 4)	Particip ant (n = 142)	Non- Particip ant (n = 79)
	Response								
	Yes	4%	2%	7%	6%	7%	0%	17%	13%
	No	70%	84%	71%	75%	70%	100%	58%	66%
	Not sure	25%	14%	22%	19%	23%	0%	25%	22%

Did you receive assistance from Energy Outreach Colorado?		Atmos		Black Hills		CNG		Public Service	
		Particip ant (n = 3)	Non- Particip ant (n = 1)	Particip ant (n = 11)	Non- Particip ant (n = 4)	Particip ant (n = 2)	Non- Particip ant (n = 0)	Particip ant (n = 24)	Non- Particip ant (n = 10)
	Response								
	Yes	67%	100%	36%	75%	100%		71%	70%
	No	33%	0%	45%	0%	0%		13%	20%
	Not sure	0%	0%	18%	25%	0%		17%	10%

PIPP Evaluation Report

How did you learn of the assistance that Energy Outreach Colorado provides?		Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 3)	Non-Participant (n = 1)	Participant (n = 11)	Non-Participant (n = 4)	Participant (n = 2)	Non-Participant (n = 0)	Participant (n = 24)	Non-Participant (n = 10)
	From [UTILITY]	0%	0%	64%	25%	50%		29%	70%
	From the Energy Outreach Colorado website	33%	0%	0%	0%	0%		13%	10%
	From an internet search (google, etc.)	0%	0%	0%	0%	0%		4%	0%
	Social media	0%	0%	9%	0%	0%		13%	10%
	Radio, television, or newspaper advertisement	0%	0%	0%	0%	0%		0%	0%
	From a friend, family member or neighbor	33%	0%	27%	50%	0%		17%	0%
	Other	0%	0%	0%	0%	0%		13%	0%
	[Human Resource]	0%	100%	0%	0%	50%		0%	0%
	[Church]	33%	0%	0%	0%	0%		0%	0%
	Do not recall	0%	0%	0%	25%	0%		13%	10%

How affordable is your natural gas bill Would you say:		Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 70)	Non-Participant (n = 55)	Participant (n = 140)	Non-Participant (n = 66)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 134)	Non-Participant (n = 72)
	Very affordable	21%	47%	37%	35%	23%	25%	10%	8%
	Somewhat affordable	51%	42%	41%	44%	37%	25%	50%	32%
	Somewhat unaffordable	16%	7%	16%	15%	27%	50%	33%	38%
	Very unaffordable	11%	4%	6%	6%	13%	0%	7%	22%

Excludes customers who said they did not have natural gas service.

How affordable is your electricity bill?		Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 71)	Non-Participant (n = 56)	Participant (n = 148)	Non-Participant (n = 68)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 142)	Non-Participant (n = 78)
	Very affordable	13%	23%	24%	22%	20%	25%	10%	3%
	Somewhat affordable	39%	41%	27%	38%	40%	50%	42%	37%
	Somewhat unaffordable	25%	23%	26%	24%	33%	25%	38%	42%
	Very affordable	23%	13%	24%	16%	7%	0%	11%	18%

PIPP Evaluation Report

Prior to your enrollment in [UTILITY]'s [PROGRAM_NAME] Program assistance, did you have difficulty paying your [FUEL_TYPE] bills?		Atmos		Black Hills		CNG		Public Service	
		Particip ant	Non- Particip ant	Particip ant	Non- Particip ant	Particip ant	Non- Particip ant	Particip ant	Non- Particip ant
	Response	(n = 49)	(n = 42)	(n = 144)	(n = 50)	(n = 17)	(n = 2)	(n = 81)	(n = 44)
	Yes	63%	60%	70%	56%	53%	100%	84%	86%
	No	37%	40%	30%	44%	47%	0%	16%	14%
	Not sure	0%	0%	0%	0%	0%	0%	0%	0%

Would you say that your participation in [UTILITY]'s [PROGRAM_NAME] Program and receiving made paying your [FUEL_TYPE] bills		Atmos		Black Hills		CNG		Public Service	
		Particip ant	Non- Particip ant	Particip ant	Non- Particip ant	Particip ant	Non- Particip ant	Particip ant	Non- Particip ant
	Response	(n = 71)	(n = 56)	(n = 148)	(n = 64)	(n = 30)	(n = 4)	(n = 139)	(n = 78)
	A lot easier	51%	55%	81%	48%	70%	50%	34%	37%
	Somewhat easier	30%	16%	13%	28%	10%	25%	42%	36%
	About the same	18%	18%	3%	19%	20%	25%	24%	22%
	Somewhat more difficult	0%	7%	1%	5%	0%	0%	1%	3%
	A lot more difficult	1%	4%	1%	0%	0%	0%	0%	3%

Before you were enrolled in [UTILITY]'s [PROGRAM_NAME] Program, were you enrolled in a budget billing plan that kept your utility bills about the same each month instead of going up and down from month-to-month?		Atmos		Black Hills		CNG		Public Service	
		Particip ant	Non- Particip ant	Particip ant	Non- Particip ant	Particip ant	Non- Particip ant	Particip ant	Non- Particip ant
	Response	(n = 70)	(n = 56)	(n = 148)	(n = 67)	(n = 29)	(n = 4)	(n = 142)	(n = 79)
	Yes	31%	39%	62%	45%	55%	25%	24%	27%
	No	69%	61%	38%	55%	45%	75%	76%	73%

PIPP Evaluation Report

As part of your enrollment in [UTILITY]'s [PROGRAM_NAME] Program you were enrolled in a budget billing plan that kept your utility bills about the same each month instead of going up and down from month-to-month.		Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 47)	Non-Participant (n = 34)	Participant (n = 56)	Non-Participant (n = 37)	Participant (n = 13)	Non-Participant (n = 3)	Participant (n = 108)	Non-Participant (n = 58)
	Yes	19%	21%	46%	41%	8%	33%	6%	5%
Were you aware that you were enrolled in this type of billing plan?	No	81%	79%	54%	59%	92%	67%	94%	95%

How much does having a monthly bill that stays about the same each month help you to pay your utility bills? Would you say:		Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 31)	Non-Participant (n = 29)	Participant (n = 116)	Non-Participant (n = 45)	Participant (n = 17)	Non-Participant (n = 2)	Participant (n = 41)	Non-Participant (n = 24)
	It helps a lot	55%	66%	71%	64%	65%	50%	41%	54%
	It helps a some	32%	14%	18%	24%	24%	0%	37%	25%
	It helps a little bit	6%	14%	3%	9%	0%	0%	17%	17%
	It does not help at all	6%	7%	9%	2%	12%	50%	5%	4%

The [PROGRAM_NAME] Program helped you to keep your home at a more comfortable temperature.		Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 71)	Non-Participant (n = 56)	Participant (n = 148)	Non-Participant (n = 68)	Participant (n = 29)	Non-Participant (n = 4)	Participant (n = 141)	Non-Participant (n = 77)
	4 (Completely agree)	42%	52%	78%	50%	59%	25%	38%	42%
	3	20%	9%	10%	13%	10%	0%	24%	22%
	2	10%	9%	6%	4%	10%	0%	13%	16%
	1	3%	2%	2%	6%	3%	0%	7%	5%
	0 (Do not agree at all)	6%	11%	1%	7%	3%	25%	4%	10%
	Don't know	20%	18%	3%	19%	14%	50%	14%	5%

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The [PROGRAM_NAME] Program made it easier for you to pay other expenses like housing and food costs.		Atmos		Black Hills		CNG		Public Service	
	Response	Particip ant (n = 71)	Non- Particip ant (n = 56)	Particip ant (n = 148)	Non- Particip ant (n = 68)	Particip ant (n = 29)	Non- Particip ant (n = 4)	Particip ant (n = 142)	Non- Particip ant (n = 78)
	4 (Completely agree)	44%	66%	76%	51%	69%	25%	41%	41%
	3	18%	7%	14%	10%	10%	0%	20%	26%
	2	14%	2%	7%	7%	0%	0%	18%	18%
	1	3%	4%	1%	1%	3%	0%	8%	3%
	0 (Do not agree at all)	6%	7%	2%	12%	3%	25%	1%	6%
	Don't know	15%	14%	1%	18%	14%	50%	11%	6%

The [PROGRAM_NAME] Program made you less worried about being able to pay your utility bills.		Atmos		Black Hills		CNG		Public Service	
	Response	Particip ant (n = 71)	Non- Particip ant (n = 56)	Particip ant (n = 148)	Non- Particip ant (n = 68)	Particip ant (n = 30)	Non- Particip ant (n = 4)	Particip ant (n = 142)	Non- Particip ant (n = 78)
	4 (Completely agree)	45%	59%	73%	53%	57%	25%	39%	45%
	3	20%	11%	15%	13%	13%	0%	21%	22%
	2	13%	4%	7%	3%	10%	0%	18%	15%
	1	3%	0%	1%	3%	3%	0%	9%	4%
	0 (Do not agree at all)	3%	11%	3%	12%	3%	25%	4%	8%
	Don't know	17%	16%	1%	16%	13%	50%	9%	6%

The [PROGRAM_NAME] Program helped you to receive fewer shutoff notices.		Atmos		Black Hills		CNG		Public Service	
	Response	Particip ant (n = 71)	Non- Particip ant (n = 56)	Particip ant (n = 147)	Non- Particip ant (n = 68)	Particip ant (n = 30)	Non- Particip ant (n = 3)	Particip ant (n = 142)	Non- Particip ant (n = 78)
	4 (Completely agree)	35%	55%	64%	41%	63%	33%	46%	44%
	3	20%	5%	10%	9%	7%	0%	12%	19%
	2	7%	7%	2%	6%	3%	0%	14%	12%
	1	3%	0%	1%	3%	3%	0%	5%	5%
	0 (Do not agree at all)	6%	14%	14%	18%	7%	33%	6%	10%
	Don't know	30%	18%	10%	24%	17%	33%	17%	10%

PIPP Evaluation Report

The [PROGRAM_NAME] Program helped you to have fewer actual utility shutoffs		Atmos		Black Hills		CNG		Public Service	
	Response	Particip ant (n = 71)	Non- Particip ant (n = 55)	Particip ant (n = 148)	Non- Particip ant (n = 67)	Particip ant (n = 30)	Non- Particip ant (n = 4)	Particip ant (n = 142)	Non- Particip ant (n = 78)
	4 (Completely agree)	32%	53%	66%	45%	57%	25%	48%	47%
	3	21%	5%	6%	3%	10%	0%	13%	18%
	2	6%	4%	3%	4%	7%	0%	12%	6%
	1	3%	0%	0%	6%	3%	0%	5%	5%
	0 (Do not agree at all)	8%	16%	14%	16%	7%	25%	4%	10%
	Don't know	30%	22%	11%	25%	17%	50%	18%	13%

The [PROGRAM_NAME] Program improved your health.		Atmos		Black Hills		CNG		Public Service	
	Response	Particip ant (n = 71)	Non- Particip ant (n = 56)	Particip ant (n = 148)	Non- Particip ant (n = 68)	Particip ant (n = 30)	Non- Particip ant (n = 4)	Particip ant (n = 141)	Non- Particip ant (n = 78)
	4 (Completely agree)	24%	38%	50%	37%	40%	25%	18%	18%
	3	15%	7%	11%	9%	13%	0%	17%	21%
	2	15%	9%	13%	6%	10%	0%	16%	15%
	1	4%	4%	2%	3%	10%	0%	11%	6%
	0 (Do not agree at all)	15%	18%	14%	21%	10%	25%	12%	18%
	Don't know	25%	25%	11%	25%	17%	50%	26%	22%

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		Atmos		Black Hills		CNG		Public Service	
		Particip ant	Non- Particip ant	Particip ant	Non- Particip ant	Particip ant	Non- Particip ant	Particip ant	Non- Particip ant
Benefit valuation	Benefit								
	Home comfort (n)	50	46	106	53	19	3	85	40
	Home comfort (Average annual value)	\$9.10	\$7.93	\$68.72	\$12.49	\$39.47	\$0.00	\$62.54	\$28.90
	Ease of paying other bills (n)	46	43	105	51	19	3	93	37
	Ease of paying other bills (Average annual value)	\$15.33	\$7.44	\$57.49	\$9.06	\$63.16	\$0.00	\$78.24	\$22.11
	Less worry (n)	47	45	103	52	18	3	98	42
	Less worry (Average annual value)	\$9.68	\$19.33	\$42.20	\$21.08	\$33.33	\$0.00	\$80.52	\$41.61
	Fewer shut off notices (n)	47	46	100	52	19	3	87	38
	Fewer shut off notices (Average annual value)	\$3.94	\$2.83	\$38.52	\$16.08	\$36.84	\$0.00	\$37.47	\$14.82
	Fewer shutoffs (n)	48	46	101	54	18	3	86	38
	Fewer shutoffs (Average annual value)	\$5.10	\$3.48	\$36.99	\$15.39	\$8.33	\$0.00	\$40.30	\$36.58
	Improved health (n)	50	50	116	57	21	3	111	51
	Improved health (Average annual value)	\$0.00	\$2.00	\$20.00	\$5.81	\$4.76	\$0.00	\$25.50	\$5.33
	Total benefit valuation	\$43.15	\$43.01	\$263.92	\$79.90	\$185.90	\$0.00	\$324.57	\$149.34

PIPP Evaluation Report

Did you receive any information from LEAP or [UTILITY] on the Colorado Weatherization Assistance Program?		Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 71)	Non-Participant (n = 55)	Participant (n = 147)	Non-Participant (n = 68)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 142)	Non-Participant (n = 78)
	Yes, from LEAP	61%	47%	40%	43%	73%	75%	40%	28%
	Yes, from [UTILITY]	3%	2%	6%	3%	10%	25%	10%	14%
	Yes, from both [UTILITY] and LEAP	7%	15%	20%	13%	0%	0%	18%	10%
	No, did not receive information on the weatherization program	14%	27%	26%	25%	13%	0%	15%	27%
	Do not recall	15%	9%	7%	16%	3%	0%	17%	21%

Has your home received services through the Colorado Weatherization Assistance Program? Through this program your home may have received improvements to help you save energy.		Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 71)	Non-Participant (n = 55)	Participant (n = 147)	Non-Participant (n = 68)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 142)	Non-Participant (n = 78)
	Yes	28%	25%	26%	32%	43%	100%	22%	21%
	No	61%	60%	64%	56%	57%	0%	61%	63%
	Not sure	11%	15%	10%	12%	0%	0%	17%	17%

Are you currently on a waitlist to receive services through the Colorado Weatherization Assistance Program?		Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 43)	Non-Participant (n = 33)	Participant (n = 94)	Non-Participant (n = 38)	Participant (n = 17)	Non-Participant (n = 0)	Participant (n = 87)	Non-Participant (n = 49)
	Yes	5%	9%	1%	0%	18%		2%	2%
	No	84%	88%	90%	97%	82%		89%	88%
	Not sure	12%	3%	9%	3%	0%		9%	10%

Did you know that [UTILITY] offered energy efficiency programs to help customers save energy?		Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 71)	Non-Participant (n = 55)	Participant (n = 146)	Non-Participant (n = 68)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 142)	Non-Participant (n = 78)
	Yes	52%	56%	53%	50%	63%	75%	56%	44%
	No	48%	44%	47%	50%	37%	25%	44%	56%

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		Atmos		Black Hills		CNG		Public Service	
		Participant (n = 36)	Non-Participant (n = 31)	Participant (n = 77)	Non-Participant (n = 34)	Participant (n = 19)	Non-Participant (n = 3)	Participant (n = 79)	Non-Participant (n = 34)
How did you first learn of your [UTILITY]'s energy efficiency programs?	Response								
	A(n) [UTILITY] customer service representative	8%	3%	10%	6%	11%	0%	9%	18%
	The [UTILITY] website	3%	0%	3%	6%	5%	0%	10%	6%
	My [UTILITY] mailed information to me	50%	58%	55%	65%	42%	33%	49%	41%
	Internet search (google, etc).	0%	0%	4%	0%	0%	0%	0%	3%
	Through a contractor	0%	0%	0%	0%	0%	0%	1%	0%
	Through social media (facebook, twitter etc).	0%	0%	3%	0%	5%	0%	0%	0%
	Through friends, family, or colleagues	8%	10%	12%	12%	16%	67%	11%	18%
	In some other way	0%	0%	0%	0%	0%	0%	0%	0%
	[News report / media]	3%	0%	1%	0%	0%	0%	0%	0%
	[LEAP]	8%	13%	3%	0%	5%	0%	0%	3%
	[DHS]	3%	0%	0%	0%	0%	0%	0%	0%
	[Social / human services]	0%	6%	4%	6%	0%	0%	1%	0%
	[Retailer associate]	0%	0%	0%	0%	5%	0%	0%	0%
	[From a school]	0%	0%	0%	0%	0%	0%	0%	3%
	[TANF]	0%	0%	0%	0%	0%	0%	1%	0%
	[WIC]	0%	0%	0%	0%	0%	0%	1%	0%
	[Advertisement]	0%	0%	1%	0%	0%	0%	0%	0%
	Do not recall	17%	10%	5%	6%	11%	0%	15%	9%

38. Did [UTILITY] give you information about their energy efficiency programs when you were enrolled in the [PROGRAM_NAME] Program?		Atmos		Black Hills		CNG		Public Service	
		Participant (n = 36)	Non-Participant (n = 31)	Participant (n = 76)	Non-Participant (n = 34)	Participant (n = 19)	Non-Participant (n = 3)	Participant (n = 79)	Non-Participant (n = 32)
	Response								
	Yes	56%	77%	76%	68%	84%	67%	68%	75%
	No	44%	23%	24%	32%	16%	33%	32%	25%

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39. Has [UTILITY] given you any tips or information to help you use less energy in your home?		Atmos		Black Hills		CNG		Public Service	
		Particip ant	Non- Particip ant	Particip ant	Non- Particip ant	Particip ant	Non- Particip ant	Particip ant	Non- Particip ant
	Response	(n = 71)	(n = 55)	(n = 147)	(n = 68)	(n = 30)	(n = 4)	(n = 142)	(n = 78)
	Yes	51%	60%	62%	47%	63%	75%	63%	49%
	No	30%	29%	22%	35%	20%	25%	18%	24%
	Not sure	20%	11%	16%	18%	17%	0%	18%	27%

40. Have you participated in any energy efficiency programs offered by [UTILITY]?		Atmos		Black Hills		CNG		Public Service	
		Particip ant	Non- Particip ant	Particip ant	Non- Particip ant	Particip ant	Non- Particip ant	Particip ant	Non- Particip ant
	Response	(n = 71)	(n = 55)	(n = 147)	(n = 68)	(n = 30)	(n = 4)	(n = 142)	(n = 78)
	Yes	20%	4%	23%	19%	23%	50%	23%	21%
	No	54%	78%	60%	62%	60%	50%	45%	53%
	Not sure	27%	18%	17%	19%	17%	0%	32%	27%

41. What type of program did you participate in?		Atmos		Black Hills		CNG		Public Service	
		Particip ant	Non- Particip ant	Particip ant	Non- Particip ant	Particip ant	Non- Particip ant	Particip ant	Non- Particip ant
	Response	(n = 14)	(n = 2)	(n = 34)	(n = 13)	(n = 7)	(n = 2)	(n = 33)	(n = 16)
	A program that makes energy improvements to my home such as adding insulation and sealing off air leaks.	43%	50%	24%	38%	86%	0%	27%	19%
	A program that provides rebates for energy efficient appliances	7%	0%	9%	15%	14%	50%	3%	6%
	A program that provides free or discounted LED light bulbs	29%	0%	65%	38%	0%	50%	61%	69%
	[Weatherization]	7%	0%	0%	0%	0%	0%	0%	0%
	[Time of use pricing]	0%	0%	0%	0%	0%	0%	3%	0%
	[A program that provides a water usage kit or discounted LED light bulbs]	0%	0%	0%	8%	0%	0%	0%	0%
	Other	0%	0%	0%	0%	0%	0%	0%	0%
	Do not recall	14%	50%	3%	0%	0%	0%	6%	6%

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42. The next few questions are about the impact of Covid-19 and your household's ability to pay its energy bills. Have you or another member of your household experienced one of the following employment changes? (Select all that apply)		Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 71)	Non-Participant (n = 55)	Participant (n = 147)	Non-Participant (n = 67)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 142)	Non-Participant (n = 78)
	Lost a job due to layoff	11%	4%	16%	10%	7%	0%	22%	31%
	Lost a job due to a furlough or temporary layoff	11%	9%	12%	3%	10%	0%	17%	22%
	Had a reduction in hours of work or salary	15%	18%	16%	12%	20%	50%	25%	40%
	Transitioned to working from home	6%	7%	5%	0%	7%	0%	7%	14%
	None of the above	65%	62%	55%	70%	63%	50%	36%	22%
	Prefer not to state	6%	9%	9%	10%	3%	0%	11%	10%

43. Have you seen an increase in your utility costs or energy usage since Covid-19 began?		Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 70)	Non-Participant (n = 55)	Participant (n = 147)	Non-Participant (n = 68)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 142)	Non-Participant (n = 79)
	Yes	43%	38%	46%	44%	57%	0%	61%	82%
	No	57%	62%	54%	56%	43%	100%	39%	18%

44. Are you aware that the LEAP/[PROGRAM_NAME] enrollment season has been extended this year?		Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 71)	Non-Participant (n = 55)	Participant (n = 147)	Non-Participant (n = 68)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 142)	Non-Participant (n = 79)
	Yes	49%	38%	25%	22%	53%	0%	40%	22%
	No	51%	62%	75%	78%	47%	100%	60%	78%

45. Do you rent or own your home?		Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 71)	Non-Participant (n = 54)	Participant (n = 147)	Non-Participant (n = 68)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 141)	Non-Participant (n = 78)
	Own	48%	48%	35%	46%	73%	50%	35%	24%
	Rent	49%	43%	60%	49%	23%	50%	59%	71%
	Don't know	0%	0%	1%	0%	0%	0%	0%	0%
	Prefer not to answer	3%	9%	5%	6%	3%	0%	6%	5%

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46. What is the primary fuel type used to heat your home?		Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 71)	Non-Participant (n = 55)	Participant (n = 147)	Non-Participant (n = 68)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 142)	Non-Participant (n = 79)
	Natural gas	90%	80%	76%	71%	90%	100%	46%	42%
	Electricity	4%	5%	18%	21%	10%	0%	39%	47%
	Other	1%	0%	1%	1%	0%	0%	1%	0%
	Don't know	4%	2%	3%	3%	0%	0%	13%	10%
	Prefer not to answer	0%	13%	1%	4%	0%	0%	1%	1%

48. Including yourself, how many people lived in your home in 2019?		Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 71)	Non-Participant (n = 55)	Participant (n = 147)	Non-Participant (n = 68)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 140)	Non-Participant (n = 79)
	1 person	37%	47%	25%	31%	40%	50%	20%	14%
	2 people	24%	15%	27%	31%	33%	25%	14%	20%
	3 people	11%	7%	16%	19%	3%	0%	24%	14%
	4 people	8%	13%	12%	4%	7%	0%	19%	29%
	5 people	10%	5%	9%	4%	7%	0%	12%	4%
	6 people	6%	5%	4%	3%	0%	25%	5%	9%
	7 people	3%	0%	1%	0%	3%	0%	1%	6%
	8 or more people	1%	0%	3%	1%	7%	0%	2%	3%
	Don't know	0%	0%	1%	0%	0%	0%	0%	0%
	Prefer not to answer	0%	7%	3%	6%	0%	0%	4%	1%

49. Are any members of your household 18 or younger?		Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 70)	Non-Participant (n = 54)	Participant (n = 145)	Non-Participant (n = 68)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 142)	Non-Participant (n = 79)
	Yes	39%	33%	48%	34%	30%	50%	59%	75%
	No	61%	59%	49%	62%	70%	50%	35%	24%
	Prefer not to answer	0%	7%	3%	4%	0%	0%	6%	1%

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50. How many children are there in your household for each of the following age ranges?		Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 23)	Non-Participant (n = 17)	Participant (n = 68)	Non-Participant (n = 22)	Participant (n = 9)	Non-Participant (n = 2)	Participant (n = 78)	Non-Participant (n = 54)
	Age 5 or under (Average number)	1.33	1.57	1.63	1.50		3.00	1.22	1.50
	Age 6-10 (Average number)	1.75	2.75	2.63	4.75	3.00		1.92	2.00
	Age 11-18 (Average number)	4.71	1.67	2.43	2.75	3.43	1.00	2.19	3.82

51. Has any member of your household been diagnosed with a disability of impairment?		Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 70)	Non-Participant (n = 54)	Participant (n = 144)	Non-Participant (n = 66)	Participant (n = 30)	Non-Participant (n = 3)	Participant (n = 142)	Non-Participant (n = 79)
	Yes	51%	33%	53%	53%	40%	67%	37%	46%
	No	43%	52%	38%	36%	53%	33%	49%	48%
	Prefer not to answer	6%	15%	8%	11%	7%	0%	15%	6%

52. Are you or another member of your household age 65 or older?		Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 71)	Non-Participant (n = 55)	Participant (n = 146)	Non-Participant (n = 68)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 142)	Non-Participant (n = 79)
	Yes	32%	40%	17%	40%	53%	75%	24%	10%
	No	68%	51%	81%	56%	47%	25%	68%	87%
	Prefer not to answer	0%	9%	2%	4%	0%	0%	8%	3%

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54. Are you of Hispanic, Latino, or Spanish origin?		Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 71)	Non-Participant (n = 55)	Participant (n = 146)	Non-Participant (n = 68)	Participant (n = 30)	Non-Participant (n = 4)	Participant (n = 141)	Non-Participant (n = 78)
	Yes	28%	18%	44%	41%	10%	0%	30%	41%
	No	70%	69%	43%	49%	87%	100%	59%	50%
	Prefer not to answer	1%	13%	13%	10%	3%	0%	11%	9%

55. What is your race? (Select all that apply)		Atmos		Black Hills		CNG		Public Service	
	Response	Participant (n = 66)	Non-Participant (n = 55)	Participant (n = 142)	Non-Participant (n = 67)	Participant (n = 28)	Non-Participant (n = 4)	Participant (n = 140)	Non-Participant (n = 78)
	White	74%	71%	54%	57%	93%	75%	62%	51%
	Black or African American	2%	4%	2%	3%	0%	25%	15%	13%
	American Indian or Alaskan Native	8%	4%	8%	4%	0%	0%	4%	9%
	Chinese	0%	0%	1%	0%	0%	0%	1%	0%
	Vietnamese	0%	0%	0%	0%	0%	0%	0%	0%
	Native Hawaiian	0%	0%	0%	0%	0%	0%	0%	0%
	Filipino	0%	0%	0%	0%	0%	0%	1%	0%
	Korean	0%	0%	0%	0%	0%	0%	0%	0%
	Samoan	0%	0%	0%	0%	0%	0%	0%	0%
	Asian Indian	0%	0%	1%	0%	0%	0%	0%	0%
	Japanese	0%	0%	1%	0%	4%	0%	0%	1%
	Chamorro	0%	0%	0%	0%	0%	0%	0%	0%
	Other Asian	0%	0%	0%	0%	0%	0%	0%	1%
	Other Pacific Islander	0%	0%	1%	0%	0%	0%	0%	0%
	Other	15%	13%	15%	21%	0%	0%	9%	17%
	Prefer not to answer	6%	20%	25%	18%	7%	0%	16%	17%

12 Appendix D: Participant Interview Guide

Awareness and perceptions of the program

1. To be enrolled in [UTILITY]'s [PIPP PROGRAM NAME] you have to first enroll in the Low-Income Energy Assistance Program, known as LEAP. Can you briefly tell me how you learned about the LEAP and why you decided to enroll?
 - a. Was the enrollment process easy or difficult?
 - b. What made it difficult?
 - c. Has there been a year when you believe you qualified for LEAP but you did not get the benefit?
 - d. When you first applied for LEAP, did you have any concerns about applying for the benefit? What were your concerns?
 2. Our records indicate that you were enrolled in [UTILITY]'s [PIPP PROGRAM NAME] after enrolling in LEAP. Did you know that you were enrolled in this program?
 3. At the time when you first enrolled in LEAP, did you know that you would be qualified for the [PIPP PROGRAM NAME] too?
 4. How did you learn about the [PIPP PROGRAM NAME]?
 5. Prior to enrolling in LEAP and the [PIPP PROGRAM NAME], had you heard of other energy assistance programs in Colorado?
 6. Can I ask how much your [UTILITY] bill is each month? [probe for the amount the household pays, only ask for a range unless they say they are not sure. I would also ask the amount that their household pays]
- [DISPLAY Q7 – Q10 IF Q3 = NO]
7. Is there a line item on your monthly utility bill that shows how much assistance you receive?
 8. Follow up with, does it say what type of assistance it is? For example, if it is LEAP a PIPP credit.
 9. How could the utility better inform you about the credit you get through the program?
 10. If you could change how much energy you would use, what kinds of changes would you make?

Comprehension of the benefit received

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11. After you were enrolled in the [PIPP PROGRAM NAME], do you feel like you understood the program and the assistance provided? What is your understanding of the assistance that you receive?
12. Do you think you have benefited from your participation in the [PIPP PROGRAM NAME]? What kinds of benefits have there been for you and your household?
13. Do you feel that the assistance you received through the [PIPP PROGRAM NAME] was enough to make your energy bills affordable? [If they feel like it was not enough, ask what monthly cost would be affordable.]

Willingness to participate

14. Do you remember what the first year was that you were enrolled in the [PIPP PROGRAM NAME]?
15. Do you plan to participate in the upcoming year? [if not, why not?]

Barriers to participation

16. [IF OPT OUT] Our records indicate that you opted out of getting the [PIPP PROGRAM NAME] benefit. Why were you not interested in receiving that benefit?
17. When you were enrolled in the [PIPP PROGRAM NAME] you were also enrolled in a budget billing program. The budget billing program estimates what your annual energy bills are and then puts you on a payment plan that keeps your utility bills the same each month. Were you aware that you were on this plan? What did you think of the Budget Billing component to the [PIPP PROGRAM NAME]? Does it help you manage your utility bills?

Customer understanding and philosophy on utility expenses (prioritization, levels of energy education, awareness of other income eligible energy services, utility bill literacy)

18. Do you read your utility bill?
19. How often? [Always, Often but not always, Sometimes, Rarely, Don't know/Refused to answer]
20. When you look at your bill can you tell how much energy your home used and how much it cost?
21. Can you see what the LEAP and the [PIPP PROGRAM NAME] benefit is on your utility bill or is that unclear?

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22. Are you aware of any other services provided by [UTILITY] that help customers with their energy bills? [if yes, which ones had they heard about?]

23. Where does your utility bill fit in your overall household expenses? In other words, does your utility bill take priority over other expenses?

Impacts of the program on household health and safety

24. The next few questions are about any health benefits you may have experienced from receiving utility payment assistance. Has the energy assistance decreased your worry about paying your utility bills or other bills? Why or why not?

25. Are you able to run your heating system more because of the assistance?

26. Does your home have a cooling system? What type of system do you have [central AC, window AC, evaporative or swamp cooler]?

27. Have you been able to use the air conditioner more because of your participation in the [PIPP PROGRAM NAME]?

28. Did you receive a heating system replacement through LEAP?

29. Did you receive services through the Weatherization Assistance Program? [if yes, go to 29a – 29d]

a. Did you receive any improvements that improved the health and safety of your home? If so, what were those?

b. Has the weatherization work improved the indoor air quality of your home?

c. Were any repairs made to the heating system, broken windows, holes to the outside of the home?

d. Have you experienced fewer illness such as colds or asthma related conditions because of the improvements?

Ability of the program to assist customer energy-related needs

30. What do you think [UTILITY] should do to help you and other customers keep your bills remain low and stay comfortable in your home?

31. I have a couple of questions about your home's energy efficiency. First, do you own or rent the home you live in? Is your home an apartment, a detached home, or a manufactured home?

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32. Do you think your home is energy efficient? Why or why not? [Probes: is your home drafty? What kind of light bulbs do you have? How old is your home?]
33. Have you heard of any program's that [UTILITY] offers to help customers improve the energy efficiency of their homes?
- a. Have you participated in any of those programs? Why or why not?

Ability of the program to assist with utility bill payment

34. What do you think [UTILITY] should do to help you and other customers reduce their monthly utility bills?
35. Is there anything else that you would like me to know about the [PIPP PROGRAM NAME] or energy assistance in Colorado? Is there any feedback you would like to provide to the [UTILITY] about your experience in the [PIPP PROGRAM NAME]?

Those were all the questions that I had for you today. Thank you for your time. I would like to send you a \$50 gift certificate for your time. Please provide your email address so I can send it to you.

Name:

Email address:

Physical address (if preferred):

13 Appendix E: Full Summary of Participant In-Depth Interviews

Twenty-one customers from all four utilities were randomly selected for an interview to get more information on their experiences with paying their utility bills and the Percentage of Income Payment (PIPP) program. The customers were offered a \$50 gift card for completing an interview. Table 1 summarizes the proportion of customers interviewed from each utility.

Table 1 PIPP Participants Interviewed by Utility

Utility	Program Name	Number of Interviewed Participants	Percentage of Sample
Xcel Energy	Energy Affordability	10	48%
Black Hills Energy	Black Hills Energy Assistance	4	19%
Atmos Energy	Percentage of Income Payment	4	19%
Colorado Natural Gas	Customer Assistance	3	14%

Out of the twenty PIPP participants interviewed, 14 were participants in 2019, five were participants in 2018 or 2017 and who did not re-enroll in 2019, and two were past PIPP participants but had opted out. The key findings from the interviews are summarized below.

Social service agencies are a common way for people to learn of the Low-Income Energy Assistance Program (LEAP). Participants must first enroll in the Low-Income Energy Assistance Program, known as LEAP, prior to enrolling in PIPP. PIPP participants provided feedback on how they learned about LEAP, with most (47%) learning through a social service agency, followed by 26% who indicated word-of-mouth, 16% who indicated other sources (e.g., they knew about LEAP for a while or through the work they do), 5% indicated they learned from a trade ally, and 5% from their utility bill.

Most PIPP participants found the LEAP enrollment process easy. Interviewed PIPP participants provided feedback about their experiences with enrolling in LEAP. Seventy-four percent stated that the enrollment process was easy while 21% percent did not view the entire process as easy. Among the customers who found the process more challenging, they often cited required paperwork as their main complaint. Seven PIPP participants stated that there was a year that they believed that they qualified for LEAP but did not get the benefit. One respondent indicated they were concerned that they may not receive the LEAP benefit, but the majority had no concerns.

Many interviewed participants were unaware they were enrolled in the PIPP programs. Seventy-four percent of PIPP participants interviewed did not realize they were enrolled in a PIPP program and 89% did they understand they would qualify for the additional assistance when they applied for LEAP. Some PIPP participants learned about PIPP through the interview. Most participants learned about the PIPP through sources outside of their utility provider (see Table

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2). Prior to enrolling in LEAP and the PIPP programs, most participants (79%) had not heard of other energy assistance programs in Colorado.

Table 2 Sources of Awareness

Source of Awareness Name	n	Percentage of Sample
Letter or mailer	5	26%
From utility (call center or website)	3	16%
Other sources (word of mouth)	3	16%
Bill	2	11%
Not aware of PIPP	6	32%

Financial benefit provided through PIPP is not well understood among most participants. PIPP participants reported not fully understanding how the programs worked and the amount of the assistance they receive on their utility bills. Interviewees did indicate they understood the LEAP benefits as they were notified by a letter how much would be credited to their account and they saw this reflected on their monthly bills. In terms of the PIPP credit, none reported a line item on their bill to identify the assistance provided. Below are the verbatim responses from participants about their understanding of PIPP or suggestions on how to better inform them of the program.

- *“Once I started getting pamphlets, I understood what it was. I would call Atmos to learn more about it. Once I learned, I passed the information along to others. LEAP is different. It is another different type of help from LEAP. It gives you other information.”*
- *“I think some information was mailed to me. I don't understand a lot, but I have had payments kick in when there was an overflow of credit.”*
- *“I understood they both came under assistance. The amount of assistance I get for electricity it great, it makes it possible to have AC in the summer. Understood the BHEAP assistance but did not understand the Xcel Energy Assistance.”*
- *“Give to an explanation about the credit. Send a letter or written information or in the bill say what the credit is.”*
- *“I'm confused about the credit and I don't understand how it works. Maybe they could send a letter or even a phone call stating how it works and if it changes why it changes.”*
- *“They send an energy comparison report card every month (compares with neighbors). I think it would be a good place to put it.”*
- *“Actually, I just need to open the online account so I could see the breakdown. But I am sure I could learn or ask somebody.”*

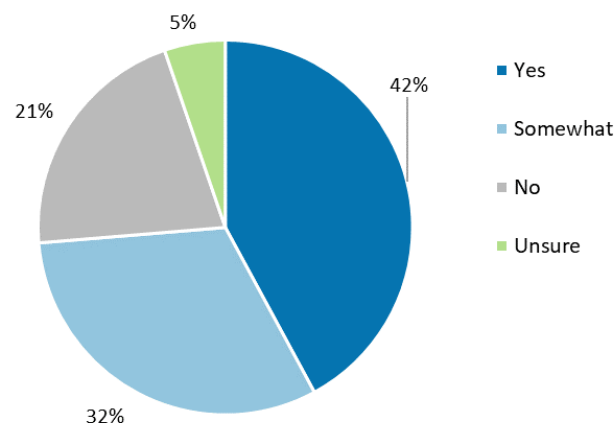
Utility bill amounts vary by fuel type and season. PIPP participants provided feedback about their monthly utility bill amounts including the assistance they receive. Some PIPP participants

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reported paying as much as \$200 per month for utilities, while others indicated they do not pay anything because of the assistance provided by LEAP and PIPP. On average, PIPP participants reported their utility bills to be approximately \$94 per month. PIPP participants indicated if they could change how they use energy in their home, many indicated they would like to reduce A/C usage in the summer months. Many stated they are trying to reduce their homes' energy usage but indicated they would like additional information and education about how to increase their homes' energy efficiency.

Some customers felt that the assistance they received was enough to make their energy bills affordable. Many respondents indicated the assistance they receive from LEAP is very beneficial but because PIPP is less understood fewer respondents affirmed the assistance made their utility bills more affordable. Forty-two percent of respondents stated the assistance they receive through PIPP was enough to make their energy bills affordable and 21% felt that it was not enough (see Figure 1). Among the respondents who stated it somewhat helped them, most indicated LEAP was more helpful.

Figure 1 Do you feel that the assistance you received through the PIPP program was enough to make your energy bills affordable?



Most PIPP participants were unaware they were enrolled in a levelized budget billing plan. Thirteen interviewed PIPP participants were not aware that they were put on the levelized budget billing plan, while six were aware they were in levelized budget billing. PIPP participants had varying opinions of the levelized budget billing component to the PIPP program. Some found levelized budget billing to be helpful for their household, while others did not like owing anything additional at the end of the year. Some respondents did not like being automatically enrolled in levelized budget billing.

- *"I think it helps families with children and seniors."*

PIPP Evaluation Report

- *"They didn't ask me; it would have been nice to ask me. It would be my choice. It should be the customer's choice. I guess it would help manage the utility...maybe more for water. If I got a credit at the end of the year."*
- *"I really like it, it helped me a lot. I would advise people "whatever you get through the mail, read it and it will help you." First time I got it, I threw it away. Not too much stress on me anymore. For example, I was telling my friend that I will have to take out of my pocket for gas...I got a letter from LEAP that they provided \$300 more."*
- *"I think if it were not for the fact that LEAP was not covering all my bills, it would be a very good program. I do not think it should be an automatic enrollment. It should be provided with accurate information and consumers should make that decision themselves."*
- *"I think my husband picked the plan. I do not like it. I have to pay a lump sum at the end of the year (this was many years). LEAP is helping because they bill in winter. They cover about 1 month of bills every 3 months. I cancelled the budget billing because I want to know the usage every month."*
- *"It does help to a point.... Sometimes it is hard. If you do not stay current, it kicks you out of it. But it does help outlining plan."*

Most customers read their utility bills to see how much they must pay. Sixty-two percent of PIPP participants interviewed indicated they read their utility bills, while 38% do not. Among those who read their utility bills, 46% reported always reading them, followed by 46% who sometimes read them, and 8% who rarely read them. Many respondents reported looking at the amount due on their bill and not examining closely their energy usage for the month. Some interviewees were not sure what their household usage is monthly. Eleven respondents indicated they can clearly identify the LEAP and PIPP benefit on their bill, while eight do not think it is clear on their bill. Among those who can identify the benefit, most indicated they can see the LEAP benefit but not necessarily the PIPP benefit.

PIPP participants who opt-out of the program were concerned about levelized budget billing. ADM interviewed two former PIPP participants who opted out of the program after their initial participation. One person who opted out did so because she moved in with family and no longer needed the assistance. Another person opted out because they did not understand the program and were concerned about the levelized budget billing component. This person indicated that they owed money at the end of the year when enrolled in levelized budget billing and this prevented them from participating in PIPP again. The other person who opted out was mostly satisfied with levelized budget billing and felt it helped manage monthly expenses.

More than half of interviewed PIPP participants recalled when they first enrolled in the program. Fifty-three percent of respondents indicated they remembered the first year they enrolled in PIPP, while 47% could not recall. Among those who recalled the first year they enrolled, it ranged from 2005 to 2019. Seventeen interviewees indicated they planned to

PIPP Evaluation Report

participate in the upcoming year. One respondent indicated they did not plan to participate and stated that LEAP covers their utility bills.

Financial assistance reduces energy insecurity among PIPP participants. Utility bills were reported as a priority in most customer's households with only rent or mortgage payments taking priority. PIPP participants reported the energy assistance they have received has decreased their worry about paying utility and other bills. Below are some verbatim responses regarding decreased worry and stress after participating in LEAP and PIPP. About one-third (33%) of PIPP participants indicated they were aware of other services provided by utilities to help customers with energy bills and 66% were not aware of other services provided to customers. Goodwill, Salvation Army, levelized budget billing, weatherization services, and home energy efficiency kits were among the services that customers identified.

- *"We are a family of six and sometimes my father-in-law stays with us. Especially in the winter with only my income, we find ourselves borrow[ing] from family to make ends meet."*
- *"Because when I was married raising kids, with a business, I never had enough. Now I am making very little, but I have very few bills. My worry has decreased because I don't have a monthly financial bills."*
- *"I am the kind of person that gets stressed. High stress and anxiety and I thought I would end up in the hospital. I gave up stuff but after LEAP I don't have the worries any more about my utilities. They really helped me a lot, stopped me from getting sick. I feel great and don't worry about anything."*
- *"The assistance was there when I didn't have grocery money. I was able to pay the correct amount on my other bills. Reduce stress."*
- *"The assistance I get from LEAP and BHEAP and Xcel given they all come under the same umbrella; it takes a great deal of pressure off me. I pay a small amount to BH and my Xcel has always been fair."*
- *"I don't worry because I know that there's is always help coming. I do not get help with my cell phone and internet. My Xcel bill is lowest priority because it is less stressful. I have MS, so in the summertime I get help from Xcel. So, the programs are a direct benefit to my health. It is literally be dangerous for me to leave the house during the summer."*
- *"I am a single mom before I was not able to afford it without this program, I don't know what I would have done. It has made it affordable for something we need."*
- *"It just reassures me that I will have electricity and not have to worry that I need to move in with my daughter."*
- *"You know the assistance programs gives me leeway to pay other bills."*

PIPP Evaluation Report

Demographics of interviewed PIPP participants

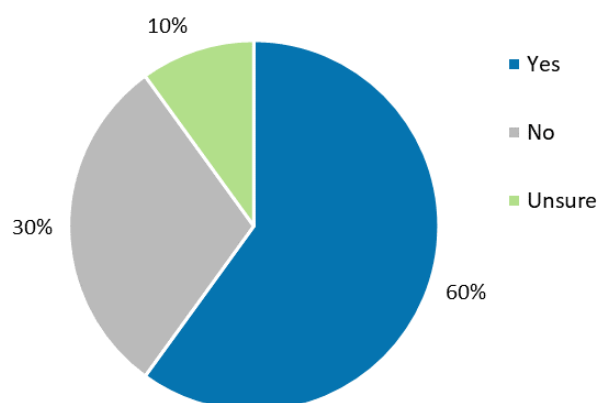
Nine respondents indicated they rented the home they lived in and an additional nine reported owning their home (two respondents indicated they lived with family or had another living arrangement). Most of the customer homes were detached homes (55%), followed by 30% who live in a manufactured/mobile home, 10% who live in a townhome/condominium, and 5% who live in an apartment. Sixty percent of respondents believed their home to be energy efficient, followed by 30% who did not and 10% who were unsure. When asked why they did not believe their homes were energy efficient, most respondents reported drafty windows and doors or living in an older home.

The majority (79%) of interviewed PIPP participants indicated they were able to run their heating systems more because of the assistance they received. Eighty-four percent of respondents reported having some type of cooling system (window AC, central AC, or swamp cooler) and 69% indicated they were able to run their cooling systems more often because of the assistance they have received. A total of three interviewed PIPP participants recalled receiving a heating system replacement from LEAP and five participants received services from the Weatherization Assistance Program (WAP). Among the participants who receive WAP services, three indicated they received improvements to their homes that improve the health and safety of their homes, three indicated the weatherization work improved the indoor quality of their home, and three stated there were repairs to the heating system, broken windows, and holes to the outside of their homes. One person indicated they have experienced fewer illness due to the WAP services.

More than half (60%) of interviewed PIPP participants believe their home is energy efficient and pointed to storm windows and weatherization improvements as to why. Among those who did not believe their home was energy efficient, drafty windows and cold rooms were common responses. Eighty-two percent of customers have heard of programs that help customers improve energy efficiency in their homes. Interviewees noted programs such as tankless water heater replacement, weatherization services, demand response, and light bulb kits. Most people had not participated in any energy efficiency program because they had not heard of any.

PIPP Evaluation Report

Figure 2 Do you think your home is energy efficient?



Customers were satisfied with LEAP and PIPP assistance they have received. PIPP participants offered suggestions for what the utilities should do to help them reduce their utility bill. Most customers (51%) did not have additional suggestions to the utilities and about the programs. The most common suggestion was that the utilities should offer education about the programs and/or energy education. Other suggestions included price adjustments (14%) and offering clean energy options (7%). A few customers recommended personal energy adjustments that customers should do themselves, that the utility should extend its benefits, and provide more assistance.

- *“Extend benefits to people regardless of citizenship. I don't know...we are good about turning on our fans over AC. We are good about leaving it set at one temperature. Sending information about energy efficiency in bills would help.”*
- *“Education - I have learned more talking to you than any time before. I am paperless on my billing, I don't know if they have brochures. Talking with someone about the programs to ensure knowledge transferred.”*
- *Maybe let the seniors or people with lower incomes know about the program right away when they sign up for Atmos or are new to the area. I don't think a lot people know about the program. I think that would help a great deal and especially seniors.*
- *“When you are talking about the total bill you have to consider the air quality and water quality and the effect of the energy source. I think sourcing the energy from the cleanest sources possible.”*
- *extra help is always nice*
- *They are very helpful, especially with families. It (PIPP) is good.*

14 Appendix F: Literature Review Bibliography

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15 Appendix G: Utility Data Request Memo

To:

From: Adam Thomas, ADM Associates, Inc.
Chris Johnson, ADM Associates, Inc.
Jeremy Offenstein, ADM Associates, Inc.

CC:

Date: April/29/2020

Re: Data request for the Evaluation of Percentage of Income Payment Plans (PIPP) programs in PY2020

15.1 Introduction

ADM Associates, Inc. (ADM) is contracted with the Colorado Energy Office (CEO) to evaluate the Percentage of Income Payment Plans (PIPP) programs administered by Black Hills Colorado Electric and Gas, Public Service Company of Colorado Electric and Gas, Colorado Natural Gas, and Atmos Energy.

The evaluation will cover the first triennial period beginning November 1st, 2016 and ending October 31st, 2019.

This memorandum details a request for data necessary to support the evaluation of the PIPP programs. The data requested is to support:

- Analysis of program impacts;
- Development of customer profiles;
- Demographic analyses; and
- Completion of surveys of PIPP participants and non-participants.

The data requested are:

- PIPP participant and non-participant records;
- Information to characterize the utility service area; and
- LEAP participation data.

ADM is available to discuss the requested data to clarify or address any questions that you may have. We can also provide a secure means of transferring data to us.

ADM will store any data on our secure server and restrict access to the ADM team. ADM has a third-party Type 2 SOC 2 audit completed on an annual basis and has information technology security policies and practices in place to protect all personally identifiable information provided.

PIPP Evaluation Report

ADM notes that while we have attempted to characterize all data needs for this study in this document, there may be additional unanticipated data requests.

15.2 Data Request 1: PIPP Participant and Non-Participant Records

ADM requests the participant and non-participant data includes records for both participant and non-participants. Participants include those customers who received PIPP program services during period from Nov 1, 2016 through October 31st, 2019. For the purpose of this study, we are defining program non-participants as customers who were not enrolled in the program but are eligible for PIPP services. To identify this group of customers, we are requesting records for customers who did not receive PIPP services during the period that we are requesting records for, and who are either on a wait-list for PIPP services, opted out of PIPP services, are enrolled in another program that serves low income customers. We are also requesting information for all customers who account is for a premise in a geographic region with high poverty rates. This list is included as an attachment to this document (Attachment – Colorado Low Income Zip Codes).

The provided datasets and data fields are expected to vary from what is specified in the table below, however, we hope this serves as a general outline of our data needs for the evaluation. Definitions of terms are specified below.

We are requesting records for the data summarized in Table 3-8 for the period from Nov 1, 2015 through Apr 15, 2020.

Table 15-1 PIPP Participant and Non-Participant Data Requested

Participant and Non-Participant Data	Requested Data Fields
Billing and Cost Data	Premise ID, Customer ID, name, address, energy usage (kWh or therms), usage duration, date range, billed amounts (\$), customer payment amount, customer payment date
PIPP Enrollment Data	Premise ID, Customer ID, name, address, PIPP enrollment status, PIPP enrollment date, income, and other demographic information provided at enrollment.
Disconnect and Arrearage Data	Premise ID, Customer ID, disconnect notice, disconnects, arrearages
Customer Demographic/Home Characteristic Data	Premise ID, Customer ID, name, address, telephone number, and email address. As available, other heating and cooling type, housing type, etc...
Other Program Enrollment Data	Premise ID, Customer ID, name, address, LEAP status, other energy assistance program status, other energy efficiency program status, etc...

15.3 Data Request 2: Utility Service Area

ADM is requesting data that can be used to geographically characterize the utility service area. This may include a list of zip codes served or shapefiles. ADM will use this information to

PIPP Evaluation Report

characterize the population of customers served using third party data such as that provided by the U.S. Census Bureau.

I 5.4 Data Request 3: LEAP Data

ADM is requesting data on Colorado Low Income Home Energy Assistance Program (LEAP) participants. The purpose for this request is to characterize the demographics of LEAP participants, and overall energy assistance that customers are receiving through it and PIPP. We are requesting data in one of two forms:

- **Customer level data (preferred):** We are seeking data on customers that receive assistance through the Low-Income Home Energy Assistance Program (LEAP). The data requested is the Customer ID (consistent with the Customer ID for PIPP participants), Customer Name, available income data, available demographic characteristics, and amount of benefit received.
- **Summary data (if customer data is not available):** This would include a summary table, by zip code or county, characterizing the LEAP participants including the number of customers enrolled, income, average benefit, and available demographic characteristics.

Definitions

Premise ID: A unique premise ID that is consistent across data types. All provided data should ideally have this data field to allow matching (crosswalking) each premise with its associated data.

Customer ID: A unique customer ID that is consistent across data types. All provided data should ideally have this data field to allow matching (crosswalking) each customer with all their associated data.

Customer Name: The customer first and last name for crosswalking with non-utility datasets.

Customer Address: The customer address for crosswalking with non-utility datasets and stratifying outcomes by geographic characteristics.

Customer Email: The email address on record for the account holder.

Customer Phone: The phone number on record for the account holder.

Energy Usage: Monthly (or daily) energy usage (kWh or therms).

Usage Duration: Length of duration of energy usage (e.g. number of days) or start and end dates of billing cycles.

Date Range: A date range (or date/month) for the billing data, identifying the start and end dates or the billing date/month.

Billed Amounts: Monthly (or daily) billed amounts (\$).

PIPP Evaluation Report

Customer Payment Amount: Amount of payment made by customer.

Customer Payment Date: Date the payment was recorded.

PIPP Enrollment Status: PIPP program status indicator identifying if a customer is enrolled in the PIPP program.

PIPP Enrollment Date: A date field that will allow us to identify when a customer is enrolled in the PIPP program.

Disconnects: A date field that will allow us to identify when customer disconnects occurred.

Disconnect notice: A date field that will allow us to identify when customers received a disconnect notice.

Arrearages: A date field that will allow us to identify when customers went into arrears, and a data field that identifies total arrearage amounts.

Customer Demographic Data Fields: These data fields will assist in measuring outcomes by demographic characteristics and providing contact information for customer surveying efforts. For customer surveys, phone numbers are preferred over other methods of contact, but we may also make use of emails for some customer groups. Suggested demographic data fields include, heating and cooling type, housing type (e.g. MF, SF), household size, etc...

LEAP Status: A date field that identifies whether a customer is enrolled in the LEAP program (if available).

Other Energy Assistance Status: Date fields that identify when a customer is enrolled in other energy assistance programs such as Energy Outreach Colorado (EOC) (if available).

Other Energy Efficiency (EE) Program Status: Date fields that identify when a customer is enrolled in other energy efficiency (EE) programs (e.g. Weatherization or DSM).

I5.5 Attachment – Colorado Low Income Zip Codes

A list of zip codes was included.

Low Income Oversight Board

3rd Quarterly Meeting

September 29, 2022

9:30 AM – 3:30 PM



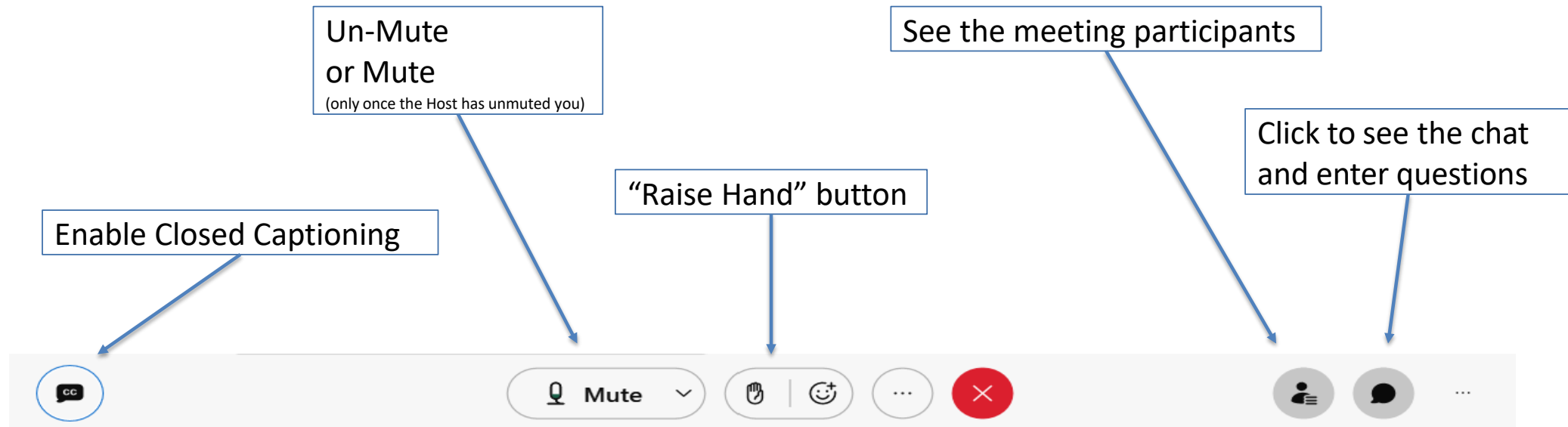
California Public
Utilities Commission

Meeting Information

- All attendees will be **automatically muted** upon entry. Only the Host can unmute attendees and will unmute those who request to speak via the “Raise Hand” Feature.
- Members of the public or community based organizations will be able to provide comment to the Low Income Oversight Board during **Agenda Item 3**, or if requested by the Board.
- The chat box feature should not be used for formal comment. Attendees can use the chat box to message the host to ask general questions, note technical issues, or request to speak.
- This board meeting is a formal CPUC event and will be **recorded** for reference purposes.
- The recording will be available at <https://www.adminmonitor.com/ca/cpuc>



Webex Webinar Participant Guide



Gray means "on" (Not Muted, Sharing Video)

Red means "off" (Muted, Not Sharing Video)

Pursuant to Sec. 382.1 of the California Public Utilities Code, the purpose of the Low Income Oversight Board (LIOB) is to advise the California Public Utilities Commission on low-income electric, gas, and water corporation customer issues and to serve as a liaison for the Commission to low-income ratepayers and representatives.

Quarterly meetings are opportunities for board members to meet and discuss topics related to low-income customer issues. All LIOB meetings are open to the public.

While this meeting is being held via WebEx, all other normal procedures and protocols apply.

Closed Captioning in English provided by Webex:



Closed Captioning in Spanish:

<https://www.adminmonitor.com/ca/cpuc/other/20220929/>

Low-Income Oversight Board

Board Member Introductions

September 29, 2022



California Public
Utilities Commission

LIOB Board Introductions



Genevieve Shiroma
CPUC Commissioner



Benito Delgado-Olson
Chair



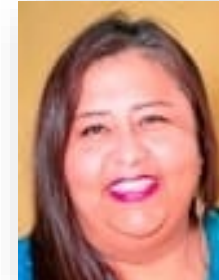
Maria Stamas
Vice Chair/Public



Robert Castaneda
Public



Lisa Castilone
Public



Lourdes Medina
Public



Paul Irwin
Public



Patricia Watts
**Weatherization
Contractor**



Jason Wimbley
CSD



John Tang
Water



Valarie Hernandez
Electric/Gas

Item 2: Approval of the July 21, 2022 2nd Quarterly Meeting Minutes

9:45 – 9:55 AM



California Public
Utilities Commission

Item 3: Public Comment

9:55 – 10:10 AM

Please use the “Raise Hand” feature in Webex window to request to speak



Public comment is intended to provide an opportunity for members of the public who wish to address the board on any topic. Members of the board are not allowed to take any formal action on an item not on the agenda. If possible, it is requested that public comment be limited to 2 minutes per speaker

Item 4: Comment from Community Based Organizations & Special Presentations

10:10 – 10:40 AM



**California Public
Utilities Commission**

Department of Developmental Services

September 29, 2022

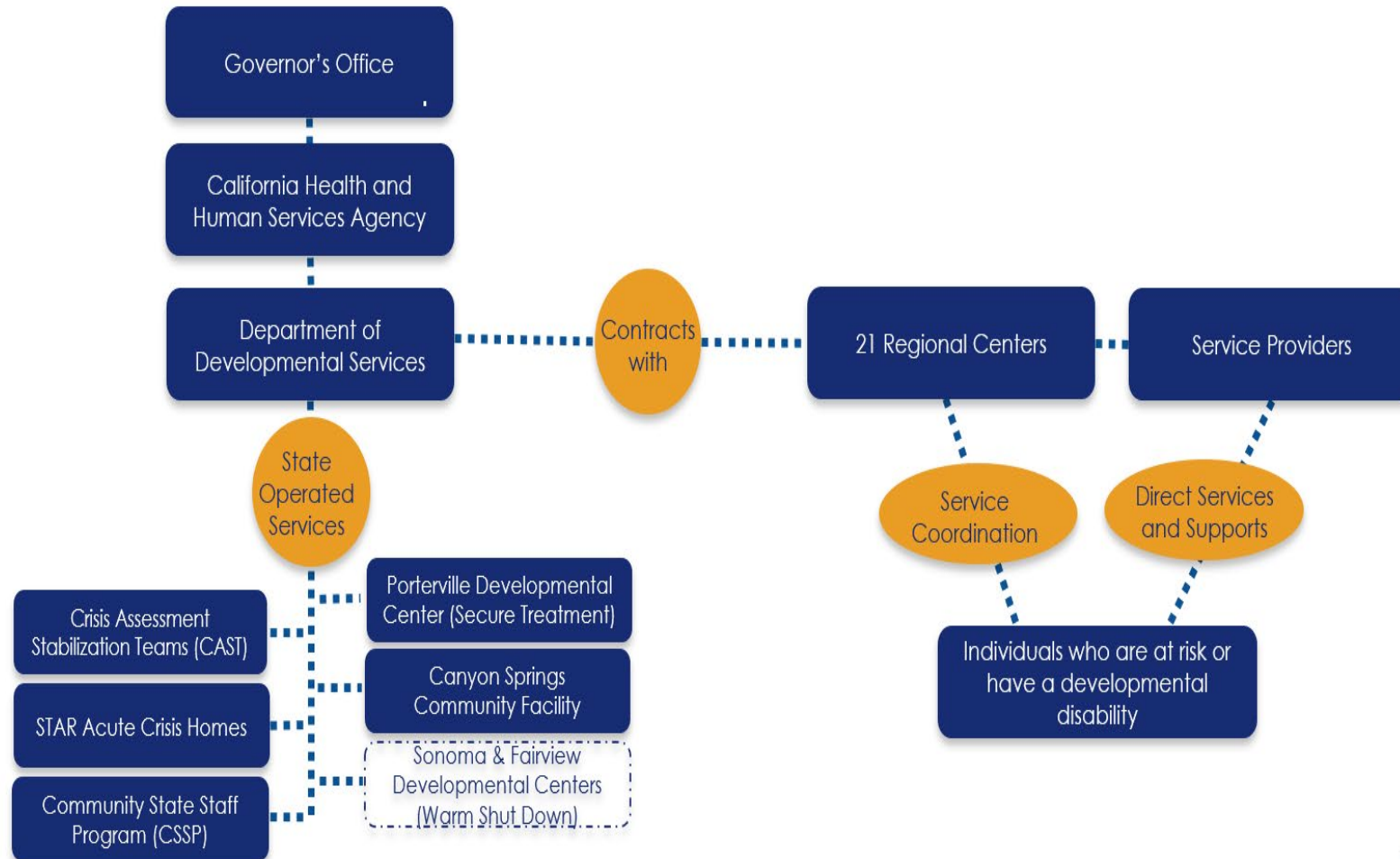
Introduction and Objectives

- Provide a high-level overview of the Department and my role
- Highlight our 2021/2022 Initiatives
- Share learning moments we have experienced
- Research examples
- What more can we do

CALIFORNIA DEPARTMENT OF DEVELOPMENTAL SERVICES (DDS)

- DDS serves 385,000 Californians who have an intellectual/developmental disability (I/DD)
- Services and supports are offered through 21 contracted, private, non-profit community agencies, known as regional centers (RCs)
- State Operated Services
 - ▶ Secure Treatment Program – Forensic I/DD
 - ▶ Community Residential (ICF/DD) – Step Down
 - ▶ Three Mobile Crisis Response Teams (CAST)
 - ▶ Four Community-Based Acute Crisis Homes (STAR Homes)

System Organization



Roles in the Developmental Services System

DDS

- Leadership & policy direction
- Oversee coordination & accountability for delivery of services
- Operate State-Operated Services
- Contract with 21 California regional centers

Regional Centers

- Assessment & eligibility
- Service coordination
- Services as directed by the Individual Program Plan (IPP)
- Oversight of services/providers
- Work with individuals & families
- Implement State & Federal policies

Map of Regional Centers by County



21/22 Initiatives

- ▶ Emergency Go – Kits
- ▶ Portable batteries
- ▶ Emergency Preparedness Materials – Residential homes
- ▶ RC Emergency Coordinators

Thank you and Closing



- ▶ Tamara Rodriguez,
Emergency Preparedness
& Response Officer
- ▶ 916-718-1942 Cell

Break

Item 5: Joint IOU Medical Baseline Program (MBL) Overview

Low Income Oversight Board 3rd Quarterly Meeting Thursday,
September 29, 2022



Medical Baseline (MBL) Program



The Medical Baseline (MBL) Program is an assistance program **for residential customers who have extra energy needs due to qualifying conditions.**



The MBL Program is **NOT an income eligibility program.**



Customers enrolled in the MBL program receive an **additional allotment of electricity and/or gas every month at the lowest price available on their rate.**



Patients must be a **full-time resident in the home.**



Enrollment in the MBL program lets the utility know that someone in the home relies on medical equipment and **may be vulnerable during power outages.**



MBL: Marketing, Education, and Outreach

Marketing

	MBL Acquisition Email	MBL Acquisition Direct Mail	Wildfire Preparedness (Email/Direct Mail)	Bill Inserts/ Onsert	Master Meter Tenant Direct Mail	Targeted Digital Campaign	Targeted Mass Market Campaign	Univision TV Ads (Spanish)	Outbound Call Campaign	IHSS Provider Campaign	Medical Device Retailer Campaign	Cross Promotion w/other Assistance Programs
PG&E	X	X	X	X	X	X	X	X	X	X		X
SDG&E	X		X	X						X	X	X
SCE	X		X	X	X	X	X			X		X
SCG	X	X		X		X	X			X		X

Education/Engagement

	Content in Multiple Language on Website	Outreach Brochures	MBL Video	MBL Factsheet	Wildfire Preparedness Brochure	MBL Healthcare Flyer and Tabletop
PG&E	X	X	X	X	X	X
SDG&E	X	X		X		
SCE	X	X	X	X	X	
SCG	X	X		X		

Outreach

	Wildfire Webinars	CBO/Faith Based Partnerships	CARE Contractors Training	Tribal Community Engagement	Healthcare Professionals/ IHSS Providers Training	Targeted Sponsorships & Partnerships	Community Events
PG&E	X	X	X	X	X	X	X
SDG&E	X	X		X	X	X	X
SCE	X	X	X	X	X	X	X
SCG		X		X	X	X	X

MBL: Benefits

1. Additional monthly allotment of energy

In the MBL program, customers on **eligible rates** receive additional

- 16.5 kilowatt-hours (kwh) of electricity/day and/or
- 0.822 therms of gas/day

at their baseline (lowest) price depending on their energy needs as verified by a medical practitioner during their MBL certification.

2. Extra notifications in advance of a Public Safety Power Shutoff (PSPS)

PSPS notifications may be sent via automated calls, texts and emails (available in sixteen languages) based on customers' contact preferences, and according to the following schedule:

2 days before power is turned off (WATCH)	1 day before power is turned off (WATCH)	Just before power is turned off (WARNING)	During the PSPS	Once power is restored

MBL customers receive extra notifications as part of this outreach, which may include **additional phone calls or a door-bell ring** to ensure they're aware and can prepare to stay safe.

It is important that MBL customers **acknowledge receipt of a notification** by answering the phone and speaking or replying to the text message.

*It is important to note that approval of the MBL program does not prevent customers from being disconnected for non-payment of bills or being impacted by power outages.

MBL: Eligibility

- Below are a few *examples* of qualifying conditions or devices that meet eligibility for the program. More information can be found on the utility's dedicated websites.
- **We encourage customers to NOT disqualify themselves if they do not see their medical condition or device listed on the utilities' websites.**
- We recognize that new devices and technologies are being introduced regularly and we evaluate every application and condition/device, for eligibility.

Examples of Qualifying Medical Conditions

- Paraplegic, hemiplegic or quadriplegic condition
- Multiple sclerosis with additional heating and/or cooling needs
- Scleroderma with additional heating needs
- Life-threatening illness or compromised immune system, and additional heating and/or cooling are needed to sustain life or prevent medical deterioration
- Asthma and/or sleep apnea

Examples of Qualifying Medical/Mobility Devices

- Motorized wheelchair/scooter
- CPAP or other breathing machines
- Respirator (all types)
- Hemodialysis machine

Note: Qualifying medical devices include any medical device used to sustain life and require additional energy. Devices are for home-use only. Devices used for therapy generally do not qualify.

MBL: Enrollment



- Pacific Gas & Electric (PG&E), San Diego Gas & Electric (SDG&E), Southern California Edison (SCE) and SoCalGas make applying for the Medical Baseline Program as convenient as possible by providing the following options to their customers:
 1. Applying online on the dedicated Medical Baseline websites, or
 2. Printing an application from the utilities' webpages and mailing it in, or
 3. Calling the utility Customer Service numbers to request an application be mailed
- Caretakers, family members or agents providing support to qualifying individuals can also assist their clients in applying for the program.
- MBL enrollment requires the MBL application form to be completed and signed by a Qualified Medical Practitioner*.
- MBL Application forms are processed within 7-30 days of receipt. Customers would start seeing additional MBL energy allotments on their energy statements within 1-2 billing cycles.

* A qualified medical practitioner is a licensed physician, nurse practitioner, physician assistant or person licensed pursuant to the Osteopathic Initiative Act

MBL: Recertification & Self-Certification

- While certifying their patient for MBL Program the medical practitioner must indicate whether the patient has a **permanent condition**, or if not, the **approximate duration of medical condition**

☐ No. of Years _____ or ☐ Permanently

- This determines how often the customer will need to re-certify for continued eligibility

Non-Permanent Medical Conditions

Every year	The customer must self-certify for continued eligibility
Every two Years	The customer must recertify, meaning they need to reapply and obtain a qualified medical practitioner's certification

Permanent Medical Conditions

Every two years	The customer must self-certify for continued eligibility

Joint IOU Proposal to Modify MBL Renewal Process

Background: MBL program was last revised in 2002 pursuant to CPUC decision D.02-04-026 (Ordering Paragraph 22). This decision also included the following modifications to the MBL recertification and self-certification processes:

1. *“Customers certified as having a permanent disability will need to self-certify their eligibility every two years, in lieu of obtaining a physician’s signature or authorization, to (at a minimum) ensure their continued residence at the service address, and*
2. *Those customers not having a permanent disability will need to self-certify each year, and will need a doctor’s certification every two years”*

Modification Proposal: On August 2, 2022, the IOUs filed a joint Petition for Modification* to modify Medical Baseline (MBL) renewal process.

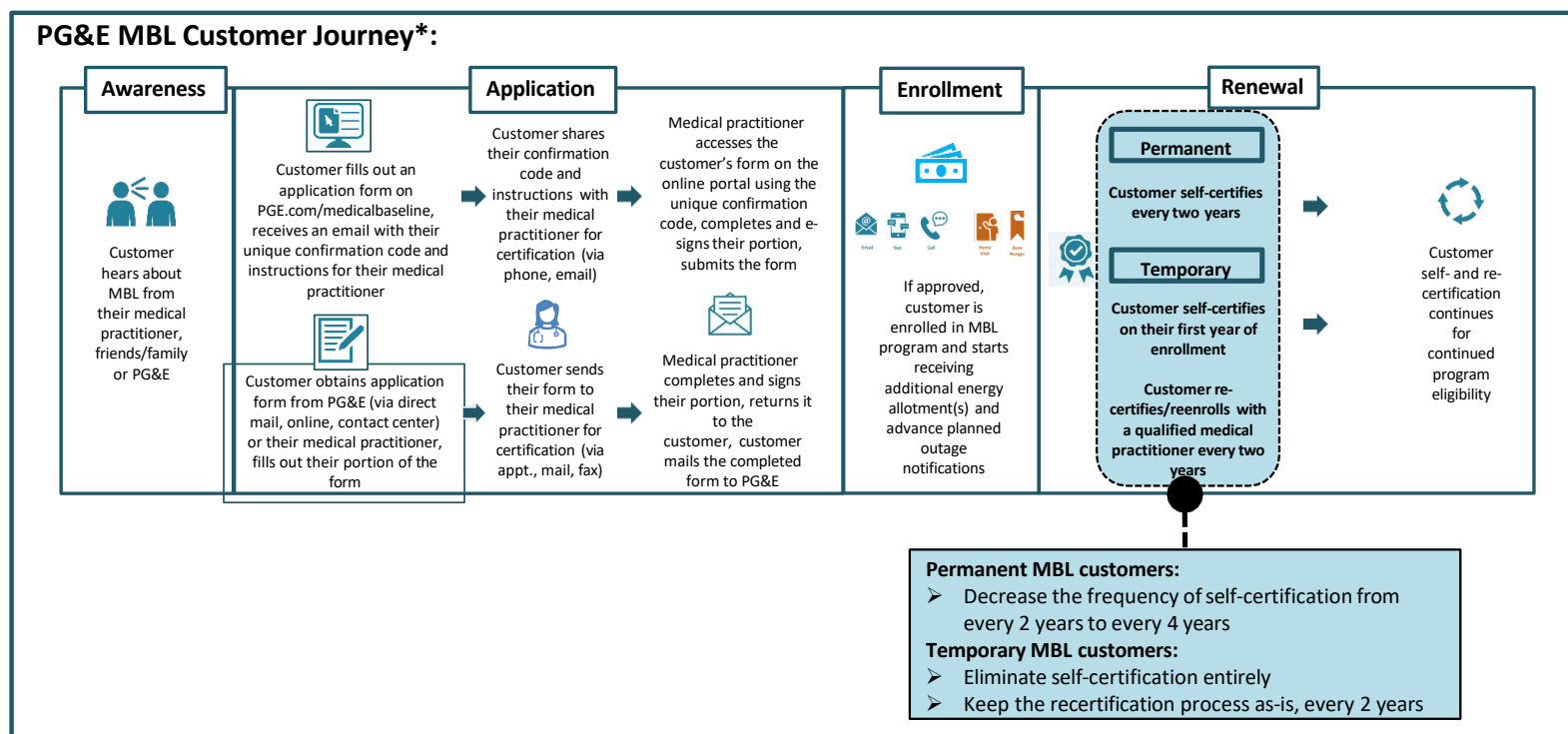
	D.02-04-026 Requirement	Joint IOU Proposal
Permanent Condition	Self-certification every two years	Self-certification every four years
Non-Permanent Condition	Self-certify annually Qualified medical practitioner certification every two years	Eliminate self-certification Retain qualified medical practitioner certification every two years

Ultimately, the Joint IOUs proposal is justified because it:

- Aligns with the shared goals of the Legislature, Commission, stakeholders, and IOUs to increase enrollments in the MBL program; and
- Supports MBL customer retention and delivery of important benefits, such as specific outreach and notifications during emergencies and additional outreach and support to avoid potential disconnection

*JOINT PETITION OF PACIFIC GAS AND ELECTRIC COMPANY (U 39-M) SAN DIEGO GAS AND ELECTRIC COMPANY (U 902-E), SOUTHERN CALIFORNIA EDISON COMPANY (U 338-E) AND SOUTHERN CALIFORNIA GAS COMPANY (U 904-G) FOR MODIFICATION OF DECISION 02-04-026

Joint PFM Aims to Simplify MBL Renewal Process and Cadence for All Customers



*The journey map presented here represents the PG&E MBL customer journey. Some program aspects related to awareness and application may slightly differ than the other IOUs

MBL: More Information



Visit PG&E MBL webpage to learn more about the program and access application forms:

pge.com/medicalbaseline

- **Apply online.** Upon form submission, you will receive an email with a confirmation number and instructions for your medical practitioner.
- Ask your medical provider to complete their portion of the application and share with them the instructions and your confirmation number in the email you received.

Or

- Download and complete Part 1 of the application form.
- Ask your medical provider to complete Part 2 of the application.
- Send in the completed application form:

Mail: PG&E Credit and Records
Center Medical Baseline

P.O. Box 8329
Stockton, CA
95208



Visit SDG&E MBL webpage to learn more about the program and access application forms:

sdge.com/medical

- Download and complete Part 1 of the application form.
- Ask your medical provider to complete Part 2 of the application.
- Send in the completed application form:

Mail: SDG&E
Medical Baseline Allowance
Program Manager

P.O. Box 129831
San Diego, CA
92112-9831

Email:
medicalbaseline@sdge.com



Visit SCE MBL webpage to learn more about the program and access application forms:

sce.com/medicalbaseline

- **Apply online** and provide the email of your medical provider. Your medical provider will receive an email requesting their signature. Please alert them that they will be receiving an email from SCE.

Or

- Download and complete Part 1 of the application form.
- Ask your medical provider to complete Part 2 of the application.
- Send in the completed application form:

Mail: SCE Medical Baseline
Department

P.O. Box 9527
Azusa, CA 91702



Visit SoCalGas MBL webpage to learn more about the program and access application forms:

socalgas.com/medical

- Download and complete Part 1 of the application form.
- Ask your medical provider to complete Part 2 of the application.
- Send in the completed application form:

Mail: SoCalGas
Medical Baseline
Allowance Program
M. L. GT19A1
P.O. Box 513249
Los Angeles, CA
90051-1249

Fax: 213-244-4665

Email:
MedicalBaselineProgram@socalgas.com



Item 6: Joint IOUs Program Highlights

Low Income Oversight Board Meeting

September 29, 2022

WebEx



Program Update – as of 7/31/2022

ESA

Homes treated: 41,199
Annual Energy Savings:

- 14,876,914 kWh
- 678,604 therms

% Expenditure: 42%

CARE

Enrollment: 1,454,447
Enrollment Rate: 104%
Discounts: \$537,893,075
% Adm. Expenditure: 45%

FERA

Enrollment: 36,643
Enrollment Rate: 21%
Discounts: \$9,338,658
% Adm. Expenditure: 57%

Additional Highlights

- PG&E exceeded its annual ESA energy savings target for gas (108%) and is on track to meet its targets for annual electricity savings (at 99% of target) and homes treated (at 69% of target) before the end of 2022
- While PG&E continues to hold its CARE enrollment rate at 104% of eligible households, its FERA enrollment is lagging at 21% (vs its enrollment goal of 40%) despite its aggressive marketing efforts to reach FERA-eligible households
- No disconnection took place through July. There are ~166k customers enrolled in AMP, with 2,569 customers completed the program since the program started in Feb 2021, amount forgiven totaled \$98M (as of 9/1/2022)
- PG&E launched its tribal grant program in June. The availability of the grant program was shared with all tribes within PG&E service territory. So far, PG&E has received one application. PG&E is evaluating ways to improve participation in 2023

Program Overview – as of 7/31/22

CARE

- Customers Enrolled: 1,193,117
- Enrollment Rate: 93%
- Newly Enrolled Customers: 177,780

FERA

- Customers Enrolled: 24,791
- Enrollment Rate: 11%
- Newly Enrolled Customers: 4,543

ESA

- Homes Treated: 33,127
- Energy Savings: 16.6 GWh
- Unspent Funds Remaining: \$21.69

MF CAM

- Properties Treated: 37
- Current Projects: 5
- SCE plans to continue running MF CAM until the Southern Multifamily Whole Building (MFWB) Program is open to participation in 2023.

Additional Highlights

Tribal

- SCE tribal liaisons have begun engaging tribal leaders to offer mini grants. Scheduled initial one-on-one meetings with 3 tribes.

Disconnections/AMP

- No Disconnections for 2022. Resumption of residential credit collection efforts expected to begin Q3 2022.
- Conducted AMP Net Energy Metering (NEM) outreach and mailed letters to AMP customers impacted by delayed billing



Program Overview – as of 7/31/22

CARE

- Customers Enrolled: 350,017
- Enrollment Rate: 121%
- Newly Enrolled Customers: 44,357

ESA

- Homes Treated: 4,478
- kWh Saved: 581,114
- Therms Saved: 11,133

MF CAM

- # of Properties: 8
- kWh Saved: 54,383
- Therms Saved: 1,738

FERA

- Customers Enrolled: 12,108
- Enrollment Rate: 28%
- Newly Enrolled Customers: 1,397

Additional Highlights

Tribal: Tribes completed ESA Meet & Confer - 12

Disconnections/AMP:

- Disconnections - Zero
- AMP - Number of customers enrolled: 13,656
- AMP - Total amount forgiven: \$9.3M



Program Overview – as of 7/31/22

CARE

- Customers Enrolled: 1,782,811
- Enrollment Rate: 111%
- Newly Enrolled Customers: 187,529

ESA

- Homes Treated: 49,665
- Therms Saved: 362,535
- Unspent Funds Remaining: \$67.52 M

MF CAM

- Central Boiler Projects: 13
- Impact: 16 bldgs., 1,212 units, 3,000+ tenants
- Therms Saved: 73,547

Additional Highlights

Tribal

- Enhancing outreach strategy to help navigate and increase engagement within tribal communities, including non-federally recognized.
- Onboarding dedicated consultant to strengthen Tribal relationships.

Disconnections/AMP

- 104,828 customers enrolled in AMP (as of 9/13/22). Disconnections to resume in Q2 2023.



Joint IOUs Energy Savings Assistance Program Solicitations & Contractor Funding

Low Income Oversight Board Meeting

September 29, 2022

WebEx

- The schedule includes key milestones across all IOUs ESA Program solicitations.
- Please use the links to check for monthly updates to help facilitate transparency and assist with bidder workload management.
- The Joint IOUs Solicitations Schedule is updated/posted on or by the 1st of every month. Any date changes are noted at the bottom of the schedule.

[illegible]

Energy Savings Assistance Program

Update on ESA Contractor Funding (Jan-July 2022)

Utility	Funding Issue	Impact
PG&E	PG&E increased contractor funding by \$27M to begin 2022 in order to provide a glide path into the new cycle.	2022 is a transition year; PG&E's budget allocation is consistent with supporting this transition equitably between the existing and new contractors.
SCE	2022 budget is fully committed. Attributed to carryover enrollments from year to year. Remaining budget is sufficient to cover existing ESA Core enrolled customers.	To mitigate overspending, SCE suspended enrollments and adopted a waitlist strategy.
SDG&E	No contractor funding issue	None
SoCalGas	Nothing to report	N/A





Joint IOUs Report of the CARE, FERA and ESA Programs

Low Income Oversight Board Meeting

September 29, 2022

WebEx

CARE Program

PU Code Section 739.1(a) requires the CPUC to establish a program of assistance to low-income electric and gas customers with annual household incomes that are no greater than 200 percent of the federal poverty guideline levels.

Jan-July 2022 CARE Program Updates*

Authorized 2022 Program Budgets and Expenditures				
Utility	2022 Budget	Expenditures	%	Rate Discounts
PG&E	\$13,760,000	\$6,242,567	45%	\$537,893,075
SCE	\$8,822,256	\$4,584,977	52%	\$344,194,395
SDG&E**	\$6,741,045	\$2,754,664	41%	\$118,266,451
SoCalGas	\$10,085,592	\$4,698,276	47%	\$124,929,206
Total	\$39,408,893	\$18,280,486		\$1,007,016,676

Jan-July 2022 Enrollment						
Utility	Total Residential Customers	Estimated Eligible Customers	Eligible Rate	Customers Enrolled***	Enrollment Rate	Newly Enrolled Customers
PG&E	5,641,365	1,401,702	25%	1,454,447	104%	117,747
SCE	4,602,750	1,276,922	28%	1,193,117	93%	177,780
SDG&E	1,390,995	289,316	21%	350,017	121%	44,357
SoCalGas	5,711,246	1,606,753	28%	1,782,811	111%	187,529
Total	17,346,356	4,574,693		4,780,392		527,413

* Authorized budgets pursuant to Decision (D.)21-06-015. Jan-July 2022 as reported in the IOU ESA-CARE-FERA Monthly Report filed August 22, 2022.

** SDG&E continues to analyze its data for changes to customer totals due to a processing backlog and potential data discrepancies currently under review.

*** Total households enrolled includes sub-metered households.

Note: Enrollment Rate is also known as Penetration Rate.



CARE Program *CARE Enrollment map*

PG&E



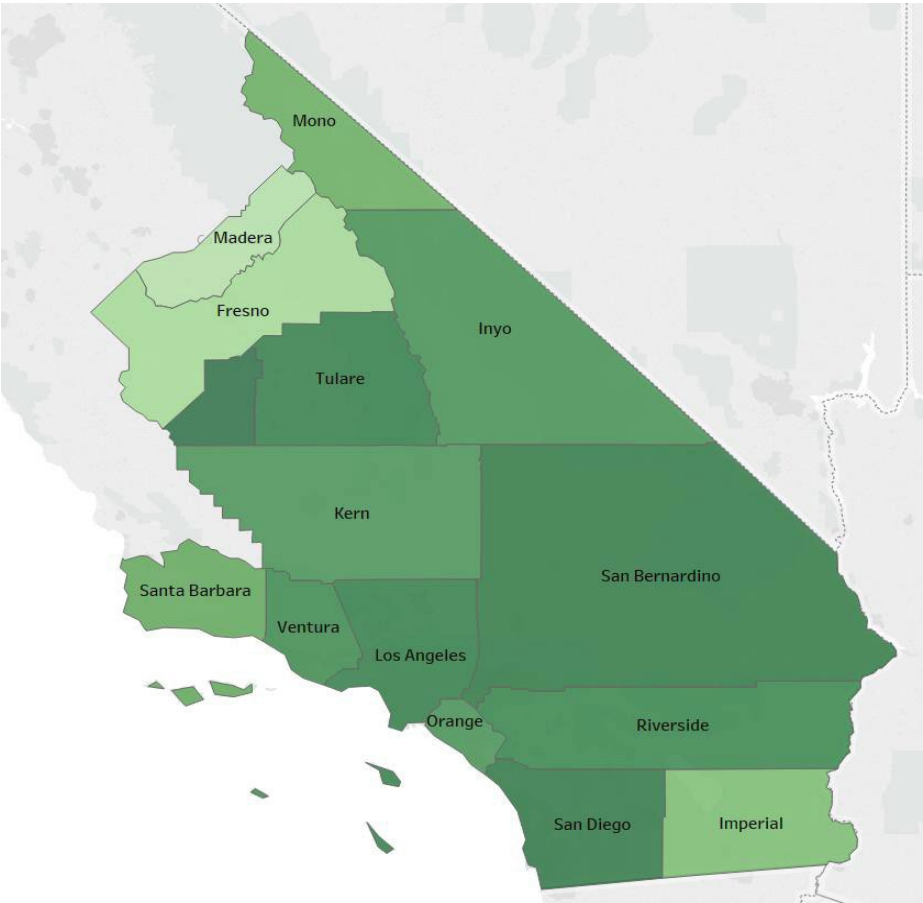
PG&E Counties With Lowest Enrollment Rates	
County	Enrollment Rate*
PLUMAS	59%
MARIPOSA	62%
CALAVERAS	69%
MENDOCINO	69%
SACRAMENTO	74%
TUOLUMNE	76%
PLACER	77%
SAN FRANCISCO	79%
SAN LUIS OBISPO	80%
STANISLAUS	80%

*Represents PG&E counties with the lowest enrollment rates, as of July 31, 2022.
*Excludes counties with less than 1,000 estimated eligible households



CARE Program *CARE Enrollment map*

SCE



County	Enrollment Rate*
Kings	110%
Riverside	108%
Tulare	104%
Los Angeles	98%
San Bernardino	92%
Ventura	82%
Orange	79%
Kern	71%
Inyo	71%
Santa Barbara	64%
Mono	34%

*Represents the enrollment rates for all SCE counties effective July 31, 2022 and excludes counties with less than 1,000 estimated eligible households

CARE Program *CARE Enrollment map*

SDG&E



Zip codes with lowest enrollment (overall)

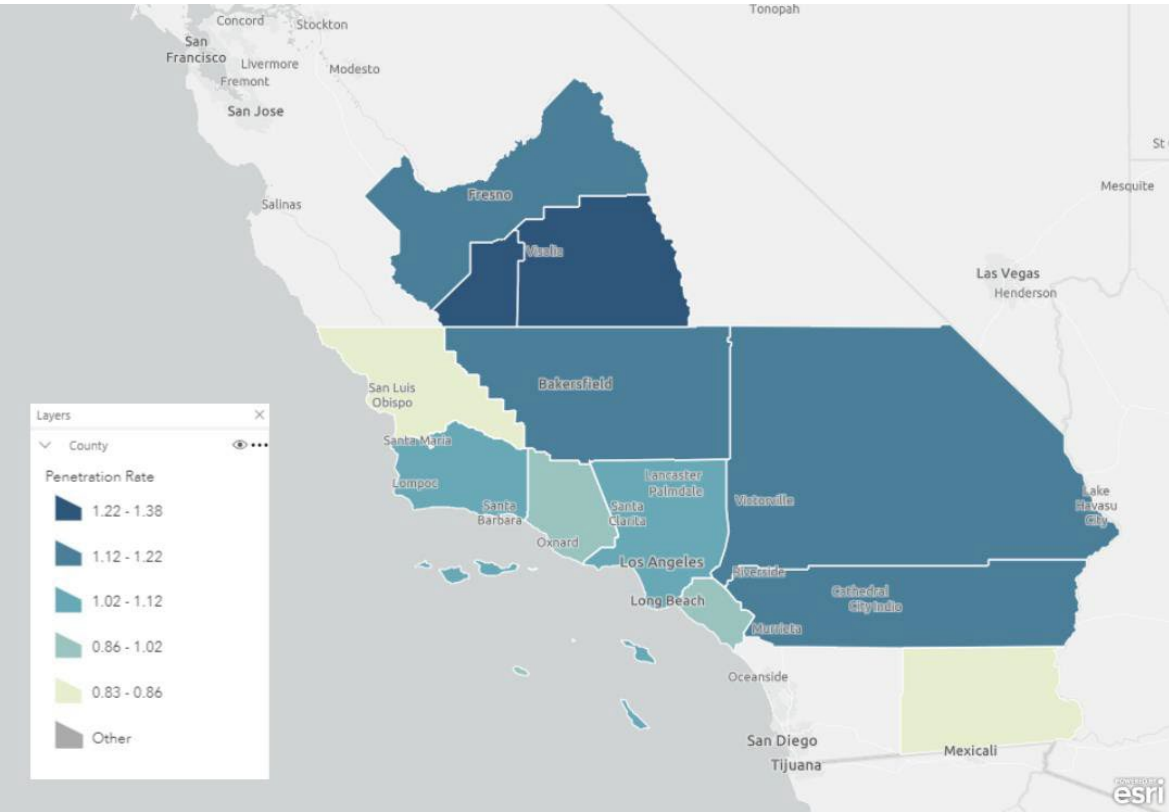
City	Enrollment Rate
Miramar	9%
Rancho Santa Fe	13%
Mount Laguna	18%
Coronado	33%
Laguna Beach	36%
Del Mar	50%

*Represents SDG&E zip codes with the lowest enrollment rates, July 31, 2022.

CARE Program *CARE Enrollment map*



SoCalGas



County	Enrollment Rate *
Kings	138%
Tulare	138%
San Bernardino	122%
Fresno	120%
Kern	120%
Riverside	119%
Santa Barbara	112%
Los Angeles	109%
Ventura	102%
Orange	97%
Imperial	86%
San Luis Obispo	83%

*Represents the enrollment rates for all SoCalGas counties effective July 31, 2022, as reported in the IOU ESA-CARE Monthly Report (Filed August 22, 2022).

FERA Program

Jan-July 2022 FERA Program Updates*

Authorized 2022 Program Budgets Expenditures				
Utility	2022 Budget	Expenditures	%	Rate Discounts
PG&E	\$2,794,400	\$1,603,641	57%	\$9,338,658
SCE	\$1,286,280	\$539,120	42%	\$5,928,852
SDG&E	\$703,150	\$150,202	21%	\$2,408,800
Total	\$4,783,830	\$2,292,963		\$15,267,510

Jan-July 2022 Enrollment						
Utility	Total Residential Electric Customers	Estimated Eligible Customers	Eligible Rate	Customers Enrolled	Enrollment Rate	Newly Enrolled Customers
PG&E**	4,802,843	174,219	4%	36,643	21%	7,686
SCE	4,602,750	221,674	5%	24,791	11%	4,543
SDG&E***	1,390,995	43,709	3%	12,108	28%	1,397
Total	10,796,588	439,602		73,542		13,626

* Authorized budgets pursuant to D.21-06-015. Jan-July 2022 as reported in the IOU ESA-CARE-FERA Monthly Report filed August 22, 2022.

** Despite expending 37% of its marketing and outreach budget, PG&E enrollment rate is forecasted to fall short of the 40% goal.

*** SDG&E continues to analyze its data for changes to customer totals due to a processing backlog and potential data discrepancies currently under review.

Note: Enrollment Rate is also known as Penetration Rate.



FERA Program *FERA Enrollment map*

PG&E



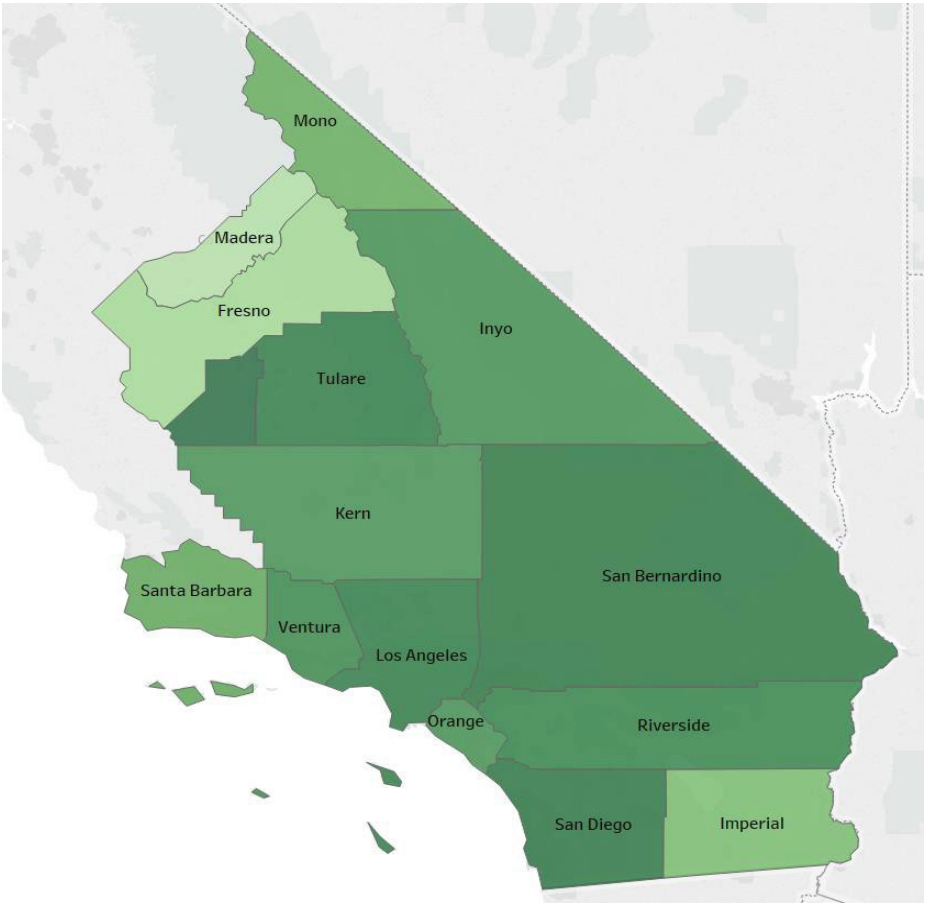
PG&E Counties With Lowest Enrollment Rates	
County	Enrollment Rate*
SANTA BARBARA	8%
TULARE	9%
MONTEREY	12%
MADERA	14%
KINGS	14%
KERN	15%
NAPA	15%
SAN LUIS OBISPO	15%
TEHAMA	16%
MERCED	16%

*Represents PG&E counties with the lowest enrollment rates, as of July 31, 2022.
*Excludes counties with less than 1,000 estimated eligible households

FERA Program *FERA Enrollment map*



SCE

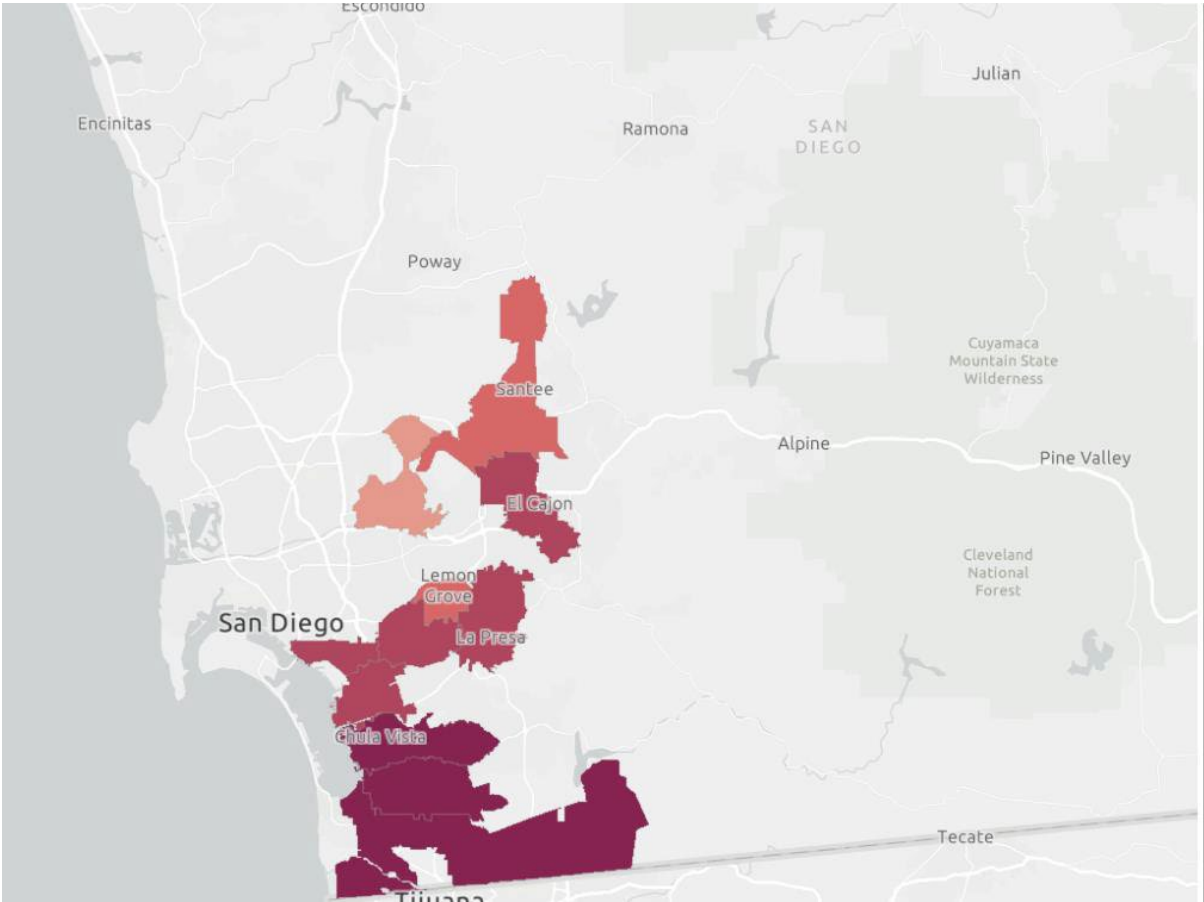


County	Enrollment Rate*
Riverside	14%
Orange	13%
San Bernadino	11%
Los Angeles	10%
Ventura	10%
Tulare	10%
Kings	9%
Kern	9%
Santa Barbara	8%

*Represents the enrollment rates for all SCE counties effective July 31, 2022 and excludes counties with less than 1,000 estimated eligible households

FERA Program *FERA Enrollment map*

SDG&E



Zip codes with lowest enrollment (overall)	
City	Enrollment Rate
Santee	43%
Chula Vista (east)	42%
El Cajon	36%
San Diego (southeast)	34%
Spring Valley	33%
Chula Vista (north)	32%
San Diego (south bay)	32%
San Ysidro	29%
National City	28%

*Represents SDG&E zip codes with the lowest enrollment rates, July 31, 2022.

Energy Savings Assistance Program

PU Code Section 2790 requires the CPUC to provide energy efficiency services to qualifying low-income households. This program provides energy efficiency services such as weather stripping, insulation, and appliance upgrades to help these Californians better manage their energy bills.

2022 ESA Program Budget Updates (Jan-July 2022) *

Jan-July 2022 Authorized Program Budgets and Expenditures			
Utility	Authorized Budget ¹	YTD Expenditures ²	%
PG&E	\$180,979,812	\$75,587,779	42%
SCE ³	\$75,300,964	\$39,721,203	53%
SDG&E	\$27,432,330	\$7,851,077	29%
SoCalGas	\$116,291,772	\$49,611,541	43%
Total	\$400,004,878	\$172,771,600	43%

* Jan-July 2022 activity as reported in the IOU ESA-CARE-FERA Monthly Reports filed August 22, 2022.

¹ Authorized budgets pursuant to D.21-06-015. Jan-July 2022 as reported in the IOU ESA-CARE-FERA Monthly Report filed August 22, 2022.

² Expenditures are the sum of amounts shown in each IOU's ESA-CARE-FERA Monthly Report, ESA Table 1, Table 1A and/or Table 2B.

³ Includes shift of \$14.7 in unspent uncommitted funds to supplement 2022 ESA program budget approved in AL 4702-E-A.



Energy Savings Assistance Program

2022 Energy Savings Targets (Jan-July 2022)

2022 Annual Savings for YTD Treatment ¹			Estimated Annual HH Usage for HH Treated YTD ²		Savings as % of Average HH Usage		Annual Program Savings Goal ³	
Utility	kWh	therms	kWh	therms	kWh	therms	kWh	therms
PG&E	14,867,914	678,604	262,520,028	13,793,425	5.7%	4.9%	15,093,167	629,105
SCE	16,672,551	N/A	210,194,408	N/A	7.9%	N/A	18,788,420	N/A
SDG&E	581,114	11,133	19,667,376	1,085,467	3%	1.0%	2,955,161	127,171
SoCalGas	N/A	362,535	N/A	16,162,978	N/A	2.2%	N/A	1,435,220
TOTAL	32,121,579	1,052,272	492,381,812	31,041,870			36,836,748	2,191,496

¹ Jan-July 2022 activity as reported in the IOU ESA-CARE-FERA Monthly Reports filed August 22, 2022.

² Derived from average CARE Customers Usage for PY 2021 (Annual Report CARE Table 9) multiplied by January 1-July 31, 2022 homes treated and annualized.

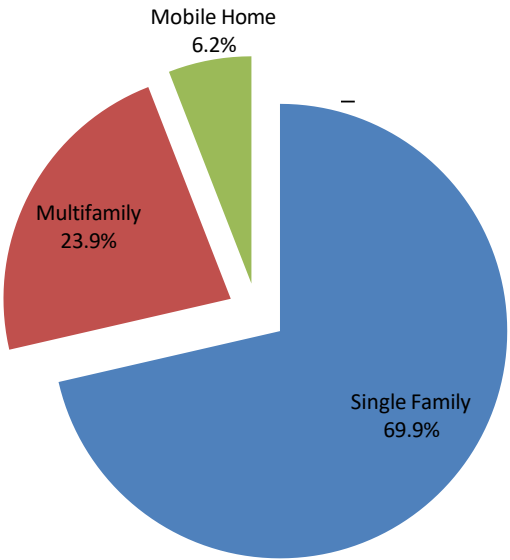
³ Per Attachment 1 of D.21-06-015. Includes ESA Program (SF, MH, MF In unit) and MF CAM.



Energy Savings Assistance Program

PU Code Section 2790 requires the CPUC to provide energy efficiency services to qualifying low-income households. This program provides energy efficiency services such as weather stripping, insulation, and appliance upgrades to help these Californians better manage their energy bills.

SW Participation By Type



2022 Households Treated
(Jan-July 2022)

2022 Households Treated ¹				
Utility	Est. HH Treated Target	Total	Total as % of 2022 Treated	Total as % of Eligible ESA HH ²
PG&E	59,340	41,199	69%	2.26%
SCE	27,051	33,127	122%	2.00%
SDG&E	13,760	4,478	33%	1.55%
SoCalGas	94,600	49,665	53%	2.13%
Total	194,751	128,469		

¹ Jan-July 2022 activity as reported in the IOU ESA-CARE-FERA Monthly Reports filed August 22, 2022.

² As of 7/1/22, Athens estimate of IOU residential customers estimated eligible for ESA at 250% of FPL; updated annually in February.



Energy Savings Assistance Program

Jan-July 2022 MULTIFAMILY UPDATES

SPOC: All IOUs have SPOC facilitation at this time. SPOC continues to leverage with other utility program offerings.

- **PG&E:** As of August 2022, PG&E's SPOC has expanded the program offerings from 39 to 41 programs and started coordination with other IOUs SPOC programs, and local water and air district program. PG&E's SPOC team has referred 285 multifamily customers to 31 programs YTD, and 45 referrals have been converted to program applications.
- **SCE:** For 2022, SCE has been authorized to spend \$1,800,000 for MF CAM. SCE is currently working on 5 projects. The budget has been allocated for these projects, so SCE has moved to a reservation process for any new MF CAM projects. As projects are completed and if there is a budget remaining, SCE will approve new MF CAM projects to commence. SCE plans to continue running MF CAM until the Southern Multifamily Whole Building (MFWB) Program is open to participation in 2023.
- **SDG&E:** SDG&E's SPOC has continued to work with ESA, ESA CAM and SOMAH implementers on leveraging leads across programs. The SPOC facilitated the Co-Branding of the SDG&E logo for the new joint IOU SOMAH implementer website.
- **SoCalGas:** Through July 31, 2022, the ESA CAM SPOCs continue deliver viable CAM projects. Customer participation in the program is increasing and it is anticipated that Project Homekey sites will begin to increase due to additional State funding. SoCalGas forecasts that ESA CAM projects will exceed its 2022 CAM goal by year end. Funding is on-target based on the carry-over funds available from the prior cycle.

Common Areas: All IOUs continue implementing their Common Area Measures Initiative Implementation Plans in 2022.

- **PG&E:** As of August 2022, PG&E has successfully completed 24 ESA CAM projects and treated 223 buildings with 2,311 units YTD. The program has reached its enrollment goal for program year (PY) 2022 and has officially closed enrollment for PY 2022 due to limited time left in this program cycle. PG&E has 27 active CAM projects in the pipeline as of August 2022.
- **SCE:** As of July 2022: Deed Restricted: In progress – 5 Whole Building, 0 Common Area, 0 In-Unit. Deed Restricted: Completed – 36 Whole Building, 24 Common Area, 25 in-unit. Market Rate: In progress – 0 in-unit. Market Rate: Completed – 34 in-unit.
- **SDG&E:** As of July 2022, SDG&E's ESA Program MF CAM implementer continued targeted marketing to potential ESA MF CAM properties, including re-syndication projects in SDG&E's service territory. SDG&E successfully treated 8 properties, benefiting 58 buildings and 770 MF Tenant units.
- **SoCalGas:** As of July 31, 2022, SoCalGas has completed 13 central boiler projects. These projects have impacted 1,212 units, 16 buildings, and improved the health, safety, and comfort of over 3,000 tenants. These projects have annual therm savings of 73,547. In addition, there are currently 11 active CAM projects in various stages of completion.

ENERGY EDUCATION

The Statewide Energy Education team is working on updating the existing Energy Education Resource Guide. The revised guide should be available in Q4 2022. In addition, the team will be establishing a series of meetings to collectively work on the development of utility neutral online education materials. These materials are anticipated to be available beginning in 2023 upon final approval by the IOUs collectively.





Tribal Community Outreach Update

Compliance/Outreach Activities as of July 2022	Opportunities
- PG&E's Tribal Consultation Plan for program year 2022 consist of outreach to the leadership of all 62 Federally Recognized and 40 Non-Federally Recognized tribal communities. The outreach plan also includes 30 Tribe Housing Authority Offices and 8 Tribal Temporary Assistance for Needy Families (TANF) offices. Outreach included email communication and phone calls with offers of in-person meetings, webinars and /or phone call consultations, and newsletters. - In June, PG&E launched its Tribal Grant Program, which offers \$5,000 in stipend to interested tribes for providing information regarding PG&E assistance programs and energy conservation to its members. Information about the grant was shared with all tribes via email and featured in PG&E's Q2 Tribal Newsletter. - In July, PG&E met with 11 tribes that requested more information about Tribal ESA Grants. Furthermore, a reminder email was sent to 13 additional tribes informing them that PG&E is inviting them to apply for grants this year. PG&E has received one application.	- PG&E is looking at ways to improve grant participation in 2023: - Evaluate existing outreach efforts - Invite feedback from tribes - Evaluating grant structure and award amount - Identify additional opportunity to coordinate with CARE/FERA CBO outreach

Tribal Community Outreach Update



OUTREACH STATUS	List of Participating Tribes
Tribes completed ESA Meet & Confer	Blue Lake Rancheria, Cloverdale Rancheria, Hoopa Valley Rancheria, Lone Band of Miwok Indians, Karuk Tribe, Robinson Rancheria, Scotts Valley Band of Pomo, Sherwood Valley Rancheria of Pomo Indians, and Tejon Indian Tribe.
Tribes requested outreach materials or applications	Sherwood Valley Rancheria of Pomo Indians
Partnership offer on Tribal Lands	(Federally-Recognized Tribes) Bear River Band of the Rohnerville Rancheria, Big Lagoon Rancheria, Big Sandy Rancheria, Big Valley Band Rancheria, Blue Lake Rancheria, Buena Vista Rancheria of Mi-Wuk Indians, Cachil DeHe Band of Wintun Indians of the Colusa Indian Community, Cahto Tribe (Laytonville), California Valley Miwok Tribe, Chicken Ranch Rancheria, Cloverdale Rancheria of Pomo Indians of California, Cold Springs Rancheria, Cortina Rancheria, Coyote Valley Band of Pomo Indians, Dry Creek Rancheria of Pomo Indians, Elem Indian Colony, Enterprise Rancheria, Federated Indians of Graton Rancheria, Greenville Rancheria, Grindstone Indian Rancheria, Guidiville Indian Rancheria, Habematolel Pomo of Upper Lake, Hoopa Valley Tribe, Hopland Band of Pomo Indians, Lone Band of Miwok Indians of California, Jackson band of Mi-Wuk Indians, Kashia Band of Pomo Indians of the Stewart's Point Rancheria, Karuk Tribe, Lower Lake (Koi Tribe), Lytton Rancheria of California, Manchester Band of Pomo Indians, Mechoopda Indian Tribe, Middletown Rancheria of Pomo Indians, Mooretown Rancheria, North Fork Rancheria, Paskenta Band of Nomlaki Indians, Picayune Rancheria of Chukchansi Indians, Pinoleville Pomo Nation, Pit River Tribe, Potter Valley Tribe, Redding Rancheria, Redwood Valley, Little River Band of Rancheria of Pomo, Robinson Rancheria, Round Valley Reservation, Santa Ynez Band of Chumash Mission Indians, Scotts Valley Band of Pomo Indians, Sherwood Valley Rancheria, Shingle Springs Band of Miwok Indians, Susanville Indian Rancheria, Table Mountain Rancheria, Tachi-Yokut Tribe (Santa Rosa Rancheria, Leemore, CA), Tejon Indian Tribe, Trinidad Rancheria, Tule River Indian Reservation, Tuolumne Band of Me-Wuk Indians, Tyme Maidu Tribe-Berry Creek Reservation, United Auburn Indian Community, Wilton Rancheria, Wiyot Tribe, Washoe Tribe of CA and NV, Yocha Dehe Wintun Nation, Yurok Tribe. (Non-Federally Recognized Tribes): Amah Mutsun Tribal Band, American Indian Council of Mariposa County (Southern Sierra Miwuk Nation), Butte Tribal Council, Calaveras Band of Mi-Wuk Indians, California Choinumni Tribal Project, Chaushila Yokuts, Coastal Band of the Chumash Nation, Coastanoan Ohlone Rumsen-Mutsen Tribe, Dumna Wo-Wah Tribal Government, Dunlap Band of Mono Indians, Dunlap Band of Mono Indians Historical Preservation Society, Haslett Basin Traditional Committee, Honey Lake Maidu, Indian Canyon Mutsun Band of Costanoan, Kern Valley Indian Council, Kawaiisu Tribe, Kings River Choinumni Farm Tribe, Mishewal-Wappo Tribe of Alexander Valley, Muwekma Ohlone Indian Tribe, Nor-Rel-Muk Nation, North Fork Mono Tribe, Northern Band of Mono Yokuts, Noyo River Indian Community, Ohlone Indian Tribe, Salinan Tribe of Monterey San Luis Obispo and San Benito Counties, San Luis Obispo County Chumash Council, Shelbelna Band of Mendocino Coast Pomo Indians, Sierra Mono Museum, Strawberry Valley Rancheria, The Mono Nation, Traditional Choinumni Tribe (East of Kings River), Trina Marine Ruano Family, Tsungwe Council, Tubatulabal Tribe, Wailaki Tribe, Winnemem Wintu Tribe, Wintu Tribe of Northern California, Wukchumni Tribal Council, Wuksachi Indian Tribe, Xolon Salinan Tribe.
Housing Authority and Tribal Temporary Assistance for Needy Families (TANF) office who received outreach (this includes email, U.S. mail, and/or phone calls)	Housing Authority Offices: Bear River Band of Rohnerville Rancheria, Berry Creek Rancheria, Big Sandy Rancheria, Big Valley Rancheria, Cher-Ae Heights Indian Community of The Trinidad Rancheria, Cloverdale Rancheria, Dry Creek Rancheria, Elem Indian Colony, Enterprise Rancheria of Maidu Indians, Federated Indians of Graton Rancheria, Fort Independence Reservation, Greenville Rancheria, Hoopa Valley Tribe, Lone Band of Miwok Indians, Karuk Tribe, Laytonville Rancheria, North Fork Rancheria, Picayune Rancheria, Pinoleville Reservation, Pit River Tribes, Round Valley Reservation, Santa Rosa Rancheria Tachi-Yokut, Stewarts Point Rancheria (Kashaya Pomo), Susanville Indian Rancheria, Tejon Indian Tribe, Tule River Indian Tribe, Upper Lake Rancheria, Washoe Tribe, Wilton Rancheria, and Yurok Tribe. TANF Offices: California Department of Social Services CALWORKS and Family Resilience Branch, Federated Indians of Graton Rancheria, Hoopa Valley Tribe, Karuk Tribe, North Fork Rancheria, Susanville Indian Rancheria, Tuolumne Rancheria, and Owens Valley Career Development Center.
Housing Authority and TANF offices who participated in Meet and Confer	Hoopa Valley Housing Authority, Hoopa Valley TANF Office, North Fork Rancheria Housing Authority, and Wilton Rancheria Housing Authority

Tribal Community Outreach Update



Energy Savings Assistance Program Table 7 - Customer Segments/Needs State by Demographic, Financial, Location, and Health Conditions											
Pacific Gas and Electric Company											
Through July 31, 2022											
ESA Main (SF, MH, MF in-unit)											
Customer Segments	# of Households Eligible [1]	# of Households Treated [2]	Enrollment Rate = (C/B)	# of Households Contacted [3]	Rate of Uptake = (C/E) [19]	Avg. Energy Savings (kWh) Per Treated Households (Energy Saving and HCS Measures) [4]	Avg. Energy Savings (kWh) Per Treated Households (Energy Saving Measures only) [5]	Avg. Peak Demand Savings (kW) Per Treated Household	Avg. Energy Savings (Therms) Per Treated Households (Energy Saving and HCS Measures) [4]	Avg. Energy Savings (Therms) Per Treated Households (Energy Saving Measures only) [5]	Avg. Cost Per Treated Households
Tribal	1,967	2	0%	3	100%	545.13	545.13	0.07	3.82	3.82	\$ 2,165

Note: This data currently only captures tribal households located on federally-recognized tribes whose trust lands are identified in the Bureau of Indian Affairs. The data does not include ESA customers who are members of non federally-recognized tribes or households that self-identified as Native American. PG&E plans to incorporate self-reported information into this reporting in Q4 2022.

Tribal Community Outreach Update

Outreach Activities	SUCSESSES & CHALLENGES
• The activities are in accordance with D.21-06-015. • SCE's tribal liaisons meet with all 13 tribes twice annually, discussing available programs & services • Maintained at least two tribal contacts per tribe • Ongoing efforts to identify tribes seeking federal recognition • Updates made to dedicated page on sce.com for tribal outreach, including wildfire safety, EE programs, etc. • Mini-grant Discussions: outreach methods, application design, grant amounts, issuance, participation guidelines and expectations	• Success: Ongoing communication with some tribal contacts • Success: Receptive to accepting and distributing program information • Challenge: Identifying non-federally recognized tribes • Challenge: Low response rates

SCE Tribal Community Landscape



- Southern California Edison has 13 federally-recognized Tribes in its service territory.

Agua Caliente Band of Cahuilla Indians	Pechanga Band of Luiseño Mission Indians of the Pechanga Reservation
Benton Paiute	San Manuel Band of Serrano Mission Indians of the San Manuel Reservation
Bishop Paiute	Soboba Band of Luiseño Indians
Bridgeport Indian Colony	Timbisha Shoshone
Chemehuevi Indian Tribe of the Chemehuevi Reservation	Tule River Indian Tribe of the Tule River Reservation
Colorado River Indian Tribes	Twenty-Nine Palms Band of Mission Indians of California
Morongo Band of Cahuilla Mission Indians	



Tribal Segment Reporting

Q1 2023: To capture tribal segments and enrollments, SCE will update its enrollment form to include an option for tribal members to self-identify, provide the name of their tribe and to indicate whether they are living inside or outside of a Tribal community.

Energy Savings Assistance Program Table 7 – Customer Segments/Needs State by Demographic, Financial, Location and Health Conditions Southern California Edison Through July 31, 2022											
ESA Main (SF,MH, MF In-Unit)											
Customer Segments	# of Households Eligible	# of Households Treated [1]	Enrollment Rate = (C/B)	# of Households Contacted	Rate of Uptake = (C/E)	Avg. Energy Savings (kWh) Per Treated Households (Energy Saving and HCS Measures)	Avg. Energy Savings (kWh) Per Treated Households (Energy Saving Measures only)	Avg. Peak Demand Savings (kW) Per Treated Household	Avg. Energy Savings (Therms) Per Treated Households (Energy Saving and HCS Measures)	Avg. Energy Savings (Therms) Per Treated Households (Energy Saving Measures only)	Avg. Cost Per Treated Households
Location											
Tribal	Unknown	44	100	0	0	0	0	0	N/A	N/A	0

[1] Households treated totals are from Chemehuevi Indian Tribe



Tribal Community Outreach Update

OUTREACH ACTIVITIES (in accordance with D.21-06-015)

- Tribal Relations Manager has contacted all Tribes SDG&E serves to conduct listening sessions.
 - To date, has held twelve (12) meet & greets.
- SDG&E sent an online survey to all tribal contacts and followed up with focus groups mid-year.
- Mini-grant process has been initiated and offered to the seven (7) tribes with members that potentially qualify for Low-Income programs.
 - To date, three (3) tribes have responded.
- Continued partnerships with two Tribal CBOs:
 - **Southern California Tribal Chairmen's Association (SCTCA)**
 - Total Outreach Activities YTD: 10
 - Total Reach: 71,074
 - **Southern California American Indian Resource Center (SCAIR)**
 - Total Outreach Activities YTD: 34
 - Total Reach: 23,438

SUCSESSES & CHALLENGES

- **Success:** SDG&E continues to be proactive in promoting low-income programs to Tribes willing to meet and confer.
- **Success:** Through ongoing CBO partnerships, SDG&E staff has been invited to participate in SCAIR and SCTCA outreach events to promote CARE, FERA, ESA.
- **Success:** Tribes that SDG&E has met with have had positive feedback regarding SDG&E's outreach and engagement efforts.
- **Challenge:** Engaging non-federally recognized tribes.
- **Challenge:** Tribes are overwhelmed with requests and have limited resources, so they don't always respond.
- **Challenge:** Mini-grants require Tribes to complete tax paperwork before payment can be issued.



SDG&E Tribal Community Landscape

- SDG&E has 17 Federally recognized and 3 non-Federally recognized Tribes in its service territory.
 - Of the 17 Federally recognized Tribes, **16 receive service*** provided by SDG&E.
 - These 16 tribes have approximately 2,900 meters** that receive electric service from SDG&E.

Federally Recognized Tribes in SDG&E's Service Territory	
Barona Band of Mission Indians	Mesa Grande Band of Mission Indians
Campo Kumeyaay Nation	Pala Band of Mission Indians
Ewiiapaayp Band of Kumeyaay Indians (Cuyapaipe Reservation)	Pauma Band of Luiseno Indians
Inaja & Cosmit Band of Indians	Rincon Band of Luiseno Indians
Jamul Indian Village	San Pasqual Band of Mission Indians
La Jolla Band of Mission Indians	lipay Nation of Santa Ysabel (Santa Ysabel Reservation)
La Posta Band of Mission Indians	Sycuan Band of Kumeyaay Nation
Los Coyotes Band of Mission Indians	Viejas Band of Kumeyaay Indians
Manzanita Band of Kumeyaay Nation	(row intentionally left blank)
Non-Federally Recognized Tribes in SDG&E's Service Territory	
Juaneno Band of Mission Indians	San Luis Rey Band of Mission Indian
Kwaaymii	(row intentionally left blank)

* Tribal communities in bold are those that receive service from SDG&E.

** SDG&E does not maintain tribal nation boundary data and is reliant on geographic boundary data provided by the San Diego Association of Governments (SANDAG.) Data is based on location of SDG&E transformers and does not reflect actual meters within the geographic boundaries of tribal land. Actual customers may fall inside or outside of those boundaries.

Tribal Segment Reporting



Energy Savings Assistance Program Table - 7 Customer Segments/Needs State by Demographic, Financial, Location, and Health Conditions

San Diego Gas & Electric
July 2022

ESA Main (SF, MH, MF in-unit)									
Customer Segments	# of Households Eligible [1]	# of Households Treated [2]	Enrollment Rate = (C/B)	# of Households Contacted [3]	Rate of Uptake = (C/E)	Avg. Energy Savings (kWh) Per Treated Households	Avg. Energy Savings (kW) Per Treated Households	Avg. Energy Savings (Therms) Per Treated Households	Avg. Cost Per Treated Households
Demographic									
Tribal	21,716	31	0%	806	4%	39.735	0.005	-0.350	\$ 188



Tribal Community Outreach Update

Outreach Activities	SUCSESSES & CHALLENGES
The activities are in accordance to D.21-06-015. • SoCalGas maintains communication with Tribes serviced by SoCalGas. • SoCalGas reaches out to all federally-recognized Tribes in its service territory via email, phone and in person at community events • SoCalGas strives to maintain at least two Tribal contacts for each Tribe in its service territory • SoCalGas is enhancing its outreach strategy to help navigate and increase engagement within tribal communities. • Finalizing contract with Tribal consultant to help roll out outreach strategy	• Success: Working with Community Based Organizations specific to Tribal communities to assist in providing information on programs to the community and at Tribal events such as Pow Wows • Challenge: SoCalGas provides service to 10 of the 21 tribes in service territory. Only 16,689 residential meters of which 93% are on leased land – providing limited opportunities for program participation • Challenge: Identifying non-federally recognized tribes • Challenge: Low response rates from tribes to receive additional program information

SoCalGas Tribal Community Landscape

- SoCalGas has 21 federally-recognized Tribes in its service territory.
 - Of the 21 Tribes, **10 have natural gas service*** provided by SoCalGas.
 - These 10 tribes have a total of 16,689 natural gas meters of which 93% are on leased land – with no certainty that the land occupant is a Tribal member.

Agua Caliente Band of Cahuilla Indians	San Manuel Band of Serrano Mission Indians of the San Manuel Reservation
Augustine Band of Cahuilla Indians	Santa Rosa Band of Cahuilla Indians
Cabazon Band of Mission Indians	Santa Ynez Band of Chumash Mission Indians of the Santa Ynez Reservation
Cahuilla Band of Mission Indians of the Cahuilla Reservation	Serrano Nation of Mission Indians
Chemehuevi Indian Tribe of the Chemehuevi Reservation	Soboba Band of Luiseño Indians
Chumash Tribe of Indians	Tachi Yokut Tribe of Indians
Fort Mojave Indian Tribe	The Juaneño Band of Mission Indians
Los Coyotes Band of Cahuilla and Cupeno Indians	Torres-Martinez Desert Cahuilla Indians
Morongo Band of Cahuilla Mission Indians	Tule River Indian Tribe of the Tule River Reservation
Pechanga Band of Luiseño Mission Indians of the Pechanga Reservation	Twenty-Nine Palms Band of Mission Indians of California
Ramona Band of Cahuilla Indians	(Intentionally left blank.)

*Tribe communities written in bold are the 10 that have natural gas service.



Tribal Segment Reporting

Energy Savings Assistance Program Table - 7 Customer Segments/Needs State by Demographic, Financial, Location, and Health Conditions
Southern California Gas Company
July 2022

ESA Main (SF, MH, MF in-unit)											
Customer Segments	# of Households Eligible*	# of Households Treated	Enrollment Rate = (C/B)	# of Households Contacted	Rate of Uptake = (C/E)	Avg. Energy Savings (kWh) Per Treated Household (Energy Saving and HCS Measures)	Avg. Energy Savings (kWh) Per Treated Household (Energy Saving Measures Only)	Avg. Peak Demand Energy Savings (kW) Per Treated Household	Avg. Energy Savings (Therms) Per Treated Household (Energy Saving and HCS Measures)	Avg. Energy Savings (Therms) Per Treated Household (Energy Saving Measures Only)	Avg. Cost Per Treated Household
Demographic											
Tribal [6]		8							6.44		

SoCalGas uses geographic boundary information to identify federally recognized tribal areas in conjunction with an augment to the ESA application to allow for customer to self-identify as a member of a tribal community.



Joint IOUs Unspent Funds for Energy Savings Assistance Program

Low Income Oversight Board Meeting

September 29, 2022

WebEx



PG&E's Unspent ESA Program Funds

Total Remaining ESA Unspent Funds (\$M)	
Unspent Funds through 12/31/2021 [1]	\$71.03
Unspent Funds through 7/31/2022 [2]	\$50.31

1. This is the remaining Unspent Funds amount from 2009-2021 program cycles. Per D.21-06-015, the remaining uncommitted and unspent funds at the end of 2021 must be used to offset 2022 collection, hence PG&E included this information in Advice Letter 6408-E-A for 2022 Annual Electric True-Up - Consolidated Electric Rate Changes Effective January 1, 2022.
2. \$24.5M is committed to off-set Aug-Dec 2022 collection. \$25.8M is committed for PY 2022 activities. Any unspent funds at the end of 2022 must be used to offset 2023 collection.



SCE's Unspent Funds for ESA Program

Total Remaining Unspent Funds (\$M)	
Unspent Funds through 12/31/21 [1][2]	\$24.75
2022 Revenue Collected (Jan – Jul)	\$34.28
2022 Expenses from (Jan – Jul)	\$37.43
2022 Accrued Interest (Jan-Jul)	\$0.08
Total Unspent Funds through 7/31/2022	\$21.69

1. This is the remaining Unspent Funds amount from 2009-2021 program cycles through December 31, 2021.
2. Requested and received approval (AL 4702-E-A) to shift \$14.7 in unspent and uncommitted funds to the ESA program to supplement the 2022 budget.

Note: Unspent funds may only be used for ESA program activities.



SDG&E's Forecasted Unspent Funds for ESA Program

Total Remaining Unspent Funds (\$ in millions) [1]		
Remaining unspent funds as of December 31, 2021 [2]		\$25.68
Unspent & uncommitted funds used to offset 2022 budget revenue requirement [3]		- \$13.60
Revenues collected through YTD July 2022		+ \$5.92
Expenses incurred through YTD July 2022 [4]		- <u>\$8.10</u>
Total remaining unspent funds as of July 31, 2022 [5]		= \$9.90
Total remaining ESA CAM committed funds as of July 31, 2022 [2]		- <u>\$3.74</u>
Total remaining unspent & uncommitted funds as of July 31, 2022 [5]		= \$6.16
1. Unspent funds are only available for ESA activities.		
2. As reported in the 2021 Annual Report, the remaining unspent funds as of December 31, 2021 of \$25.68M includes \$4.33M for ESA CAM (Table 1A). D.19-06-022 directs the IOUs to use unspent and uncommitted ESA CAM for program year 2021. D.21-06-015 directs the IOUs to carry-forward all unspent and uncommitted ESA common area measures funding as of June 30, 2021 into the remainder of program year 2021 and 2022.		
3. D.21-06-015, OP 114, SDG&E is instructed to use unspent and uncommitted funds before requesting new funds. SDG&E estimated to have \$13.60M in unspent and uncommitted LIEEBA and PGLIEEBA funds to offset the 2022 authorized funding in the 2022 Public Purpose Program rates.		
4. Reflects expenses from ESA Tables 1 + 1A, net of manual adjustments.		
5. Does not include YTD interest income recorded in the ESA balancing accounts.		

Energy Savings Assistance Program

Unspent/Uncommitted ESA Funds



SoCalGas Remaining Unspent Funds

Total Remaining Unspent Funds (\$M)	
Remaining 2009-2016 Unspent Funds [1]	\$125.15
2017-2020 Revenues Collected	\$491.69
2017-2020 Total Expenses [2]	\$394.62
2017-2020 Unspent Funds [1]	\$97.07
Total Remaining Unspent Funds through PY 2020 [1]	\$222.22
2021 Revenues Collected	\$9.12
2021 Total Expenses [2]	\$112.91
Total Remaining Unspent Funds through PY 2021 [1]	\$118.43
2022 Revenues Collected	\$0.00
2022 Total Expenses [3]	\$50.91
Total Remaining Unspent Funds as of 7/31/2022 [1]	\$67.52
Footnotes	
[1] Unspent Funds related to Revenues Collected	
[2] Total Expenses from Annual and Monthly Reports - Tables 1 and 1A	
[3] Total Expenses from July 2022's Monthly Report - Summary Table	
Note: Unspent funds can only be used for ESA Program activities or returned to ratepayers	



Smart Thermostats for ESA Customers

Low Income Oversight Board Meeting

September 29, 2022

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Smart Thermostats for ESA Customers

	PG&E	SCE	SDG&E	SoCalGas
<i>When does a low-income customer receive a smart thermostat?</i>	In general, if an ESA customer has a forced air unit and does not already have a smart thermostat	When a contractor has determined the home is eligible and a smart thermostat is feasible to install.	All ESA participants are eligible for a Smart Thermostats unless they meet one of the non-feasibility criteria identified in the IS Manual.	When a contractor has determined the home is eligible and a smart thermostat is feasible to install.
<i>What % of 2022 customers served received a smart thermostat?</i>	19%	6.7%	1.4%	8%
<i>Do you offer smart thermostats in all climate zones?</i>	Yes	Yes. Limited based on budget availability	Yes	Yes
<i>Do you use the IS Manual requirements to identify eligible customers?</i>	Yes, PG&E applies the requirements in the IS Manual to identify measure feasibility and installation requirements. Customer eligibility can be found in Section 2 of the Policy and Procedures Manual.	Yes. The IS Manual is primarily used to identify measure feasibility and installation requirements.	Customers eligible to receive this measure are determined through the in-home assessment process. The program utilizes the IS Manual requirements to identify if the property is ineligible for a smart thermostat installation based on the non-feasibility criteria for this measure.	Yes, although the IS Manual is primarily used to identify measure feasibility and installation requirements. Customer eligibility can be found in Section 2 of the Policy and Procedures Manual.



PSPS Ongoing Activities

Low Income Oversight Board Meeting

September 29, 2022

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Different Types of Safety Outages

Public Safety Power Shutoffs (PSPS)

Turning off power to prevent tree branches and debris from contacting energized lines



WHEN

During times of high winds, low humidity and dry vegetation



NOTIFICATIONS

In advance through automated calls, texts, and emails along with real-time updates



2022 FOCUS

Continuing to refine the program and reducing impacts in the areas at highest risk

Enhanced Powerline Safety Settings

Settings quickly and automatically turn off power if a problem is detected on the line



WHEN

Elevated wildfire risk is present, most likely from May to November, but can occur year-round



NOTIFICATIONS

Customers receive notifications at the start of an outage, and regular updates; since power is automatically shut off within one-tenth of a second, we are unable to provide advanced notice



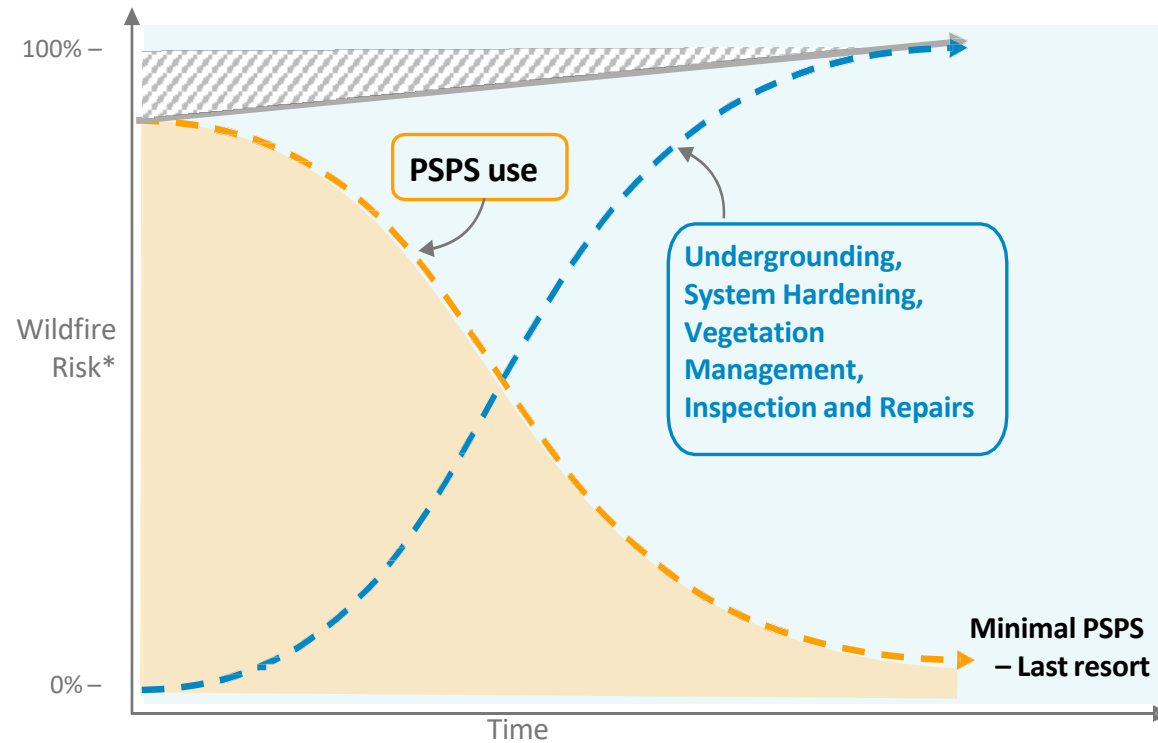
2022 FOCUS

Expanding from approximately 45% HFTD to 100% of HFRA circuits



Improving PSPS

As we work to build the electric system of the future, with efforts like undergrounding and system hardening, PSPS as a measure of last resort will continue to decline.



PSPS impacts have declined significantly through new, advanced technologies and improvements to the electric system infrastructure.

	2019	2020	2021
PSPS Outages	7	6	5
Customers Impacted	2,014,000	653,000	80,400
Damage/Hazards	722	257	442
Average Outage Duration (Hours)	43	35	31
Average Restoration Time (Hours)	17	10	12

Data is approximate

*Based on applying current PSPS protocols to catastrophic wildfires between 2012 and 2020, resulting in mitigating 96% of the structures impacted.

Some of the measures included in this presentation are contemplated as additional precautionary measures intended to further reduce the risk of wildfires.



Resources To Help Customers Prepare

- **Community Resource Centers:** Providing a safe location to meet basic power needs and access information and essential items during a PSPS.
Pge.com/crc
- **Food Resource Partnerships:** Helping customers access food replacement packages and delivering nutritious meals to seniors.
Pge.com/disabilityandaging
- **Portable Battery Program:** Supporting customers with fully subsidized portable battery solutions.
Pge.com/pspsresources
- **211 Partnership:** Delivering 24-7 free confidential support and resources via calls or texts. 211ca.org
- **Kids Emergency Safety Site:** Educating kids in grades K-6 about emergency safety.
Kidsemergencysecurity.com
- **California Foundation for Independent Living Centers:** Providing qualifying customers with access to hotel stays, food stipends and more. Cfilc.org
- **Generator and Battery Rebate Program:** Offering rebates for eligible customers to purchase a qualifying generator or battery.
Pge.com/backuppower
- **Safety Action Center:** Sharing tips to help customers prepare for wildfire season, including how to build an emergency kit and plan.
Safetyactioncenter.pge.com
- **Wildfire Safety:** Providing information and support for our wildfire prevention efforts.
Pge.com/wildfiresafety



January –
September

Statistics	Activations	Customer Interruptions	Circuit Interruptions	Customer Minutes of Interruption
2022 Fire Season	3	209	2	~208,000

MITIGATING IMPACTS OF PSPS

Customer Care Programs

2022 COMMUNITY CARE RESOURCES

67 COMMUNITY RESOURCE CENTERS (CRC)

Contracted and available based on potential shutoff locations. Location and hours listed online before shutoffs

8 COMMUNITY CREW VEHICLES (CCV)

Can be deployed rapidly for remote locations. Location and hours listed online before shutoffs

8 RESILIENCY ZONE SITES

Enable backup power generation at certain essential sites in remote communities



Thanksgiving Day, 2021

9 RESILIENT CRCs

CRCs that have or are in the process of installing a transfer switch and/or have a backup generator

BACKUP POWER SUPPORT

- Critical Care Battery Back-up (CCBB) program provides a free portable back-up battery and solar panel for charging to eligible customers. Expanded the program in August 2022 to include additional customers. Since program inception, more than 8k batteries have been delivered through the program.
- \$75 rebate for portable batteries for customers in HFTDs to power devices and appliances. Beginning September 1st, SCE will increase the rebate amount to \$150.
- \$200 rebate for portable generators for customers in HFTDs
- \$500 rebate for portable generators for customers in HFTDs and enrolled in CARE/FERA or Medical Baseline Allowance. Beginning September 1st, SCE will increase the rebate amount to \$600.
- Statewide Self-Generation Incentive Program (SGIP)

2022 ACHIEVEMENTS

- Dedicated Access & Functional Needs (AFN) Liaison on the PSPS Incident Management Team
- Deployed 7,579 free portable backup batteries (CCBB)
- Provided 959 Portable Power Station Rebates
- Provided 681 Portable Generator Rebates



AFN Expanded Support in 2022



Data + Automation

Data-driven, leveraging digital factory bots & automation to identify & target customers.



PSPS Support

Identifying insulin/medicine cooler bags for distribution through community partners in HFTD.



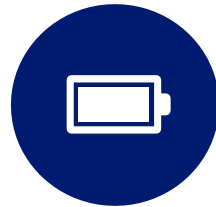
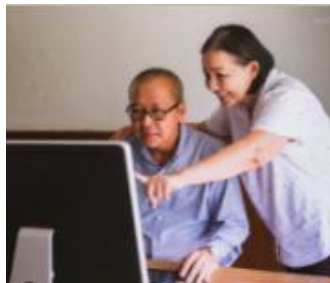
Accessibility

Launched portal with Deaflink to simi automate process for accessible custom notifications.



Community Partners

~16 Joint IOU and local resiliency, PSPS support services & wildfire preparedness trainings. New partnerships with Rural Health & Safety Collaborative Groups.



Generators

No cost Portable Power Station for qualifying individuals of MBL & AFN. Rebates \$300 & \$100 available.



Marketing + Research

PSPS preparedness & support services direct mail campaign to Multifamily Dwellings and Modular Home Parks in HFTD

AFN PSPS Support



Centralized Resource Hub

211 San Diego and 211 Orange County connect customers to resources and direct support from 1,000+ orgs (24/7/365, in 200+ languages)



Community Resource Centers

Enhanced support including privacy screens, signage, dedicated parking and on-site ASL interpretation



Tribal Communities

Southern Indian Health Council (SIHC) & Indian Health Council (IHC) partners provide resiliency items, generators and other needs to tribal communities



Food Support

SD Food Bank & Feeding SD partners provide mobile food pantries at rural, tribal and PSPS sites, with warm food provided as needed



Transportation

FACT paratransit partnership provides accessible transportation to customers' location of choice



Hotel Stays

Salvation Army partnership provides no-cost hotel stays



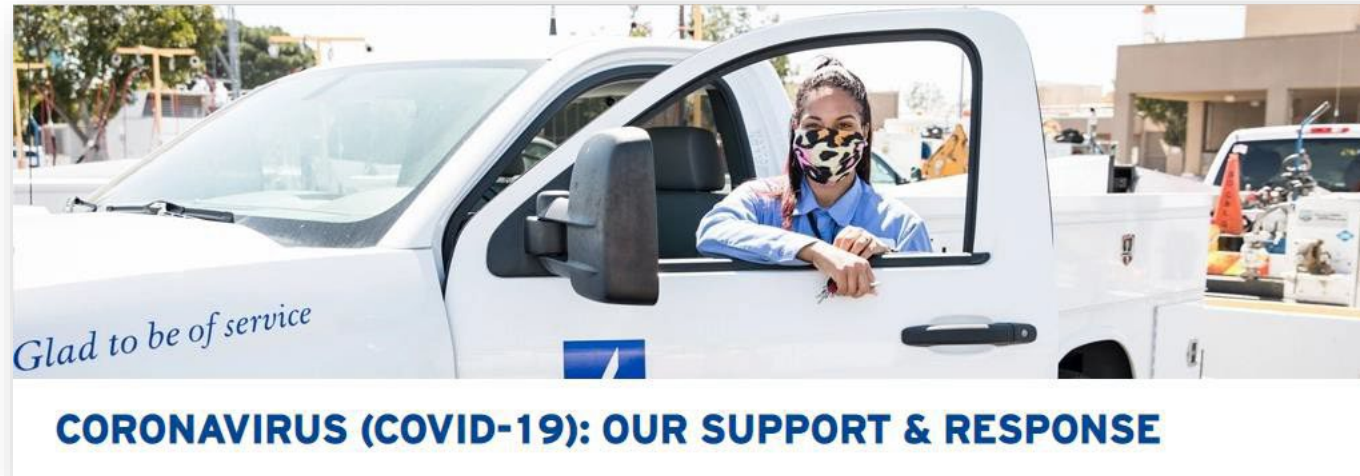
Wellness Checks

CERTS and YANA provide wellness checks to those who may need support



Post-Moratorium Extension

Continued Customer Support



- socalgas.com/Coronavirus continues to be updated, providing customers with a reference hub as new programs and payment plan assistance may become available.
- Disconnections for residential customers are not anticipated until Q2 2023
- Additional updates will be made as needed.



State of Disconnections and Arrearage Management Plans (AMP)

Low Income Oversight Board Meeting

September 29, 2022

WebEx



PG&E Disconnections Status and AMPs

Arrearage Management Plan (AMP)

- Number of customers enrolled: 166K
 - Percentage of eligible households enrolled: 61%
 - Number successfully completed 12-month program launched in Feb. 2021: 2,569
- Total arrearages: \$265M
- Total amount forgiven: \$98M

*Updated 9/1/2022

Disconnections

Number of disconnections, CY 2021 – YTD 2022: Zero

Residential credit collection notices resumed in late July 2022.

*Updated 8/19/2022

AMP Case Management

To support customer success in AMP, PG&E continues to conduct outbound calling campaign to customers with missed payments.

AMP missed payment outreach (outbound calls)

- 2021 – 111,020 calls completed
- 2022 (YTD)* – 58,826 calls completed
 - TOTAL: 169,846



AMP eligible customer outreach (outbound calls)

- 2021 – 49,846 calls completed
- 2022 (YTD)* – 18,996 calls completed
 - TOTAL: 68,842



*Updated 9/1/2022



SCE Disconnections Status and AMPs

Arrearage Management Plan (AMP)*

- Number of customers enrolled: 24,062
 - Percentage of eligible households enrolled: 34%
 - Number successfully completed 12-month program launched in Feb. 2021: 3
- Total arrearages: \$32.7M
- Total amount forgiven: \$13M

*Updated 9/7/2022

Disconnections

Number of disconnections, CY 2021 – YTD 2022*: Zero

Resumption of residential credit collection efforts expected to begin ~Q3 2022.

*Updated 9/7/2022

AMP Case Management

To manage customer satisfaction in AMP, SCE has implemented an outbound calling initiative to customers who have gone on the NEM tariff and no longer eligible to participate in AMP in order to provide those customers with other options to assist with their arrearage balances.

SCE has also began another initiative to reach out to customers who are experiencing delayed billing and provide accommodations where needed.

AMP NEM outreach (outbound calls)

- 2022 (YTD)* – 197 calls completed



AMP Delayed Billing outreach

- 2022 (YTD)* - 2,279 letters mailed



*Updated 9/7/2022



SDG&E Disconnections Status and AMPs

Arrearage Management Plan (AMP)*

- Number of customers enrolled: 13,656
 - Percentage of eligible households enrolled: 37%
 - Number of customers successfully completed 12-month program: 1,990
- Total arrearages actively enrolled in AMP: \$14.5M
- Total amount forgiven: \$9.3M

*As of 7/31/2022

Disconnections

Number of disconnections, CY 2021 – YTD 2022*: Zero

At this time SDG&E is still evaluating when normal residential credit and collection activities will begin.

*As of 7/31/2022

AMP Marketing

Targeted Communications

- Dedicated AMP email to 30k AMP eligible customers
- Included AMP messaging in
 - CARE-eligible monthly bill comparison email
 - COVID-19 Customer Protections communications
 - CARE/FERA recertification backlog communications

General Outreach

- Organic social media posts (Facebook, Instagram, Nextdoor)
- Added AMP messaging on sdge.com/assistance
- Bill inserts & bill package
- Continued program education through SDG&E's Energy Solutions Partner Network, comprised of 200+ CBOs.

SoCalGas Disconnections Status and AMPs



Arrearage Management Plan (AMP)*

- Number of customers enrolled: 103,675
 - Percentage of eligible households enrolled: 33%
 - Number successfully completed 12-month program launched in Feb. 2021: 24,464
- Total arrearages: \$61.7M
- Total amount forgiven: \$18.3M

*Data as of 8/31/2022

Disconnections

Number of disconnections, CY 2021 – YTD 2022*: Zero

Resumption of residential credit collection efforts expected to begin ~Q2 2023.

*Updated 9/16/2022

AMP Case Management

To support customer success in AMP, SoCalGas implemented a text and email campaign targeting customers with missed payments



AMP missed payment outreach

- June Pilot launched to test the effectiveness of digital communications
- 4,400 Accounts received notifications
- Observed an overall increase of 11% in payments received
 - Timing of the pilot and the bill dates played a significant factor in success, with increases of 21% in payments received

AMP eligible customer outreach

- June Pilot launched to promote enrollment in AMP
- 27,000 customer accounts targeted
- ~4K customers (14%) enrolled in AMP, resulting in \$2.1M in forgiveness
- Monitoring for continued effectiveness and plan completion



*Updated 9/16/2022

Lunch

Item 7: CSD Updates

2022 California Arrearage Payment Program (CAPP) Update

Coordination Report on Low Income Weatherization Program (LIWP)

Board Member Jason Wimbley, CSD

Item 8: CPUC Standing Reports

1:15 – 2:15 PM

- Water Division
- Energy Division
- Legislative Update

Water Utilities Update

Low – Income Oversight Board

Water Division

September 29, 2022

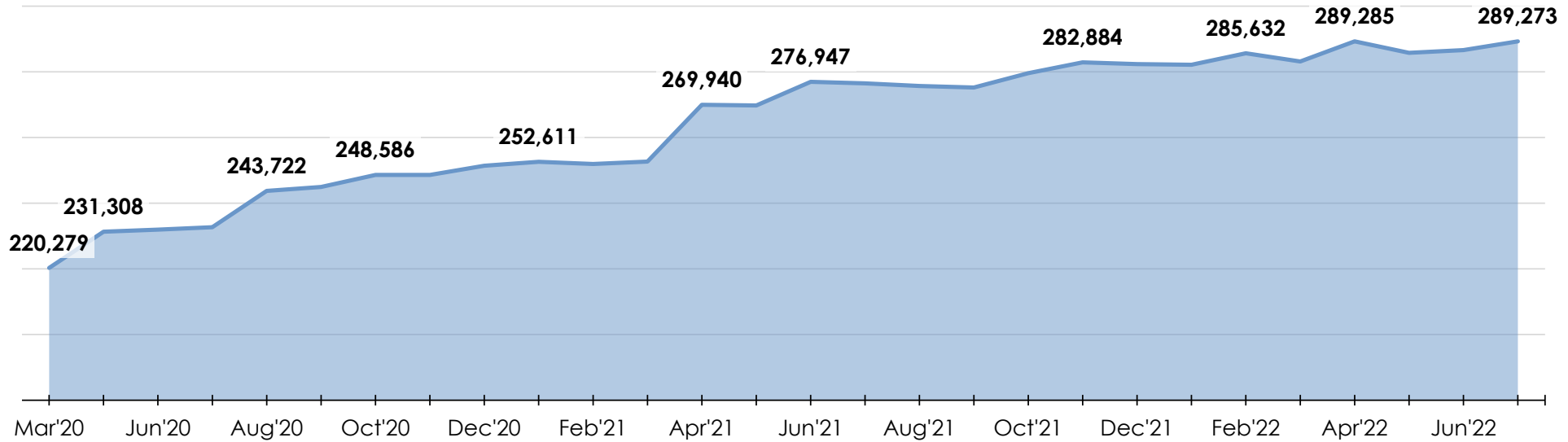


California Public
Utilities Commission

Overview

- Customer Assistance Program (CAP) Enrollment
- Conservation
- Water Utility Acquisitions Proceeding

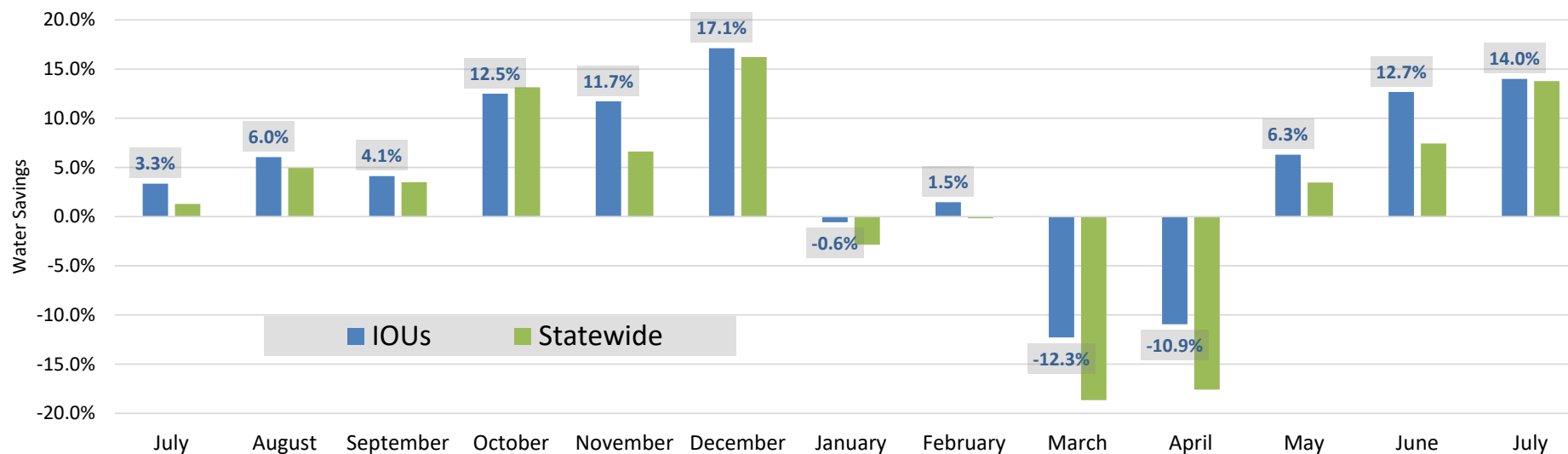
Total CAP Enrollment



- Currently, 24% of total IOU residential customers enrolled in CAP
- 2 of 4 Data Exchanges with Energy IOUs completed

Water Usage Conservation

Investor-Owned Water Utilities



- Governor's call for Voluntary 15% reduction began in July 2021
 - Compared to 2020 usage
- **Water IOUs** currently saving **6.0%** combined since July 2021
 - Statewide: 3.4%

Order Instituting Rulemaking R.22-04-003

Water Utility Acquisitions

- Prehearing Conference was held on Aug 5th
- Scoping memo will be issued soon
 - Review and improve upon the existing framework from 1999
- Total of 4 workshops planned
 - 1st workshop tentatively scheduled for December
 - Focus: Inadequately Operated & Maintained Systems

Low Income Oversight Board Energy Division Update

Presented by Kapil Kulkarni, Energy Division Staff
September 29, 2022



California Public
Utilities Commission

Agenda

- Large IOUs ESA/CARE/FERA program cycle
 - IOUs 2022 ESA reporting
 - ESA Working Group
 - Program solicitations
- Low Income Needs Assessment

Large IOUs ESA/CARE/FERA program cycle

- **Reporting**

- August monthly reports are now available, with new reporting on customer segment data and program metrics.

- **ESA Working Group**

- October 2022
 - Agenda being developed now
 - Potential and Goals (P&G) study overview
- December 2022 – discuss mid-cycle process
- January 2023 – discuss 2022 year end update
- Materials available at <https://pda.energydataweb.com>

Large IOUs ESA/CARE/FERA program cycle – upcoming activities

- Solicitation process for potential bidders
 - Conclusion of solicitations for various ESA program components
 - Contract awards and program launch beginning for IOUs and winning bidders
 - More information available at the IOUs' solicitations websites, and www.caeecc.org
- All proceeding documents, including monthly reports, are available in the docket card for A.19-11-003 at <https://www.cpuc.ca.gov/proceedings-and-rulemaking> as well as through the service list.

Large IOUs ESA/CARE/FERA program cycle

- ESA program solicitations – timeline

Energy Savings Assistance Program Solicitations Schedule ALL DATES ARE SUBJECT TO CHANGE*		September				October					November				December				
		9/5	9/12	9/19	9/26	10/3	10/10	10/17	10/24	10/31	11/7	11/14	11/21	11/28	12/5	12/12	12/19	12/26	
3	SCE	Clean Energy Home Pilot			Contract Awards and Issuance/Program Launch	Program Ramp Up										Open to Participation (Tentative)			
10		ESA Plus/Deep Implementation Pilot (Joint SCE/SCG)**	Program Ramp Up								Open to Participation 11/9								
11		ESA Plus/Deep Evaluation Pilot (Joint SCE/SCG)**	Contract Awards and Issuance/Program Launch	Program Ramp Up							Open to Participation 11/9								
12		Building Electrification and Clean Energy Homes Pilot Evaluation			Contract Awards and Issuance/Program Launch	Program Ramp Up									Open to Participation (Tentative End Q4 2022)				
13		Interactive Energy Education Note: This timeline is preliminary and subject to change based on future program needs being identified.	Proposal Release, Bidders Conference and RFP Proposal Due date (TBD)			Bid Evaluation and Scoring (TBD)		Contract Negotiations (TBD)				Contract Award/Issuance (TBD)	Program Ramp Up (TBD)						
14	SoCalGas	Main ESA (Basic/Plus) Program (delivery of core single-family in-home services)	Contract Negotiations							Contract Awards and Issuance/Program Launch									
16		Customer Experience Technology Platform and Customer Online Audit	Contract Negotiation Bidder Notifications; Contract Package Prep					Contract Negotiations					Contract Awards and Issuance						
17		Main ESA (Basic/Plus) Program	Program Transition Period																
18																			
19		Multifamily Whole Building Program	Contract Negotiations									Contract Awards/ Issuance ⁽⁴⁾	AL Submission 11/30/22		ED Review of A				
20																			

Questions?

2022 Low Income Needs Assessment

Current Activity

- Draft report posted by October 19, 2022
- Draft report will be presented at LIOB public meeting October 25, 2022

Upcoming Activity

- Comments on draft report due November 14, 2022
- Response to comments will be posted November 21, 2022
- Final report will be released by December 31, 2022

2022 Low Income Needs Assessment

2022 Low Income Needs Assessment Schedule												
Task	2020				2021				2022			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
LIOB LINA Sub-Committee Meeting	■											
Develop Scope of Work	■	■										
LIOB LINA Sub-Committee Meeting on SOW		■										
RFP released			■									
Consultant selection				■								
Develop Research Plan					■	■						
LIOB LINA Sub-Committee Meeting on Research Plan					■							
Data collection and analysis						■	■	■	■	■		
Draft Report											■	
LIOB LINA Sub-Committee Meeting on Draft Report												■
Final Report												■

Thank you!

Kapil Kulkarni, Energy Division
Kapil.kulkarni@cpuc.ca.gov
213-620-6453



California Public Utilities Commission

Legislative Bill Update – Office of Governmental Affairs

*Bills of Interest to the Low-Income Oversight Board Quarterly Meeting – Thursday
September 29th, 2022*

The 2021-2022 Legislative Session concluded on August 31st. As summarized below, several bills of interest to the Low-Income Oversight Board (LIOB) passed and have been presented to the Governor. The last day for the Governor to sign or veto bills passed by the Legislature is September 30th.

1. Assembly Bill 2316 (Ward) - Public Utilities Commission: customer renewable energy subscription programs and the community renewable energy program.

Requires the CPUC to evaluate existing customer community renewable energy programs in order to modify and/or terminate these programs. This bill also requires the CPUC to determine whether it is beneficial to ratepayers to develop a new or modify a tariff or program for community renewable energy by an electrical corporation, based on specified criteria, including ensuring at least 51% of the energy capacity serves low-income customers.

Status: *Passed; Enrolled and presented to the Governor on September 9th*

2. Assembly Bill 2750 (Bonta) - Department of Technology: state digital equity plan

This bill would require the Department of Technology (CDT), by January 1, 2024 and in consultation with the public, the CPUC, and the California Broadband Council, to develop a state digital equity plan. The bill would require the plan to include, among other things, the identification of barriers to digital equity faced by specified populations, including, among other barriers, the availability and affordability of access to fixed and wireless broadband technology.

The bill would additionally require the plan to include measurable objectives for documenting and promoting digital equity among those populations and an assessment of existing digital navigator programs. The bill would require the CDT, to the extent practicable, to obtain all available federal funding for purposes of developing and implementing the plan.

Status: *Passed; Enrolled and presented to the Governor on August 31st*

3. Senate Bill 1020 (Laird, Caballero, Durazo, and Atkins) - Clean Energy, Jobs, and Affordability Act of 2022.

This bill requires new interim targets for renewable and zero-carbon resources to supply 90% of all retail sales of electricity by December 31, 2035; 95% of all retail sales of electricity by the end of 2040; and 100% of electricity procured to serve all state agencies by December 31, 2035.

This bill requires the CPUC, in coordination with the California Energy Commission (CEC) and the California Air Resources Board (CARB), to issue a joint reliability progress report reviewing system and local reliability, with a focus on summer reliability and energy and capacity procurement progress.

This bill also requires the CPUC to develop a definition on energy affordability and to use energy affordability metrics and affordability thresholds develop protections, incentives, discounts, or new programs to assist customers facing disconnections and to assess the impact of proposed rate increases on different types of residential customers.

Status: *Passed; Enrolled and presented to the Governor on September 2nd*

4. Senate Bill 1208 (Hueso) - Low-income utility customer assistance programs: concurrent application process.

This bill requires the CPUC, on or before June 30, 2024, in coordination with other relevant state agencies, that provide low-income electric or gas utility customer assistance programs, to develop a process that enables customers to concurrently apply, or begin to apply, to multiple low-income customer assistance programs.

This bill also requires the Low-Income Oversight Board (LIOB) to report to the Legislature on opportunity and process for expanding the third-party administrator (TPA) contract used for the California LifeLine program for purposes of facilitating enrollment between electric, water, gas, and communications low-income assistance programs.

Status: *Passed; Enrolled and presented to the Governor on September 13th*

5. Senate Bill 1213 (Hueso) - Public Utilities Commission and State Energy Resources Conservation and Development Commission: public outreach: community-based organizations

This bill would require the CPUC and CEC to collaborate to develop and maintain a list of community-based organizations to help ensure adequate public outreach regarding available programs and incentives. The bill also would require the CPUC and CEC to work with existing committees, boards, and community-based organizations in developing the list.

Status: *Passed; Enrolled and presented to the Governor on September 6th*

Break

LIOB CBO Arrears Case Management Pilot Overview

Presenters: Claire Coughlan and Tom Knox

September 29, 2022





CBO Arrears Case Management Pilot Decision

D. 22-04-027 CBO Arrears Case Management Pilot proposed to address current gaps in assisting customers:

1. Case Management
2. Targeting by Geography and Community Type
3. Navigating the Numerous Relief and Assistance Programs

Proposed Decision Requires:

- PG&E to convene a CBO Pilot Working Group to guide and oversee the development of the CBO Case Management Pilot as well as select a CBO to co-lead.
- The Pilot Working Group shall propose a budget, payment structure, and evaluation method for the CBO Pilot
 - IOUs shall produce a single statewide database and map of CBOs, to be updated quarterly
 - CBO Working Group shall develop and finalize a proposal for budget, contract administration plan, payment structure, and evaluation plan for CBO Arrears Case Management Pilot
 - CBO Working Group shall file a proposal for CBO Arrears Case Management Pilot Program in the docket of Rulemaking 18-05-007,



CBO Pilot: Proposal Overview

Pilot Size

12,000 Participants

- 4,800 PG&E customers
- 4,800 SCE & SoCalGas customers
- 2,400 SDG&E customers

Eligibility

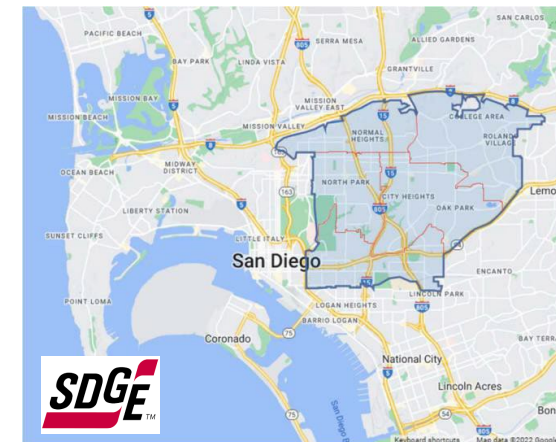
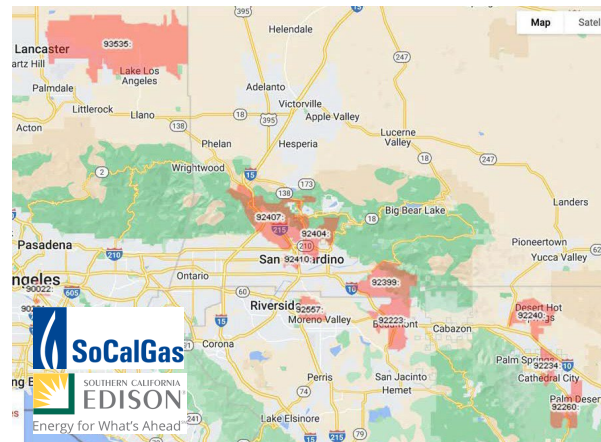
Participating customer criteria:

- Reside in a target zip code (AR 20)
- Have arrears at least 90 days old and may be at risk for disconnection
- No income qualifications- any income level will qualify

Pilot Design

Multi-tiered Case Management Approach to reduce customer arrears:

- **Tier 1 Services (months 1-3)**
 - Basic energy education, financial training and best practices
 - Immediate program relief (AMP, LIHEAP, etc.)
 - Negotiation of payment plans (if necessary)
 - Refine and continue customer assessment and action plan
- **Tier 2 Services (months 4-6)**
 - Continued energy education, financial training and best practices
 - Enrollment in additional energy management programs (ex. EE, DR, etc.)
 - Renegotiation of payment plans as necessary
- **Tier 3 Services (months 7-12)**
 - Evaluation of progress out of debt
 - Consideration of any changes in circumstances, impacts on action plan, necessary revisions
 - Reinforced energy education, sound financial practices and energy usage behavior
 - Monitoring at an agreed frequency based on customer specific situation





CBO Pilot: Cost/ Payment Structure Overview

CBO Payment Structure

Payment Structure:

- *Upfront grant* not to exceed 30% of 2-year contract amount
- *Monthly payments* for each customer enrolled in pilot
- *Monthly case management fee* for each enrolled customer

Additional Details:

- Upfront grant payment to cover pilot pre-planning and set up costs
- CBOs may request upfront payment in solicitation process

Total Proposed Budget

Category	PG&E	SDG&E	SoCalGas	SCE	Total
Case Management Planning/ Overhead	\$80,000	\$40,000	\$40,000	\$40,000	\$200,000
CBO Outreach, Customer Enrollment and Reporting	\$1,100,000	\$550,000	\$550,000	\$550,000	\$2,750,000
Case Management Services and Reporting	\$2,220,000	\$1,110,000	\$1,110,000	\$1,110,000	\$5,550,000
Total Arrearage Case Management CBO Services	\$3,400,000	\$1,700,000	\$1,700,000	\$1,700,000	\$8,500,000
EM&V	\$400,000	\$200,000	\$200,000	\$200,000	\$1,000,000
ME&O	\$185,000	\$50,000	\$60,000	\$60,000	\$355,000
Administration*	\$415,000	\$400,000	\$120,000	\$450,000	\$1,385,000
Total IOU Marketing, Evaluation and Administration	\$1,000,000	\$650,000	\$380,000	\$710,000	\$2,740,000
Grand Total	\$4,400,000	\$2,350,000	\$2,080,000	\$2,410,000	\$11,240,000

* Administration budget includes costs for a Single Point of Contact to support CBOs with specific customer account resolution issues



CBO Pilot: Reporting Overview

CBO Reporting Requirements

Proposed monthly reporting metrics include:

- Number of customers in the sample group
- Number of pilot customers contacted through outreach by each CBO
- **Number of signed customer participation agreements**
- **Number of customers enrolled in each service level tier**
- **Number of completed case management action plans**
- Number of customers who have completed the first six months of the case management program
- Number of customers who have completed the twelve months of the case management program
- **Number of customers that unenrolled (or withdrew) from the case management program**
- **Number of disconnections from pilot program enrolled and unenrolled customers**
- Total and average number of programs recommended per customer
- **Total and average number of programs enrolled in per customer** (based on customer self-report)
- Number of customers enrolled/confirmed enrolled in each program
- Average LIHEAP Cash Relief per customer
- Participating customers' arrearage status:
 - Arrearage at the time of the signed participation agreement compared to subsequent arrearage by each month-end
 - Calculate pilot program aggregate and per account difference:
 - Increased arrearages, by dollar and percentage of accounts
 - Same/reduced arrearages, by dollar and percentage of accounts

IOU Reporting Requirements

Metric	Frequency
For pilot program accounts, report using Disconnection OIR (R.18-07-005) Report Section-3 format, by number of accounts, day, and amount owed. First report to be filed the month following the close of the enrollment period – enrollment period lasts 6 months. This locks in the list of pilot participants for consistency of reporting*	Monthly
Number and dollar amount of ALL customers facing arrears 12 months after pilot initiation, per CBO geographic location, exclude pilot accounts	Annual
Number and dollar amount of targeted customers facing arrears 12 months after pilot initiation, per CBO geographic location, exclude pilot accounts	Annual
Number and dollar amount of pilot accounts (i.e., signed participation agreements) facing arrears 12 months after pilot initiation, per CBO geographic location (Pilot accounts only)	Annual
Number and percentage of pilot accounts successfully complete the Case Management Service and eliminate all arrearage, within 12 months of case management services	Annual
Number of pilot accounts successfully remain current on energy bills, after 24 months	Annual
Number and dollar amount of pilot accounts that are part of the arrearage again, after 24 months	Annual
Number and percentage of pilot customers who successfully reduced arrearage but did not eliminate all debt, after 12 months of case management services	Annual
Number and percentage of pilot customers with no change, withdrew from the pilot or increased arrearage, after 12 months of case management services	Annual



CBO Pilot: Evaluation Proposal

High Level Scope

Conduct Data Assessment	Identify data needs, recommend data collection and management processes for IOUs and CBOS
Perform Impact Evaluation	- Conduct baseline assessment - Conduct quasi-experimental design comparing participants and non-participants - Conduct evaluability assessments
Perform Process Evaluation	- Design and launch surveys with customers, CBOs, stakeholders - Identify improvement opportunities - Compare case management effectiveness across CBOs

Evaluation Goals

1. Assess if case management is effective in reducing arrearage and level of disconnection
2. Pilot participants will be compared to similar control group of non-participants to gauge impact of participation
3. Determine if quantitative and qualitative benefits sufficiently outweigh costs to warrant program expansion.
4. Determine which interventions or combination of interventions are effective in arrearage and disconnection reductions.
5. Recommend if case management pilot should expand in scale beyond the pilot phase.

Item 10: Subcommittee Reports

2:45 – 3:10 PM

- Low Income Energy Assistance Programs (LIEAP)
 - Castaneda, Stamas, Watts, Wimbley, Medina, Irwin, Castilone, Hernandez
- Legislative
 - Stamas, Watts, Castaneda, Delgado-Olson, Hernandez
- Low Income Needs Assessment (LINA)
 - Delgado-Olson, Stamas, Castaneda, Medina
- Water & Climate Change
 - Tang, Delgado-Olson, Castaneda, Medina, Irwin

LIOB LIEAP Subcommittee 09132022 SCE (ESA) Program & Budget Status Update Summary

Benito Delgado Olson, Maria Stamas, Pat Watts, Jason Wimbley, Lourdes Medina, Paul Irwin, Lisa Castilone, and Valarie Hernandez

Robert Castaneda, Low Income Energy Assistance Programs Subcommittee Chairman

Commissioner Genevieve Shiroma, Chery Wynn, Kapil Kapurni

September 22, 2022

LIOB LIEAP Subcommittee 09132022 SCE Summary

A personal note: I want to personally thank all who attended and contributed to a most important discussion of issues regarding SCE's ESA program and budget. The following is an itemized listing of issues raised and discussed. They are:

Adding, Modifying & Removing ESA Main Measures

There was discussion as to the need for a clear and concise protocol (as delineated in ESA/CARE/FERA Decision) regarding ESA main measure offerings and the dismissal of program measures. Whereas the Commission previously retained approval for measure-related changes, the IOUs now possess authority to institute these changes after **collaboration** with the ESA Working Group and providing notice through their monthly filing. SCE is requested to adhere to this process of collaboration with the ESA Working Group and to provide notice of ESA measure changes via their monthly filing. This process ensures transparency and inclusion as envisioned by the Commission. Collaboration with the ESA Working Group consisting of program stakeholders, contractors and participants and is part of the public record. This process allows the IOUs to evaluate, revise and modify measures to best meet the goals of the Decision and the low-income customer. This process, its findings and conclusions should also be published in the respective IOU monthly reports. It is further advised that this matter be discussed, defined and a formal process assigned by the ESA Working Group.

Improved Communication

The subcommittee opined that two-way communication is in the best interests of the ESA Program and the populations ESA serves. Many of the ESA contractors have been with the ESA program for over two decades and know the program metrics and the eligible communities and their needs very well. Their experience is valuable, and it should be harnessed to make the ESA program as effective and efficient as possible. It is recommended that Southern California Edison should immediately establish means of effectively communicating plans for completing the transition to the 2023 ESA, including fulfilling service commitments to enrolled customers and forecasting program service delivery for the remainder of the 2022 program cycle to best position the existing ESA workforce to meet remaining 2022 service objectives.

LIOB Oversight

The full LIOB should discuss and determine IOU reporting metrics and benchmarks to inform the board of their respective transitional plans and program impacts at its quarterly meetings. Subject matter should include, but not limited to, ESA program transition plans, real or potential program disruptions, timetables for new program elements, the dismissal of measures and why, status of the ESA workforce, affordability impacts, to date allocation of funds and funds that are spent and unspent.

ESA Budget Flexibility

The Decision restricts ESA Main budget dollars to the appropriated fiscal year not allowing for financial/budget flexibility. Unforeseen impacts given increased customer demand and growing wait lists have resulted in SCE ceasing to enroll new customers via their outreach and enrollment contractors. The ESA workforce - specifically in the Southern California Edison territory – has seen significant layoffs and program disruptions due to a significant transition into the new program. The CPUC should address this issue with a stable, flexible, and sustainable funding stream that appropriately finances ESA operations to ensure that eligible customers are served, and the ESA workforce is part of this transition to the new program.

Clarification As to The Installation Of “All Feasible Measures” In The ESA Program As Delineated In PUC Code 2790.

This clarification by the Energy Division will significantly aid the IOUs in establishing program deliverables that best meet the needs and requirements of the customer and program compliance. Absent clarification as to the determining process of “all feasible measures” it will be next-to-impossible to know what customers are eligible to receive. Clarification of an all feasible measures set of guidelines will avoid arbitrary and subjective decision making on behalf of the program and our customers.

Mitigating Service Impacts to Customers

Southern California Edison should recalibrate its 2022 ESA budget to ensure sufficient funding remains to honor service commitments to Edison customers with expressed interest in ESA services and enrolled in the program. Edison should pursue all administrative options at its disposal to render timely service response to these customers, preferably by the conclusion of the 2022 program cycle.

ESA Workforce Contracting

Southern California Edison should structure contracts with ESA service providers in a manner that expressly defines services delivery, budget, and service work expenditures by specific time periods covering the entire span of the ESA annual contract cycle. This method of calibrating contractor budgets, service delivery, and reimbursement payments will enable ESA contractors to better manage its program operations and operating expenses over the course of the entire program year cycle and lull periods due to accelerated performance by a contractor.

CPUC

The 2023 ESA program cycles marks a critical point for enhancing ESA measuring offerings and service investment in qualified dwellings, this, combined with recent eligibility expansion for ESA, the CPUC shall establish of annual and multi-year market penetration goal achievement across all IOUs. In addition, the CPUC should define metrics to effectively measure first-year implementation of the 2023 program design in order derive new baselines for average service investment.

Item 11: Future Quarterly LIOB Meeting Options

3:10 – 3:15 PM



California Public
Utilities Commission

Item 12: Technical Advisory Committee

Board Chair Delgado-Olson & Board Member Wimbley

3:15 – 3:20 PM



California Public
Utilities Commission

Item 13: Wrap Up & Closing Remarks

3:20 – 3:30 PM

Save-the-date!

4th Quarterly Meeting - December 8, 2022



California Public Utilities Commission

Energy Efficiency in Michigan Homes

Michigan has adopted the 2015 International Energy Conservation Code (2015 IECC) as the baseline energy code for residential buildings in the state. You can use the checklist below to verify key residential code requirements that are easy to identify in your home.

While this checklist doesn't include every requirement, it serves as a helpful guide for homeowners to better understand the energy efficiency features in your home. Please refer to the state energy code for complete documentation of all requirements and consult your local code official for questions and clarification. Michigan buildings are constructed in climate zones 5a, 6a and 7.

Mandatory Requirements:

Energy Certificate

- ☐ An energy certificate located on a circuit breaker box is completed and signed

See Reverse Side for Example

Heating & Cooling

- ☐ Home has a programmable thermostat installed
- ☐ **All** ducts are sealed with approved materials (e.g. mastic or UL 181 tape)
Regular duct tape is not acceptable
- ☐ Ducts in an uninsulated attic or basement are tested to ensure entire ductwork system is properly sealed

Mechanical Ventilation

- ☐ Home has a mechanical ventilation system to provide fresh and controlled air. Systems can be exhaust only, supply only, or balanced.

Windows & Doors

- ☐ Windows, skylights and sliding glass doors meet minimum infiltration and efficiency requirements. (You can find the u-factor and infiltration rates on new window and door stickers or the energy certificate)

Lighting

- ☐ At least **75%** of the home's lighting fixtures are energy efficient fixtures

Air Sealing

- ☐ All holes between ceilings, floors and through walls are sealed using caulk or foam

Key areas include:

- Points where phone & cable wires enter home
- Points where plumbing goes through walls, floors and ceilings
- Points where dryer vents, bathroom exhaust, furnace air intake and exhaust, and kitchen exhaust goes through walls/roofs

- ☐ Blower door test performed to ensure home is well-sealed and meets the specified air leakage rate. You can request a copy of the results from the contractor

Other Requirements

- ☐ Wood-burning fireplaces have tight flue dampers or doors, outdoor combustion air, and should be vented to the outside
- ☐ Hot water piping insulated to a minimum of R-3 for >105° F or <55° F

Energy Code Compliance Paths:

Compliance with the energy code requirements can be achieved in four different ways. Ask your builder for documentation showing the home meets minimum requirements for energy consumption according to the path they've chosen.

SAMPLE ENERGY CERTIFICATE

Michigan Homes

This energy certificate illustrates the energy efficiency standards which have been adopted and are required in every new home in each Michigan jurisdiction. This sample form has been completed with the minimum prescriptive standards for each building element in the home. Homes may meet other standards for these measures if a builder is using an alternative compliance path. Look for this certificate on or near the home's circuit breaker box or electric panel box. Make sure that it has been fully completed and signed by the builder and identifies the other contractors.

If you have any questions about what is reported on the certificate, ask the builder or the building permits office.

R-values

R-values are used to measure the efficiency of insulation materials. Insulation materials with higher R-values are more efficient and better at resisting heat transfer.

U-factor

A U-factor is a measure of efficiency for windows and doors. U-factors are the inverse of R-values, so lower u-factors mean the material is more energy efficient.

Heating and Cooling (HVAC)

Minimum levels of efficiency for heating and cooling systems depend on the type of equipment and fuel used. Heating and cooling systems with higher ratings are more efficient. Use the chart below to determine the minimum rating allowed for each system.

Type	Min Rating
Air Conditioner	13 SEER
Gas Furnace	80 AFUE
Gas Boiler	82 AFUE
Heat Pump	14 SEER 8.2 HSPF

*"10/13" means R-10 continuous insulated sheathing on the interior or exterior of the home (sealed at joints) or R-13 cavity insulation at the interior of the basement wall.

2015 Michigan Energy Code Certificate

Compliance Method	Date	Climate Zone
Prescriptive	5/1/2019	5
Insulation	R-Value	
Ceiling/Roof	38	
Exterior Walls	20 or 13+5	
Exterior Floors	30	
Ducts	8	
Basement Walls	10/13 *	
Window and Door Rating	U-factor	
Windows	0.32	
Doors	0.32	
HVAC Equipment	Type	Rating
Furnace	Gas	80 AFUE
Water Heating	Type	EF Value
Water Heater	50 Gal, Gas	0.60
General Contractor:	ABC Contractors	
Insulation Contractor:	123 Insulation	
Form Completed By:	John Smith	

Water Heater

The minimum efficiency factor (EF) for water heaters depends on the size and fuel type used. Water heaters with higher EF ratings are more efficient.

Minimum EFs for Water Heaters

Size	Gas	Electric
30 gal	0.63	0.95
40 gal	0.62	0.95
50 gal	0.60	0.95
65 gal	0.75	1.98
75 gal	0.74	1.97



MICHIGAN DEPARTMENT OF
ENVIRONMENT, GREAT LAKES, AND ENERGY

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Furnaces and Boilers

Energy Saver

[Energy Saver](#) » [Home Comfort](#) » [Home Heating Systems](#) » Furnaces and Boilers

Most U.S. homes are heated with either furnaces or boilers. Furnaces heat air and distribute the heated air through the house using ducts. Boilers heat water, and provide either hot water or steam for heating. Steam is distributed via pipes to steam radiators, and hot water can be distributed via baseboard radiators or radiant floor systems, or can heat air via a coil. Steam boilers operate at a higher temperature than hot water boilers, and are inherently less efficient; however, high-efficiency versions of all types of furnaces and boilers are currently available. To learn more about furnaces, boilers and other types of home heating systems, explore our [Energy Saver 101 infographic on home heating](#).





📷 Upgrading to a high efficiency furnace or boiler is an effective way to save money on home heating.

Understanding the Efficiency Rating of Furnaces and Boilers

A central furnace or boiler's efficiency is measured by annual fuel utilization efficiency (AFUE). The Federal Trade Commission requires new furnaces or boilers to display their AFUE so consumers can compare heating efficiencies of various models. AFUE is a measure of how efficient the appliance is in converting the energy from fuel to heat over the course of a typical year.

Specifically, AFUE is the ratio of the furnace's or boiler's annual heat output compared to its total annual fossil fuel energy consumed. An AFUE of 90% means that 90% of the energy in the fuel becomes heat for the home and the other 10% escapes up the chimney and elsewhere. AFUE doesn't include the heat losses of the duct system or piping, which can be as much as 35% of the energy for output of the furnace when ducts are located in the attic, garage, or other partially conditioned or unconditioned space.

An all-electric furnace or boiler has no flue loss through a chimney. The AFUE rating for an all-electric furnace or boiler is between 95% and 100%. The lower values are for units installed outdoors because they have greater jacket heat loss. However, despite their high efficiency, the higher cost of electricity in most parts

of the country makes all-electric furnaces or boilers an uneconomic choice. If you are interested in electric heating, consider installing a heat pump system.

Read about the [standards for residential furnaces](#).

You can identify and compare a system's efficiency not only by its AFUE but also by its equipment features.

Older, low-efficiency heating systems:

- Natural draft that creates a flow of combustion gases
- Continuous pilot light
- 56% to 70% AFUE.

Mid-efficiency heating systems:

- Exhaust fan controls the flow of combustion air and combustion gases more precisely
- Electronic ignition (no pilot light)
- Compact size and lighter weight to reduce cycling losses
- Small-diameter flue pipe
- 80% to 83% AFUE.

High-efficiency heating systems:

- Condensing flue gases in a second heat exchanger for extra efficiency
- Sealed combustion
- 90% to 98.5% AFUE.

Retrofitting Your Furnace or Boiler

Furnaces and boilers can be retrofitted to increase their efficiency. These upgrades improve the safety and efficiency of otherwise sound, older systems. The costs of retrofits should be carefully weighed against the cost of a new boiler or

furnace, especially if replacement is likely within a few years or if you wish to switch to a different system for other reasons, such as adding air conditioning. If you choose to replace your heating system, you'll have the opportunity to install equipment that incorporates the most energy-efficient heating technologies available.

Retrofits are fuel-specific, so see the following sections for retrofit information:

- **Gas-Fired Furnaces and Boilers** (includes units fired with natural gas and propane)
- **Oil-Fired Furnaces and Boilers.**

Other retrofitting options that can improve a system's energy efficiency include installing **programmable thermostats**, **upgrading ductwork** in forced-air systems, and adding zone control for hot-water systems, an option discussed in **Heat Distribution Systems**.

Replacing Your Furnace or Boiler

Although older fossil fuel furnace and boiler systems have efficiencies in the range of 56% to 70%, modern conventional heating systems can achieve efficiencies as high as 98.5%, converting nearly all the fuel to useful heat for your home. Energy efficiency upgrades and a new high-efficiency heating system can often cut your fuel bills and your furnace's pollution output in half. Upgrading your furnace or boiler from 56% to 90% efficiency in an average cold-climate house will save 1.5 tons of carbon dioxide emissions each year if you heat with natural gas, or 2.5 tons if you heat with oil.

If your furnace or boiler is old, worn out, inefficient, or significantly oversized, the simplest solution is to replace it with a modern high-efficiency model. Old coal burners that were switched over to oil or gas are prime candidates for replacement, as well as natural gas furnaces with pilot lights rather than electronic ignitions. Newer systems may be more efficient but are still likely to be

oversized, and can often be modified to reduce their operating capacity.

Before buying a new furnace or boiler or modifying your existing unit, it is suggested that you first improve the energy efficiency of your home by adding insulation and/or new energy-efficient windows, then have a heating contractor size your furnace. Energy-efficiency improvements will save money on a new furnace or boiler, because you can purchase a smaller unit. A properly sized furnace or boiler will operate most efficiently, and you'll want to choose a dependable unit and compare the warranties of each furnace or boiler you're considering.

When shopping for high-efficiency furnaces and boilers, look for the ENERGY STAR® label. If you live in a cold climate, it usually makes sense to invest in the highest-efficiency system. In milder climates with lower annual heating costs, the extra investment required to go from 80% to 90% to 95% efficiency may be hard to justify. However, keep in mind that higher efficiency units will have lower emissions than units in the 80% range.

Specify a sealed combustion furnace or boiler, which will bring outside air directly into the burner and exhaust flue gases (combustion products) directly to the outside, without the need for a draft hood or damper. Furnaces and boilers that are not sealed-combustion units draw heated air into the unit for combustion and then send that air up the chimney, wasting the energy that was used to heat the air. Sealed-combustion units avoid that problem and also pose no risk of introducing dangerous combustion gases into your house. In furnaces that are not sealed-combustion units, back drafting of combustion gases can be a big problem.

High-efficiency sealed-combustion units generally produce an acidic exhaust gas that is not suitable for old, unlined chimneys, so the exhaust gas should either be vented through a new duct or the chimney should be lined to accommodate the acidic gas (see the section on maintaining proper ventilation below).

Maintaining Your Furnace or

Boiler

The following maintenance should be provided by a heating system professional.

All systems:

- Check the condition of your vent connection pipe and chimney. Parts of the venting system may have deteriorated over time. Chimney problems can be expensive to repair, and may help justify installing new heating equipment that won't use the existing chimney.
- Check the physical integrity of the heat exchanger. Boiler heat exchangers may leak water and are easy to spot. Furnace heat exchangers mix combustion gases with house air when they leak—an important safety reason to have them inspected. Combustion gases leaking into the house can cause carbon monoxide poisoning. It is suggested that every home have a working carbon monoxide alarm.
- Adjust the controls on the boiler or furnace to provide optimum water and air temperature settings for both efficiency and comfort.
- If you're considering replacing or retrofitting your existing heating system, have the technician perform a combustion-efficiency test.

Forced Air Systems:

- Check the combustion chamber for cracks
- Test for carbon monoxide (CO) and remedy if found
- Adjust blower control and supply-air temperature
- Clean and oil the blower
- Remove dirt, soot, or corrosion from the furnace or boiler
- Check fuel input and flame characteristics, and adjust if necessary
- Seal connections between the furnace and main ducts.

Hot Water Systems:

- Test pressure-relief valve
- Test high-limit control
- Inspect pressure tank, which should be filled with air, to verify that it's not

filled with water

- Clean the heat exchanger.

Steam Systems:

- Drain some water from the boiler to remove sediments and improve the heat exchange efficiency
- Test low-water cutoff safety control and high-limit safety control
- Drain the float chamber to remove sediments, which will prevent the low-water cutoff control from sediment clogs
- Analyze boiler water and add chemicals as needed to control deposits and corrosion
- Clean the heat exchanger
- See also [steam radiators](#).

Chimneys

Properly functioning chimney systems will carry combustion byproducts out of the home. Therefore, chimney problems put you at risk of having these byproducts, such as carbon monoxide, spill into your home.

Most older furnaces and boilers have natural draft chimneys. The combustion gases exit the home through the chimney using only their buoyancy combined with the chimney's height. Natural draft chimneys often have problems exhausting the combustion gases because of chimney blockage, wind or pressures inside the home that overcome the buoyancy of the gases.

Atmospheric, open-combustion furnaces and boilers, as well as fan-assisted furnaces and boilers, should be vented into masonry chimneys, metal double-wall chimneys, or another type of manufactured chimney. Masonry chimneys should have a fireclay, masonry liner or a retrofitted metal flue liner.

Many older chimneys have deteriorated liners or no liners at all and must be relined during furnace or boiler replacement. A chimney should be relined when any of the following changes are made to the combustion heating system:

- When you replace an older furnace or boiler with a newer one that has an AFUE of 80% or more. These mid-efficiency appliances have a greater risk of depositing acidic condensation in chimneys, and the chimneys must be prepared to handle this corrosive threat. The new chimney liner should be sized to accommodate both the new heating appliance and the combustion water heater (if present) by the installer.
- When you replace an older furnace or boiler with a new 90+ AFUE appliance or a heat pump. In this case, the heating appliance will no longer vent into the old chimney, and if the combustion water heater is present it will now vent through an oversized chimney. This oversized chimney can lead to condensation and inadequate draft. The new chimney liner should be sized for the water heater alone, or the water heater in some cases can be vented directly through the wall.

Other Ventilation Concerns

Some fan-assisted, non-condensing furnaces and boilers, installed between 1987 and 1993, may be vented horizontally through high-temperature plastic vent pipe (not PVC pipe, which is safely used in condensing furnaces). This type of venting has been recalled and should be replaced by stainless steel vent pipe. If horizontal venting was used, an additional draft-inducing fan may be needed near the vent outlet to create adequate draft. Floor furnaces may have special venting problems because their vent connector exits the furnace close to the floor and may travel 10 to 30 feet before reaching a chimney. Check to see if this type of venting or the floor furnace itself needs replacement. If you smell gases, you have a venting problem that could affect your health. Contact your local utility or heating contractor to have this venting problem repaired immediately.

Methane and NO_x Emissions from Natural Gas Stoves, Cooktops, and Ovens in Residential Homes

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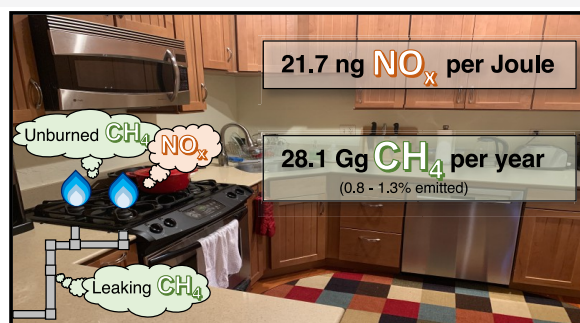
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Supporting Information



ABSTRACT: Natural gas stoves in >40 million U.S. residences release methane (CH₄)—a potent greenhouse gas—through post-meter leaks and incomplete combustion. We quantified methane released in 53 homes during all phases of stove use: steady-state-off (appliance not in use), steady-state-on (during combustion), and transitory periods of ignition and extinguishment. We estimated that natural gas stoves emit 0.8–1.3% of the gas they use as unburned methane and that total U.S. stove emissions are 28.1 [95% confidence interval: 18.5, 41.2] Gg CH₄ year^{−1}. More than three-quarters of methane emissions we measured originated during steady-state-off. Using a 20-year timeframe for methane, annual methane emissions from all gas stoves in U.S. homes have a climate impact comparable to the annual carbon dioxide emissions of 500 000 cars. In addition to methane emissions, co-emitted health-damaging air pollutants such as nitrogen oxides (NO_x) are released into home air and can trigger respiratory diseases. In 32 homes, we measured NO_x (NO and NO₂) emissions and found them to be linearly related to the amount of natural gas burned ($r^2 = 0.76$; $p \ll 0.01$). Emissions averaged 21.7 [20.5, 22.9] ng NO_x J^{−1}, comprised of 7.8 [7.1, 8.4] ng NO₂ J^{−1} and 14.0 [12.8, 15.1] ng NO J^{−1}. Our data suggest that families who don't use their range hoods or who have poor ventilation can surpass the 1-h national standard of NO₂ (100 ppb) within a few minutes of stove usage, particularly in smaller kitchens.

KEYWORDS: cooking, climate, combustion, pollutants, post-meter emissions, appliances, houses

INTRODUCTION

Since 1750, methane (CH₄) has contributed about one-quarter of the world's radiative forcing,¹ and its concentration continues to rise.² Methane is a shorter-lived gas than carbon dioxide (CO₂) but is nevertheless 34–86 times more potent than carbon dioxide on 100 and 20 year timescales, respectively.³

Leaks of natural gas (>90% methane) across the ~3 million miles of pipeline in the United States' supply chain⁴ have been studied extensively.⁵ However, comparatively little work has been done on emissions inside homes and buildings, so-called “post-meter” emissions. The United States Environmental Protection Agency (USEPA) Inventory of U.S. Greenhouse Gas Emissions and Sinks only documents leaks from residential gas meters and incomplete combustion from residential gas appliances, but more information is needed on methane leaks from transitory on–off phases and quiescent steady-state-off emissions, particularly from gas stoves.⁶ Previous work found

that appliances in Boston and Indianapolis—excluding pilot light emissions—were estimated to emit 0.038% of the natural gas they consumed.⁷ A separate study in California found that whole-home post-meter residential emissions totaled 0.5% of residential natural gas consumption in the state.⁸

Natural gas is a popular fuel choice for home cooking. Nationally, over one-third of households (>40 million homes) cook with gas.⁹ In some states, the proportion is substantially higher; over 60% of households in California cook with gas, for instance.¹⁰ People interact more directly with their stove than with other gas appliances, increasing potential exposure to any

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natural gas constituents and compounds formed during combustion, including formaldehyde (CH_2O), carbon monoxide (CO), and nitrogen oxides (NO_x). Here, we define NO_x as the sum of nitric oxide (NO) and nitrogen dioxide (NO_2). Among all gas appliances, the stove is unique in that the byproducts of combustion are emitted directly into home air with no requirement for venting the exhaust outdoors. In fact, some kitchens have “ductless” hoods that recirculate fumes through activated charcoal filters, which are generally less effective at cleaning the air.¹¹ Vented hoods have a range of effectiveness and function best when overhanging the stove.^{12,13} Because exhaust hoods are separate from the stove and must be operated manually, vented hoods in practice are used only 25–40% of the time.^{14–16}

To date, the majority of research concerning gas stoves has focused on their effect on indoor air quality.^{17,18} In particular, research has measured long-term averaged indoor concentrations of NO_x and CO ,^{19,20} with limited direct measurements of emission rates. NO_2 is a respiratory irritant and can lead to asthma, coughing, wheezing, and difficulty breathing, occasionally resulting in hospitalization.^{21,22} Chemically, NO forms NO_2 indoors upon interaction with ozone (O_3), and NO_2 concentrations will decrease through interactions with interior surfaces.²³ Concentrations of NO_x and other indoor pollutants depend greatly on the turnover rate of air in homes; over time, outside air will enter the house through ventilation and infiltration, reducing any gradient between indoor and outdoor concentrations.

There are currently no U.S.-based indoor exposure guidelines or standards for NO_2 ; however, Canada has a maximum residential exposure limit of 90 parts per billion (ppb) over a 1 h exposure and 11 ppb over the long term (>24 h).²⁴ In 2010 the EPA set a 1 h outdoor exposure limit of 100 ppb for NO_2 which was retained in 2018; the annual standard of 53 ppb was established in 1971 and has not been updated.²⁵ Recently, in 2021, the WHO set the outdoor standard for NO_2 to be approximately 13 ppb over 24 h.²⁶ NO_2 concentrations of 100 ppb are regularly exceeded if stoves are used without adequate indoor ventilation, either due to a low capture efficiency of the exhaust hood or the hood not being activated by the user.¹⁷

We measured methane emissions from stoves during all phases of operation (steady-state-off, turning on and off, and during combustion), with additional measurements quantifying NO_x emissions during combustion. We used a kitchen chamber approach to take measurements with a measured kitchen volume, sealed using a plastic partition. For cooktops, we focused our measurements on emissions from individual burners at different intensities to gain a fuller picture of total emissions. We quantified steady-state-off emissions from stoves because they were not included in most previous cooktop emissions studies and because, previously, we found steady-state-off emissions to be a substantial, sometimes dominant, component of total methane emissions from storage water heaters.²⁷

MATERIALS AND METHODS

We define a “cooktop” as a flat surface with individual burners, typically four or five per stove, and an occasional “griddle” element. The “oven” is an enclosed heated space, usually containing two burners: a “bake” burner below the bottom steel plate and a “broil” burner typically exposed and affixed to the oven’s roof. A “stove” (also referred to as a “range”) is a freestanding unit that contains both a cooktop and an oven,

typically both using gas, although some combine a gas cooktop with an electric oven.

Site Selection. We measured methane emissions from stoves in 53 homes in 7 California counties between January 2020 and May 2021 (Table S1). Our sample set included private homes, properties for sale or rent by real estate agents, and, because of the constraints of COVID-19, Airbnb rentals. We measured methane emissions from gas cooktops (18 unique brands) at all 53 homes and tested gas ovens and broilers in 40 and 31 homes, respectively. For stoves with information available, we found the ages of stoves ranged between 3 and 30 years. Cooktop burners ranged in heat output from 4500 to 25 000 British thermal units (BTU) h^{-1} , and most oven burners ranged between 16 000 and 19 000 BTU h^{-1} , as per product specifications.

We additionally measured NO , NO_2 , and NO_x emissions from 32 cooktops and 24 ovens of the stoves tested for methane emissions (Table S1). The NO , NO_2 , and NO_x emission rates are important because—coupled with circulation, ventilation, infiltration, and room size—they determine the concentration of NO_x pollutants that build up in kitchens.

Sampling Overview. We measured each stove burner using a static flux chamber (“room chamber”) method (Figure S1), which we tested in the lab and in homes before initiating the study. The stove was contained in an airtight portion of the room of known volume (average of 20 m^3 , range of 8–83 m^3 , Figure S2) by hanging plastic sheets (4–6 mil thickness) to partition the kitchen from surrounding space using a ZipWall Dust Barrier System (zipwall.com) with 8 or 10 ft tension poles. Clear plastic sheets were sealed along the ceiling, walls, and floor using a combination of ZipWall foam bars, painter’s tape, and/or 3 kg sandbags. We used one or two Lasko 3300 Wind Machine Fans on low or medium to circulate the air within the space. We took care in selecting fan speed, position, and direction to minimize any disruptions to burners (Figure S1). An additional fan or two circulated the air outside the chamber to ensure that the “background air” was homogenous. We collected concentration measurements of methane (CH_4), ethane (C_2H_6), and CO_2 at a rate of <1 Hz on a Picarro cavity ring-down spectrometer (model G-2210i). In addition, we used one of two analyzers to measure concentrations of NO_x , including direct measurements of NO and NO_2 : a Teledyne model 200A chemiluminescence analyzer and a Thermo Fischer Scientific 42iQ analyzer. Kitchen temperature was recorded using an Onset HOBO Logger (UX100-23A).

General Sampling Scheme. After partitioning the kitchen with plastic sheets, we set up two inlet hoses to the analyzers, one near the center of the enclosed kitchen area about 4–6 ft off the ground and a second in a space outside the enclosed area at a similar height for background measurements. We took background measurements of methane and NO_x for at least 2 min before collecting stove measurements.

To test the size and seal quality of the room chamber, we briefly entered the enclosed kitchen through a zipper door and released a 300–500 mL aliquot of ethane with a glass syringe (“ethane inject”) to estimate the room volume by dilution. We found this method to be more straightforward for estimating kitchen volume than taking measurements of chamber dimensions, which proved challenging with cabinetry and nonstandard configurations of many modern kitchens, although both methods agreed well (Figure S2). Ethane was chosen for the dilution measurements because the Picarro measured it and there were no additional sources of ethane in

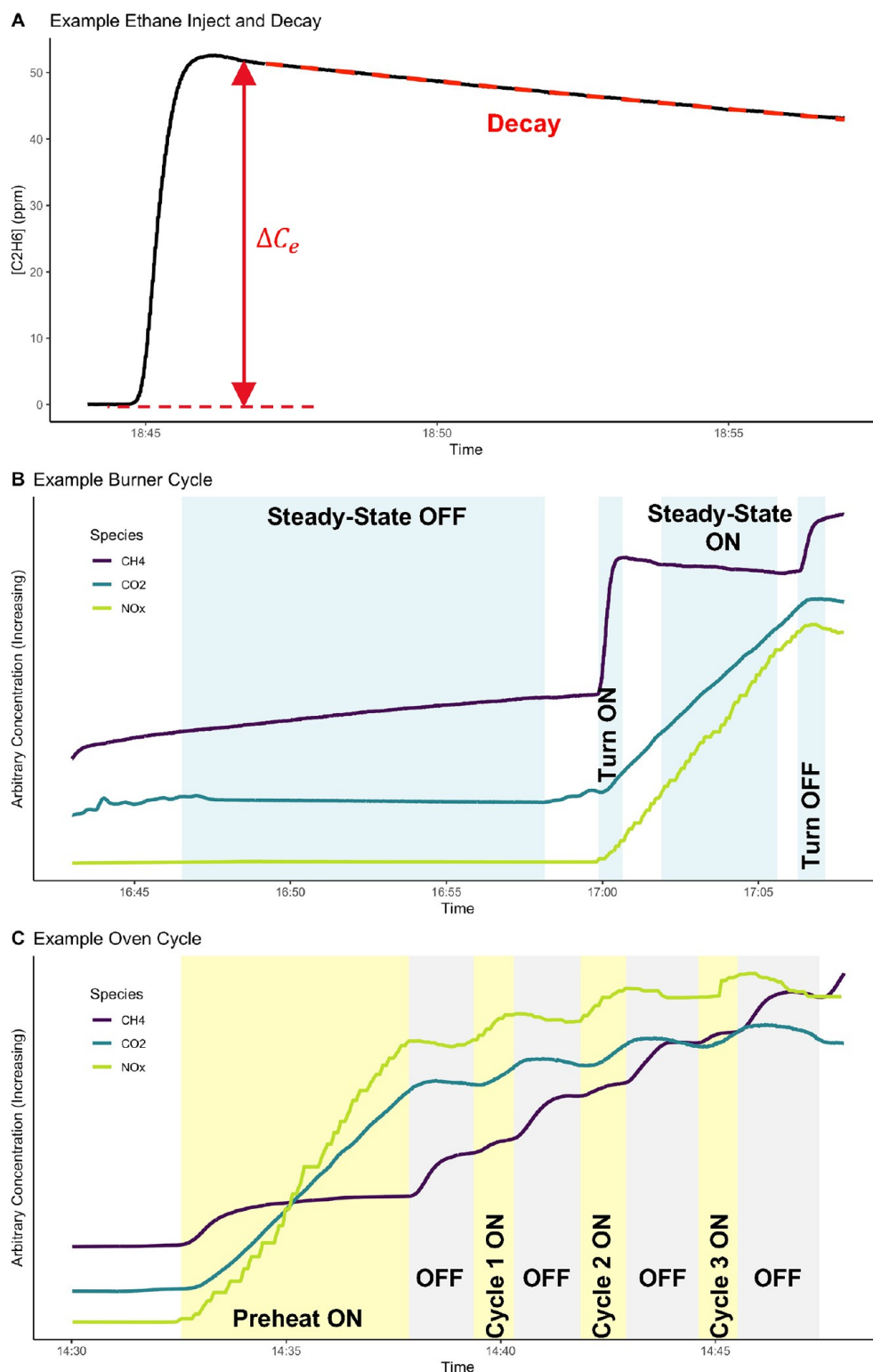


Figure 1. Example concentration plots for various measurement events using data from actual measurements in our study. (A) Ethane injection and decay: first, we injected 500 mL of ethane into the space created by the plastic wall to determine its volume based on dilution. ΔC_e is the change in ethane concentration, which resulted from our injection of ethane. Then, we allowed the elevated ethane to exponentially decay over time (dotted red line) to measure the air changes per hour (ACH) in the space created by the chamber. This value was used to correct CH_4 , NO_x , and CO_2 values measured during other test phases. (B) Cooktop burner measurement cycle: “steady-state-off” before the burner is ignited, “turn on” for the pulse of gas emitted when the burner is ignited, “steady-state-on” for the emissions while the burner is on a steady state, and “turn off” for the pulse of emissions observed when the burner is extinguished; (C) oven measurement cycle: “preheat” for the increase in concentrations while the oven is reaching the set temperature and “cycling” for the on/off behavior of the oven while it maintains the set temperature.

the kitchen while the stove was off beyond small emissions of ethane co-emitted in the natural gas from the stove or nearby pipes and fittings, which were at most 2 orders of magnitude lower than the amount of ethane we injected (Figure 1A; details and calculations in the Supporting Information (SI)). After leaving the kitchen, we measured the “ethane decay”, which we used to calculate the diffusion and exchange of air outside the partitioned space through unavoidable, small gaps in the plastic and through leaky doors, windows, and vents (Figure 1A).

Simultaneously with ethane decay, “steady-state-off” measurements of methane from the stove were taken for 5–10 min (Figure 1B). Emissions from steady-state-off are not attributable to a specific source within the stove or piping but capture all emissions from the stove and piping within the chamber volume. Ethane injection/decay and steady-state-off measurements were repeated throughout sampling for a total of two to seven independent measurements of volume, air exchange, and steady-state-off methane emissions per stove.

To begin combustion measurements of methane and NO_x (NO and NO₂), we entered the kitchen and ignited one burner on the cooktop, which initiated the “on pulse”. Because NO_x is a byproduct of combustion, we never observed pulses of NO_x while turning burners on or off. We left the burner on, and after the pulse was completely mixed in the room, typically 90 s after ignition, we exited the kitchen and collected a “steady-state-on” measurement of both methane and NO_x for at least 3 min while vacant. We then returned inside, waited 30 s, and turned off the burner (Figure 1B). After 90 s, another single burner was lit. We measured burners individually on some combination of low, medium, or high for both methane and NO_x emissions. We aired out the kitchen chamber volume whenever the concentration of methane inside approached the limit of the Picarro (~30 ppm CH₄). Details of the calculations, including correction for the measured air exchange rate, are presented in the SI.

We tested ovens similarly for methane and NO_x emissions using our kitchen chamber system. We used the oven’s bake setting to set the temperature between 350 and 425 °F. We observed a distinct “preheat” phase of emissions as the oven warmed to temperature and a “cycling” phase as the oven maintained temperature, which we saw in the CH₄, CO₂, and NO_x data output (Figure 1C). We allowed the bake burner to preheat the oven and cycle at least three times, taking ~20–30 min. We tested broiler burners using the same method but only while preheating.

Scaling Methane Emissions. We scaled our appliance measurements to national estimates of total emissions using activity data from Chan et al.²⁸ and Zhao et al.,¹⁸ assuming that stove usage does not vary substantively across the United States with climate the way that furnace usage does (Figure S7). Chan et al. and Zhao et al. report activity data from 80 residences, collectively, including the number and length of time that the occupants used individual burners on their stove and how often they used their ovens. We also obtained information on the numbers of appliances from the 2015 Residential Energy Consumption Survey.⁹ The total number of appliances was assumed to be the total number of stoves and any secondary cooktops, 43.4 million appliances (standard deviation: 1.3 million) nationally.

Using Chan et al., Zhao et al., 2015 RECS, and our measurements, we created an “expanded dataset” with one observation for every possible combination of stove *i* (*n* = 53)

and usage datapoint *j* (*n* = 80), creating 4240 unique observations of annual stove emissions. From here, we scaled our measurements using the number of appliances (43.3 million) reported in the RECS database for the United States.

For each pairing of stove *i* and usage datapoint *j*, we divided the time based on the selected usage environment into steady-state-off, steady-state-on, and oven usage periods, broken down into preheat and cycling phases. We calculated the total methane emissions that would be expected in a day given the selected stove’s emissions for the total length of these periods and the number of expected pulses using eq 1

$$\begin{aligned} \text{emissions (g day}^{-1}\text{)} &= \text{SS. On}_i \text{ (g h}^{-1}\text{)} \times \text{Hours. Cooktop}_j + \text{Oven}_i \text{ (g h}^{-1}\text{)} \\ &\times \text{Hours. Oven}_j + \text{SS. Off}_i \text{ (g h}^{-1}\text{)} \\ &\times (24 - \text{Hours. Cooktop}_j - \text{Hours. Oven}_j) \\ &+ \text{On/Off Pulse}_i \text{ (g)} \times \text{Burner. Ignitions}_j \end{aligned} \quad (1)$$

with emissions in total grams CH₄ per day, SS.On_{*i*} is the emission rate (g h^{−1}) during steady-state-on for stove *i*; SS.Off_{*i*} is the emission rate (g h^{−1}) during steady-state-off for stove *i*; Oven_{*i*} is the emission rate (g h^{−1}) for an oven set to 350–425 °F from kitchen *i*; Pulse_{*i*} is the emission magnitude from each on/off pulse for stove *i*; Hours.Cooktop_{*j*} is the total number of hours per day any burner from cooktop *j* was used, as reported by Chan et al. and Zhao et al.; Hours.Oven_{*j*} is the total number of hours per day oven *j* was used; and Burner.Ignitions_{*j*} is the total number of times a burner was ignited per day from stove *j*.

We calculated the mean estimate for a stove (burners plus oven) as the mean of the expanded dataset and the 95% confidence interval from a bootstrap using 25 000 replicates and sample sizes of 53 to capture the full uncertainty associated with our stove emissions dataset.^{29,30}

Total Volumetric Emissions. In total, previous inventories report that natural gas residential indoor cooking appliances use 113 billion cubic feet (bcf) of gas per year in the United States, the third most gas from residential appliances, after space heating (2677 bcf year^{−1}) and water heating (1019 bcf year^{−1}).⁹ We estimated the total percentage of gas emitted using eq 2

$$\%_{\text{leaked}} = \frac{\text{Vol}_{\text{CH}_4}}{\text{Vol}_{\text{NG}}} \quad (2)$$

where Vol_{CH₄} is the amount of methane emitted by the stoves and Vol_{NG} is the volume of natural gas used by the stoves.

We estimated the annual volume of natural gas used by stoves with two different methods: (1) using the natural gas reported by RECS and (2) calculating the natural gas emissions using our recorded CO₂ data combined with the usage data. For both methods, we used our estimate of total emissions from stoves as the numerator in eq 2. In the first method, we used 113 billion cubic feet, provided by RECS. In the second method, we calculated the volume of natural gas using our direct CO₂ emissions and using the first two terms of eq 1 (steady-state-on and ovens) to calculate the assumed total emissions given the usage patterns and total number of national appliances.^{9,18,28}

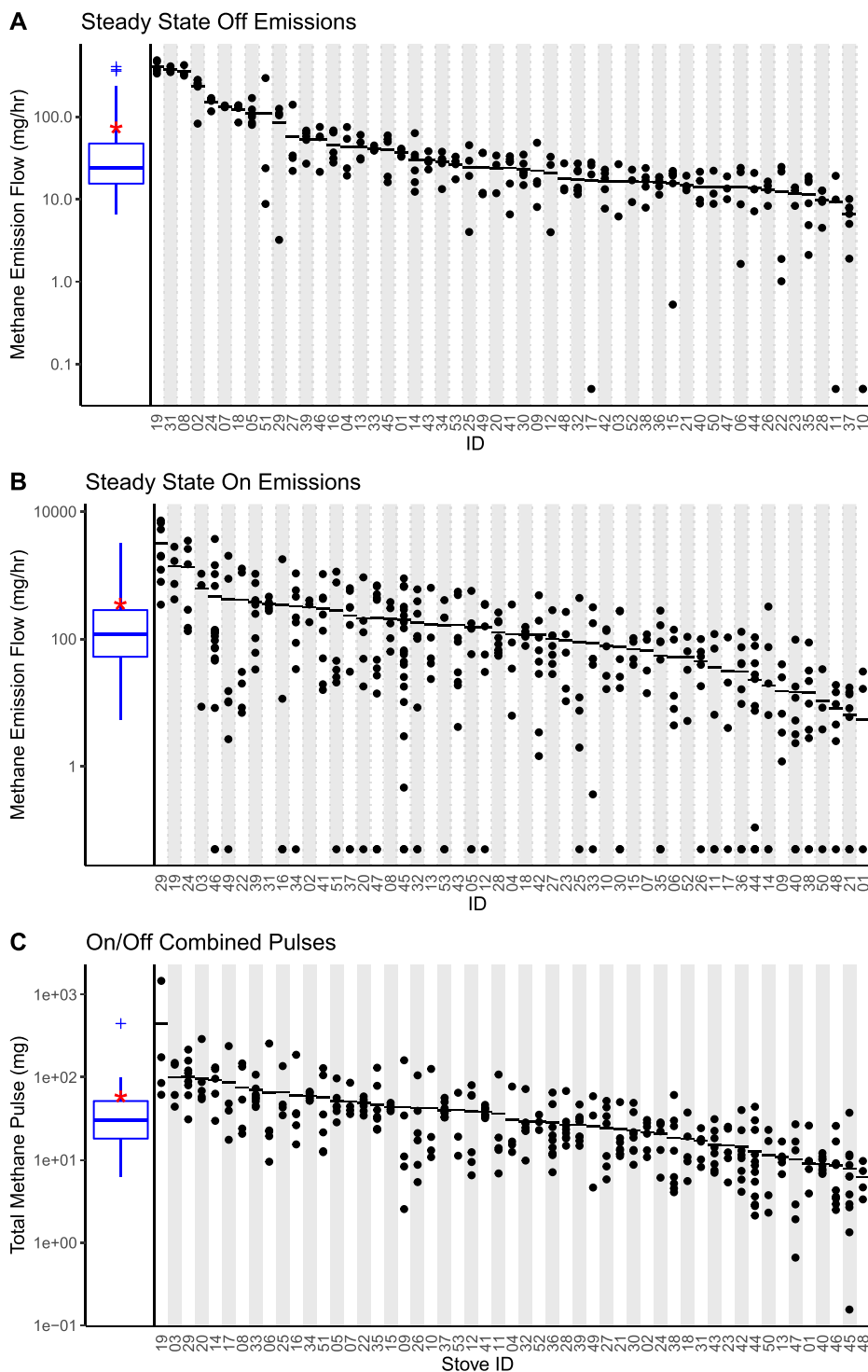


Figure 2. Stove emission components from each individual stove, represented on a log scale, from steady-state-off, steady-state-on, and the on/off pulses. The blue box-and-whisker plot on the left in each panel summarizes each component of stove emissions. The median, 25th, and 75th quartiles are shown, with blue + symbols denoting outliers. The red * represents the mean. On the right side of each plot, every “bin” above a stove ID represents either one measurement of steady-state-off as shown in (A) or a measurement of one burner’s emissions, as shown in (B) and (C). The small black horizontal line represents the average for each stove. (A) All steady-state-off emissions are reported for each stove that we measured—most stoves were measured three to five times. The mean ($58 \text{ mg CH}_4 \text{ h}^{-1}$) was higher than the median ($24 \text{ mg CH}_4 \text{ h}^{-1}$). Negative values were set to $0.05 \text{ mg CH}_4 \text{ h}^{-1}$. (B) Average steady-state-on emission was $259 \text{ mg CH}_4 \text{ h}^{-1}$, which is slightly higher than the median ($119 \text{ mg CH}_4 \text{ h}^{-1}$). Negative values were set to $0.05 \text{ mg CH}_4 \text{ h}^{-1}$. (C) Collective on/off pulses are represented by the individual black dots; one dot is the sum of the on-and-off pulse (if any) for an individual burner. The mean (46 mg CH_4) is again higher than the median (30 mg CH_4).

RESULTS AND DISCUSSION

Stove Steady-State-Off Emissions. During steady-state-off measurements, we found that stoves emitted 57.9 [95% CI from bootstrapping: 36.3, 84.0] mg CH₄ h⁻¹ on average (Figure 2A). The data for steady-state-off measurements were long-tail skewed, with the top 5 stoves (9% of sampled units) emitting half (49%) of all steady-state-off emissions. Interestingly, all but four stoves had steady-state-off emissions greater than 10 mg CH₄ h⁻¹, suggesting that most stoves and associated nearby piping leak some methane continuously. We never measured any NO_x emissions while the burners were off because NO_x is formed from the oxidation of nitrogen in the high temperatures of combustion.

Cooktop Steady-State-On Emissions. Total steady-state-on methane emission rates (per unit time) from a single cooktop burner during combustion, averaged over all measured burner sizes and intensities, were 259 [95% CI: 151, 408] mg CH₄ h⁻¹, approximately 4.5× more than steady-state-off emission rates from the entire stove when off (Figure 2B). More methane is therefore emitted instantaneously during combustion than when the cooktop is idle, although the length of time during the day when burners are idle is substantially longer in homes, where emissions occur continuously from steady-state-off leaks. Steady-state-on emission measurements were also long-tailed: the top 5 stoves (9%) emitted 51% of all steady-state-on emissions. Methane emission rates while on were not correlated with burner intensity or CO₂ emission rates (Figures S4 and S5).

During steady-state-on, we also estimated that volumetric-based total NO_x emissions were directly proportional ($p \ll 0.01$; $r^2 = 0.76$) to the rate of natural gas combustion (Figure 3). Therefore, we measured the energy output from the burner using the flow rate of CO₂ to calculate the Joules (J) of energy usage. Average emissions from stoves during steady-state-on ranged between 13.9 and 28.3 ng NO_x J⁻¹ (1.5–3.0 g NO_x Therm⁻¹), with an average value of 21.7 [20.5, 22.9] ng NO_x J⁻¹. The NO_x emission rate was comprised of 7.8 [7.1, 8.4] ng NO₂ J⁻¹ and 14.0 [12.8, 15.1] ng NO J⁻¹ (Figure 4B). Volumetrically, emissions were 15.8, 63.2, and 151.5 mL NO_x h⁻¹ for burners on low, medium, and high, respectively (Figure 4A), further demonstrating that more NO_x is emitted from burners during higher intensity usage.

Cooktop On/Off Pulse Emissions. Methane emissions from one combined on/off pulse (extra gas emitted while igniting and extinguishing a burner) from a single burner averaged 45.9 [95% CI: 33.1, 64.8] mg CH₄ (Figure 2C). This on/off methane pulse equaled the amount of gas emitted during ~10 min of average steady-state combustion.

Similar to the steady-state emissions, these on/off pulses exhibited a long-tail distribution driven predominantly by a few cooktops—even individual burners within cooktops—that emitted most of the methane. The highest emitters were the cooktops that ignited using a pilot light (total of eight burners); these burners had an average on/off pulse of 258 mg CH₄. One particularly large outlier—stove 19 (Figure 2C)—emitted on average 450 mg per pulse, nearly 4× higher than the second-highest emitter. This particular stove was one of the two stoves with a pilot light; on this specific unit, some burners took several seconds to ignite, while burners on other units with pilot lights took less time to ignite (thus releasing less methane), suggesting that delays in pilot light ignition may drive some emissions from on/off pulses.

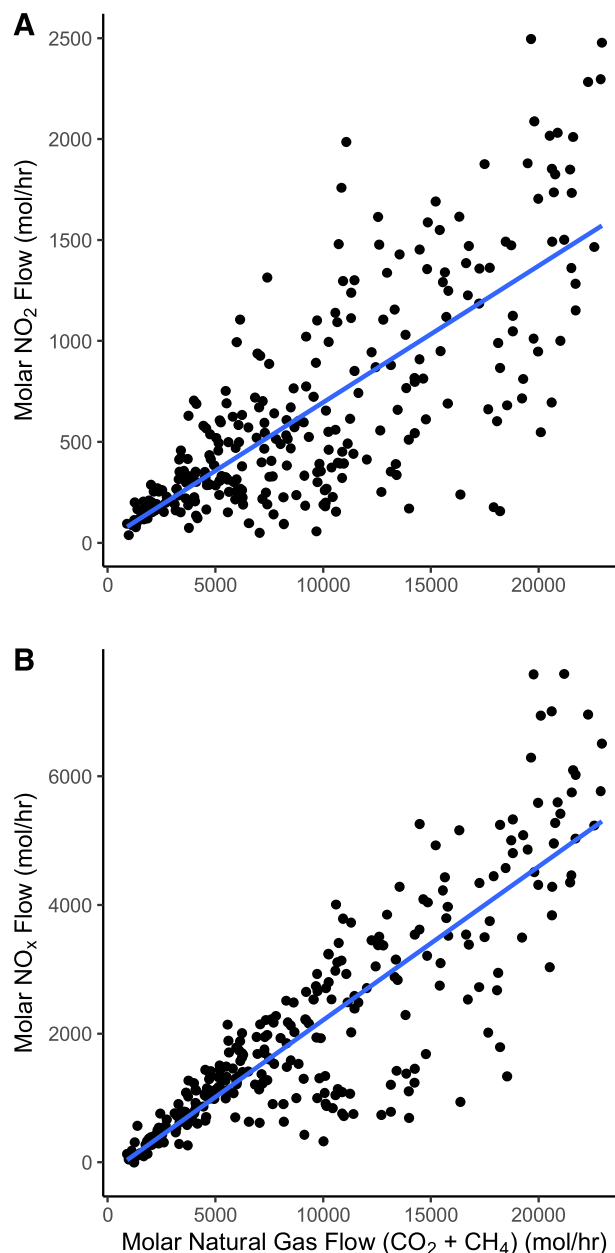


Figure 3. NO₂ and NO_x flows are linearly proportional to natural gas flow. Each black dot represents a measurement of steady-state-on, either for a cooktop burner, or for an oven broil or bake burner. (A) Emissions of NO₂ are plotted on the y-axis with the natural gas flow (i.e., emissions of CO₂ + CH₄) plotted on the x-axis. There is a clear correlation between the natural gas flow (estimated by summing the measured methane and carbon dioxide flow rates) and the NO₂ flow rate ($p \ll 0.01$; $r^2 = 0.59$). (B) Similarly, for NO_x (i.e., NO + NO₂), there is a correlation between natural gas flow and the NO_x flow rate ($p \ll 0.01$; $r^2 = 0.76$).

In contrast, 180 burners that were lit with a built-in operational electronic sparker emitted less methane, 38 mg CH₄. We also lit 22 burners with a match or lighter because their built-in electronic sparker did not work (but homeowners said they used them nonetheless). For these, we held a lit match next to the burner before turning the gas on. On average, these burners emitted 48 mg CH₄ per on/off pulse, similar to the burners with a functioning electric sparker. We

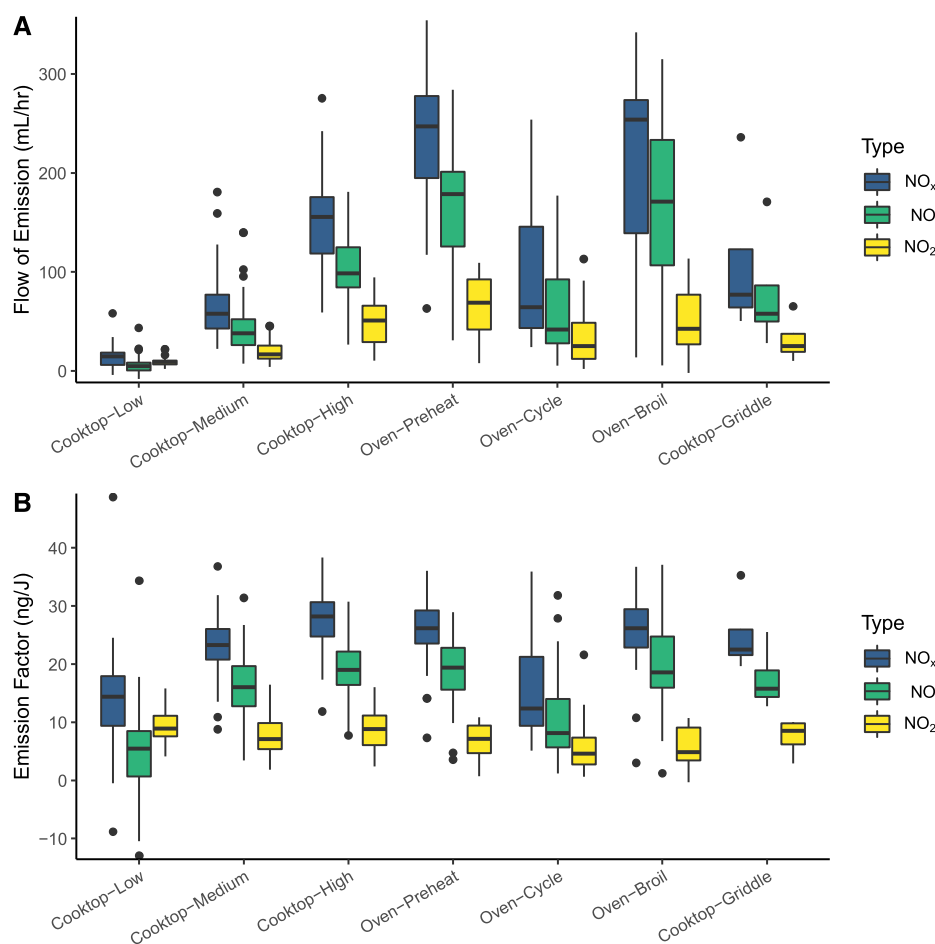


Figure 4. NO_x, NO, and NO₂ total emissions and normalized by energy output. NO_x emissions are shown in total emissions for various burner sizes and intensities and by constituents: NO and NO₂. We separate emissions into various phases of stove operation: cooktop emissions while burners are on low, medium, and high; oven emissions during preheat, cycling (maintaining temperature), and from the oven's broil burner; and emissions from those cooktops that had a griddle element. (A) Emissions are reported as a flow, in mL h⁻¹. These emissions were directly measured using our chamber-based approach, with concentrations measured on the real-time analyzer. (B) The emissions are normalized for the energy output of the burner, reported in Joules (J), and calculated from the total CO₂ emissions we simultaneously measured from each burner. The molecular weight of NO_x was assumed to be 46 g mol⁻¹, as is convention. For direct comparison, emission factors of NO also used 46 g mol⁻¹ as the molecular weight.

analyzed these samples in our overall on/off pulse estimate because ignition with the match or lighter simulated “typical operation” for these burners according to the homeowners.

Oven Emissions. We measured the baking (main) burner for 40 ovens and found that during the preheat phase (from room temperature to the setpoint between 350 and 425 °F), ovens emitted on average 117 [95% CI: 74, 178] mg CH₄ over a period of about 13 min, with an average rate of 663 [408, 1030] mg CH₄ h⁻¹. Once the ovens reached preheat temperature, they “cycled”, where the burner periodically ignited and extinguished to maintain the setpoint temperature. During this period, it emitted on average 759 [435, 1310] mg CH₄ h⁻¹. In comparison, the broiler burner only emitted 112 [50, 186] mg CH₄ h⁻¹ while on. Unlike the bake burner, broil burners usually stayed lit and cycled on and off less often.

We also measured NO_x emissions from ovens and calculated them to be 25 ng NO_x J⁻¹. Volumetrically, this is equal to 232 mL NO_x h⁻¹ (broken down into 163 mL NO h⁻¹ and 69 mL NO₂ h⁻¹) during the preheat phase for the bake burner set to 350–425 °F, 92 mL NO_x h⁻¹ (58 mL NO h⁻¹ and 34 mL NO₂ h⁻¹) for the bake burner when it was in cycling mode, and 215

mL NO_x h⁻¹ (162 mL NO h⁻¹ and 53 mL NO₂ h⁻¹) for the broil burners. We found that ovens could produce enough NO₂ to exceed the 1-h ambient standard (100 ppb) within a few minutes (Figure S11). We also found that NO₂ and NO_x emissions were correlated with the size of the burner for both cooktops and ovens (Figure 3).

Cumulative Methane Emissions. For our methane emission measurements, we scaled our measurements to calculate the total amount of methane emitted from stoves overall, employing the usage patterns reported by Chan et al. and Zhao et al.^{18,28} (see the Materials and Methods section). We estimated that an average stove (burners plus oven) emitted 649 [95% CI: 427, 949] g CH₄ year⁻¹ (Figure S5). When scaled to total U.S. emissions, and taking into account uncertainty in the estimate of the number of appliances reported in RECS, we estimated total national methane emissions from stoves were 28.1 [18.5, 41.2] Gg CH₄ year⁻¹. Using a 20 year timescale for the lifetime of methane, these methane emissions were comparable in climate impact to the carbon dioxide emissions of approximately 500 000 gas-powered cars.³¹

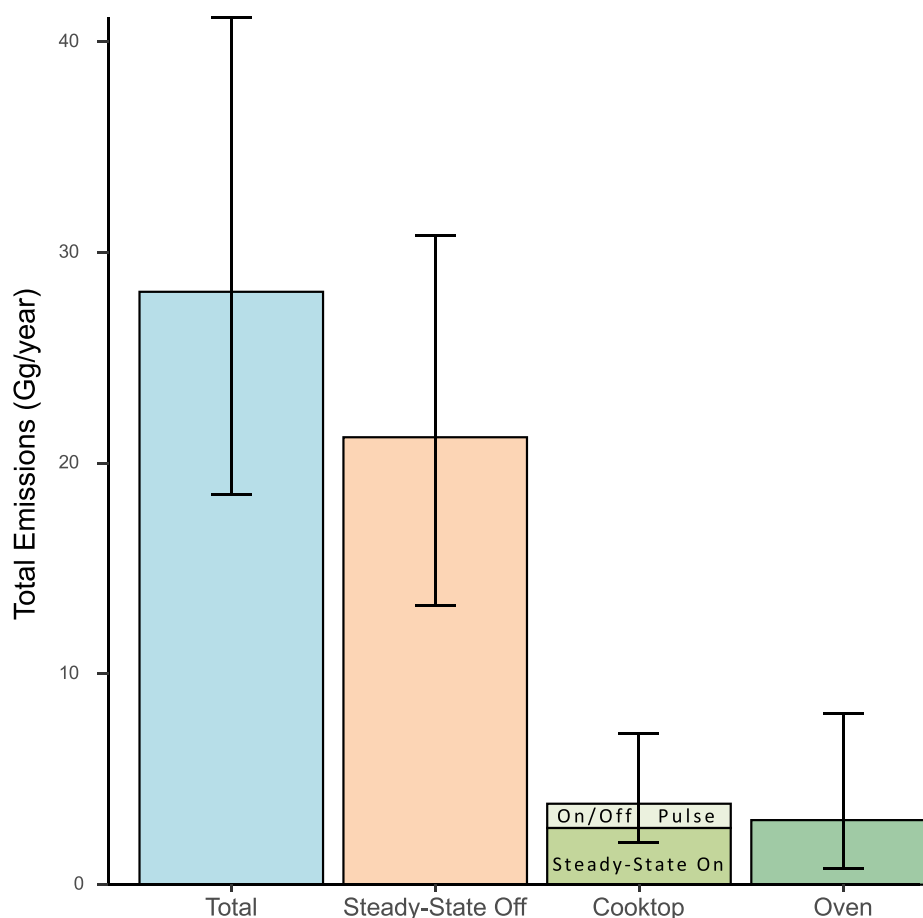


Figure 5. Total methane emissions by source. We report our scaled U.S. national estimates of methane emissions from stoves categorized into the various phases of emission sources: steady-state-off, cooktop emissions (broken down into steady-state-on and on/off pulses), and oven emissions. Bar height and error bars (95% confidence intervals) show the total methane emissions expected from each category. We found that 76% of the total methane emissions from stoves originated during steady-state-off.

Similar to our previous measurements in homes and to the results of other researchers,^{7,8,27} our results were long-tail skewed. Considering our expanded dataset, a plot of the cumulative count of measurements vs fraction of emissions showed that the top 10% of all observations in the expanded dataset were responsible for emitting 47% of total emissions (Figure S6). These data approached the “5/50 rule” where the top 5% of emitters typically emit 50% of all emissions.³²

We also calculated the total emissions based on whether the stove was on or off. Including both emission and usage data, we estimated that total emissions were 21.2 [13.3, 30.8] Gg CH₄ year⁻¹ during steady-state-off (i.e., emissions over most of the day); 2.7 [1.3, 5.3] Gg CH₄ year⁻¹ during steady-state-on from cooktops alone; and 1.1 [0.7, 1.9] Gg CH₄ year⁻¹ from the on/off pulses. For ovens alone, we only used emission data from the bake burner because we lacked comprehensive broil burner usage information but suspect it is small (~10%) based on user-reported datasets. Overall, we estimated that ovens emitted 3.1 [0.8, 8.1] Gg CH₄ year⁻¹ while on (Figure 5).

Volumetric Percentage Emissions. We used two methods to estimate the total percent methane emitted, the first using the report of gas used from the 2015 RECS survey and the second based on our CO₂ measurements combined with usage data (see the Materials and Methods section). From the first method, the volumetric fraction of our methane

emissions using the RECS data was 1.3% of gas consumed, assuming that the volume of natural gas was measured at standard pressure and 60 °F. In the second method, we estimated that the total volumetric fraction emitted was lower—0.8%—because the appliances we measured used more gas than the national average from RECS. This approach assumes that our usage data and selection of low/medium/high burner intensities approximated usage in all regions. For example, stove usage does not seem to vary regionally in the United States in the same way that furnace usage varies attributable to local climate (Figure S7).⁹

Comparison to National Inventories. In 2019, the United States emitted an estimated 158 million tons of carbon dioxide equivalent (MMT CO₂e) of methane from natural gas systems. Because the EPA used a 100 year global warming potential of 25 for methane, this is equivalent to 6.3 Tg CH₄ year⁻¹.⁶ The USEPA included specific emission sources such as residential and commercial meters and leaks from mains and services and also included a category for “stationary combustion” from various sectors (assumed to be incomplete combustion) but did not take into account leaks from appliances. While the USEPA did not report emissions from specific residential natural gas appliances, they reported methane emissions for residential stationary combustion from natural gas: 24 Gg CH₄ year⁻¹. From stoves alone, we

estimated total methane emissions to be about 28 Gg CH₄ year⁻¹, more than the emissions currently reported by the USEPA from stationary combustion from all appliances, suggesting that the USEPA substantially underestimated emissions from residential natural gas combustion. Our previous work estimated that water heaters alone emitted 82 Gg CH₄ year⁻¹ from leaks and incomplete combustion, further suggesting that the USEPA is underestimating emissions from stationary combustion.²⁷

We combined the total methane and carbon dioxide emissions from stoves and calculated that methane emissions add an extra one-third of CO₂e emissions to combustion-based CO₂ emissions from stove natural gas use. Using the estimate of natural gas consumption from RECS (113 billion cubic feet per year),⁹ we estimated that CO₂ emissions from gas stoves are 6.2 MMTCO₂ year⁻¹ as a direct result of combusting the natural gas they use. Over a 20-year timescale, the global warming potential of methane is 86 times greater than carbon dioxide.³ Using this scaling factor, we calculated the impact of methane over 20 years added an additional 2.4 MMTCO₂e from methane emissions, or 39% of the 6.2 MMTCO₂ year⁻¹. Reducing these short-term climate impacts due to methane emissions is important for achieving climate goals in the coming decades.

Comparison to Previous Methane Studies. We compared our methane results to past studies that measured residential methane emissions. Merrin and Francisco estimated that national U.S. methane emissions from cooktop use—including both steady-state-on and on/off pulses for burners (but without steady-state-off emissions from stoves)—were 2.7 Gg CH₄ year⁻¹.⁷ We estimated similar emissions nationally from the same sources, 3.8 Gg CH₄ year⁻¹ for burners (2.7 Gg CH₄ year⁻¹ for steady-state-on emissions and 1.1 Gg CH₄ year⁻¹ from on/off pulses). However, unlike Merrin and Francisco,⁷ we also measured steady-state-off emissions from stoves nationally and estimated their emissions to be 21.2 Gg CH₄ year⁻¹, far larger than estimates for burners during combustion and on/off pulses.

Another study, Fischer et al., estimated that emissions from cooking appliances during steady-state-on from California alone totaled 1.6 Gg CH₄ year⁻¹.⁸ In our work, we scaled our emissions to the number of stoves in California using the 2019 RASS data³³ and found that total methane emissions from stoves in California were 4.8 [95% CI: 3.1, 7.0] Gg CH₄ year⁻¹, of which 1.2 Gg CH₄ year⁻¹ comes from steady-state-on, on/off pulses, and ovens. Additionally, Fischer et al.⁸ measured steady-state-off measurements in their “whole-home quiescent” leakage rates, which accounts for steady-state-off emissions from all appliances as well as interior pipeline leaks. They estimated this source to be 23.4 Gg CH₄ year⁻¹ for California. We calculated steady-state-off emissions from stoves alone in California to be 3.6 Gg CH₄ year⁻¹. Applying previous work by our lab to the numbers of appliances in California, we estimated that water heaters emit an additional 12.9 Gg CH₄ year⁻¹ during steady-state-off alone.²⁷ Together with the estimate of quiescent emissions from Fischer et al.,⁸ our work provides strong evidence that steady-state-off emissions provide the largest source of natural gas leakage in homes.

Comparison to Previous NO_x Studies. Relatively little recent research has measured total NO_x flow rates from stoves, with the exception of Singer et al.,¹⁷ who estimated NO_x emissions to be ~40 ng NO_x J⁻¹ (ranged between 30 and 45 ng NO_x J⁻¹). Traynor et al. estimated that NO_x emissions from

stoves had a geometric mean of 32 ng NO_x J⁻¹,³⁴ and Singer et al. estimated NO_x emissions to be 30–36 ng NO_x J⁻¹.³⁵ Overall, these values are slightly higher than our estimate from cooktops: 21.7 [20.5, 22.9] ng J⁻¹. Previous modeling-based approaches suggest that residents are exposed to NO₂ levels above outdoor acute (1 h) exposure guidelines 62% of the time while using their stove but not using their range hoods,³⁶ and people use their range hoods only 28–36% of the time.¹⁵

Relationship between Emissions with Stove Age, Price, and Median Income. We also tested potential relationships among emissions and age, purchase price, and average income levels of where the stoves were located. For the stoves in our dataset with a known manufacturing date, we found no evidence of a relationship between either the age of the stove or purchase price of the stove with methane emissions nor with NO_x emissions normalized by burner energy (Figures S8 and S9; *p* values all >0.5). Finally, median income from census tracts where the stove was located had no relationship with methane emissions (Figure S10, *p* = 0.79).

STUDY LIMITATIONS AND RECOMMENDATIONS FOR FUTURE DIRECTIONS

To improve future home-appliance emissions research, we provide the following recommendations, building on suggestions from previous researchers:^{7,8,37}

1. A rapid technique such as a portable methane detector could be used to locate the largest emitters qualitatively during steady-state-off conditions. In this study, we estimated that emissions from steady-state-off were responsible for 76% of all methane emissions from gas stoves.
2. Because of sampling limitations from COVID-19, we were limited in where and how we could sample homes and could not include a representative selection of low-income, multifamily homes; future work should emphasize measurements within this demographic.
3. More comprehensive data on appliance usage and activity should be collected. Such information would help researchers scale the number of on/off pulses per day and average consumption periods. Having better information about the number of burners that are on simultaneously and their emissions during real-world use would also help inform estimates for indoor NO_x pollution and indoor air quality modeling projects.
4. Additional measurements of direct emission rates of other pollutants from stoves should be collected, such as CO and formaldehyde, as such data are currently lacking. Additionally, we recommend measuring NO_x emission rates from other gas appliances and from electric appliances for comparison (i.e., as a control for comparison). Our data and additional data collection on emission factors could be used for indoor air quality modeling to calculate concentrations of NO_x that home occupants are exposed to under various cooking and ventilation scenarios.

ASSOCIATED CONTENT

Supporting Information

The Supporting Information is available free of charge at <https://pubs.acs.org/doi/10.1021/acs.est.1c04707>.

Details of calculations; photo of the setup; room volume estimates; volunteer information; methane emissions per

stove; correlation plots; methane cumulative emissions from stoves; gas usage per household; NO_x concentrations from the use of an oven (PDF)

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Notes

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Pollutant concentrations and emission rates from natural gas cooking burners without and with range hood exhaust in nine California homes



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ABSTRACT

Combustion pollutant concentrations were measured during the scripted operation of natural gas cooking burners in nine homes. Boiling and simmering activities were conducted on the stovetop and in the oven with and without range hood exhaust ventilation or air mixing via a forced air system. Time-resolved concentrations of carbon dioxide (CO₂), nitric oxide (NO), nitrogen oxides (NO_x), nitrogen dioxide (NO₂), particles with diameters of 6 nm or larger (PN), carbon monoxide (CO), and fine particulate matter (PM_{2.5}) were measured in the kitchen and bedroom area of each home. Four of the nine homes had kitchen 1 h NO₂ exceed the national ambient air quality standard (100 ppb). In all homes, the highest 1 h integrated PN exceeded $2 \times 10^5 \text{ cm}^{-3}\text{-h}$, and the highest 4 h PN exceeded $3 \times 10^5 \text{ cm}^{-3}\text{-hr}$ in the kitchen. Range hood performance varied widely, but one with a large capture volume and a measured flow of 108 L/s reduced concentrations 80–95%. Increased awareness of the need to ventilate when cooking, along with building standards for minimum range hood flow rates and volume, could substantially reduce exposures to NO₂ and ultrafine particles in homes.

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1. Introduction

The combustion products of natural gas cooking burners (NGCBs) include pollutants that can degrade indoor air quality. While complete combustion directly produces water vapor and carbon dioxide (CO₂), the high flame temperatures also produce nitrogen oxides (NO_x) including nitrogen dioxide (NO₂), a respiratory irritant. Incomplete combustion can produce non-negligible emissions of other air pollutants including carbon monoxide (CO), formaldehyde (CH₂O), and nanometer-sized particles (PN) [25]. Residential NGCBs emit nanoparticles that grow to tens of nm but mostly remain within the <100 nm diameter threshold that defines ultrafine particles (UFP) [20,39].

The U.S. EPA sets national ambient air quality standards to protect both the general population and sensitive sub-populations [35,36]. The EPA limits for CO are 35 ppm averaged over 1 h and 9 ppm averaged over 8 h. The short-term exposure standard for NO₂ is 100 ppb over 1 h. There is a short term standard for fine particulate matter, PM_{2.5}, of 35 $\mu\text{g m}^{-3}$ averaged over 24 h;

however, the particles emitted from NGCBs don't have sufficient mass to approach this threshold. Currently there are no widely recognized standards or guidelines for UFP exposure. An expert elicitation review of the available literature rated the likelihood of increased short-term UFP exposure causing health effects as medium to high [12]. Another review noted the substantial experimental evidence and plausible mechanisms for respiratory and cardiovascular effects of UFP intake, but deemed the evidence as "not sufficiently strong to conclude that short-term exposures to UFPs have effects that are dramatically different from those of larger particles" [11].

Emission factors of CO and NO₂ from NGCBs have been measured in laboratory and field studies [16,25,26,34]. Several studies have reported emission factors and/or indoor concentrations of ultrafine particles resulting from NGCB use without food preparation [2,20,25,39]. Many studies have reported elevated concentrations of CO and NO₂ in homes with natural gas cooking burners, compared to homes with electric cooking [8,18,23,24,29,30,41,42]. A recent study of 350 California homes reported that NO₂ and NO concentrations increased with increasing self-reported use of NGCBs across homes [18]. A modeling study of

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multifamily housing in Boston found that cooking with gas burners is a major source of NO₂ in homes [4].

While several measurement-based studies have reported time-resolved CO, (e.g. [18]), only a few have reported time-resolved or peak NO₂ concentrations resulting from NGCB use [5,7,17,19,22]. A recent simulation study found that the weekly highest 1 h mean NO₂ concentrations exceed 100 ppb in the majority of a representative sample of Southern California homes in which NGCBs were used without kitchen exhaust ventilation [13].

The primary strategy for mitigating exposure to pollutants from cooking burners is to use a venting range hood or other kitchen exhaust ventilation [33]. Recent assessments of range hoods in the U.S. indicate wide performance variations across devices and also across airflow settings and burner configurations for many devices tested [3,15,21,28]. Several of these studies used capture efficiency, CE, as the performance metric. CE indicates the fraction of pollutants generated at the cooking appliance that are removed or exhausted by the range hood before they can mix into the air of the home. These studies found that for many range hoods, CE is much higher for the back than for the front cooktop burners. The [13] modeling study of Southern California homes found that routine use of a venting kitchen range hood with a 52% CE (reflecting performance of a common hood for front burner cooking) should dramatically reduce the percentage of homes with 1 h mean NO₂ exceeding 100 ppb.

NGCB pollutants that are not exhausted directly by a range hood are removed from the air in the home by air exchange with outdoors and for NO₂ and PN by deposition to interior surfaces. Deposition rates for NO₂ in US homes can be estimated from data reported in several studies. A comparison of decay rates for NO₂ and the conserved tracer SF₆ following gas burner use in 5 homes yielded an estimated deposition rate of 0.8/h [31]. Comparing decay rates of NO₂ to those for NO, CO, and CO₂ – which are not removed by deposition – obtained in 21 homes using unvented gas fireplaces [6,9] yielded a mean deposition rate estimate of 0.7/h. Particle deposition rates vary with particle size and environmental conditions. Measurements in homes provide estimated deposition rates for 15–50 nm particles that range from 0.2/h to 3/h [1,10,14].

The primary objective of the research reported here was to quantify time-resolved concentrations of NO₂ resulting when NGCBs are used under realistic conditions, and specifically to investigate if the threshold of 100 ppb over 1 h is commonly exceeded. We also sought to measure concentrations of NO, NO_x, CO₂, CO, PM_{2.5}, and the number of particles with diameters ≥ 6 nm (PN, most of which are UFP) following controlled burner use. Another objective was to conduct a pilot study of the benefits of using venting range hoods to reduce in-home concentrations of pollutants emitted by NGCBs.

2. Methods

2.1. Overview

The study entailed operation of NGCBs and measurements of the resulting pollutant concentrations in nine homes in the San Francisco Bay area of California. Experiments were conducted, by permission, when residents were away from the home. Researchers controlled the operation of cooking appliances, ventilation, and forced-air heating systems. The NGCB operation sequences were designed to represent common cooking patterns. To avoid generating pollutants from food preparation, pots containing tap water were used as heat sinks. Air pollutants including NO_x, NO, number concentrations of particles ≥ 6 nm (PN), CO, CO₂, and estimated PM_{2.5} were measured in the kitchen and a hallway or bedroom that was far from the kitchen. CO₂ was also measured in a common

room between the other two locations but generally closer to the kitchen. NO₂ was inferred as the difference between NO_x and NO, even though that value likely includes non-negligible amounts of nitrous acid (HONO) [32].

The base set of experiments included operation of each type of cooking burner (cooktop, oven bottom burner, and broiler top burner, as available) with windows closed, no forced air unit (FAU) operation, and no mechanical exhaust. Additional experiments were conducted with the FAU operated in fan-only mode when this setting was available, and with a venting range hood when available.

2.2. Study homes

The nine homes varied in size and layout, as described in Table 1. They included seven detached houses, one flat (first floor of two-flat duplex), and a small apartment. There were three homes with open floor plans and no walls enclosing the kitchen. Four of the homes had kitchens that were distinct rooms, connected to other rooms in the home via standard interior doorways. Two homes had semi-open kitchens. One of these (labeled H6) had a small galley kitchen with both a floor-to-ceiling passage and a large pass-through connecting the kitchen to the adjacent dining room. The other (H9) had two wide, open passages between the kitchen and adjacent rooms.

Cooking appliances varied across homes. Table 2 summarizes the natural gas cooking appliances in each study home. The burner firing rates were obtained from the nameplate tag found on the appliance or by searching online product literature for the make and model. Five homes had a gas range with cooktop, oven bottom burner and broiler top burner; two homes had a gas range with only a cooktop and oven burner; and two homes had a gas countertop cooktop separate from an electric oven. A venting range hood was present in six homes. Six homes had FAUs that could be operated in fan-only mode.

Study home access was arranged with owners or renters who were paid \$200 for each day and \$200 for each overnight period that a home was unoccupied and made available for experiments, up to a total allowable payment per home of \$600. A single day of experiments required 11 h of access to the home without occupants.

Table 3 describes the kitchen exhaust fans in the study homes. Six of the homes had exhaust devices above the cooktop. Two of the venting hoods were “microwave over range” (MOR) appliances that combine the functions of a microwave and externally venting exhaust fan. Home H3 and H4 had no range hoods of any kind. H7 had a non-venting (recirculating) range hood that was operated during two experiments.

2.3. Burner operation and simulated cooking

A procedure was developed to simulate common usage scenarios for cooktop, oven, and broiler burners. The procedures, used in homes H2 to H9, are described in Table 4. The “Boil” and “Sauté” activities were done simultaneously in the “Cooktop” procedure. The procedures were not finalized until after experiments were completed in H1; H1 experiments featured variations of the procedures, as discussed in the Supplemental materials. The same clean pans and pots were used in all homes, but cooking appliances generally were operated as found. In a couple of cases the appliances were wiped with wet paper towels to remove large debris.

Upon arriving to each home, we reviewed the planned experimental procedures with the host (homeowner or renter) and obtained her/his signature for the agreed usage periods. With the host, we conducted a walk-through to identify potential hazards

Table 1
Study home and burner descriptions.

ID	Floor area (m ²)	Levels	BR/Ba	Year built	Kitchen design	Flooring ^a	Gas burners ^b	Venting range hood?	FAU fan only mode?
H1	134	1	2/2	1910	Closed	Hard	CT/O/B	Y	Y
H2	124	1	4/2	1963	Open	Hard	CT/O/B	Y	Y
H3	117	1.5 ^c	2/2	1904	Closed	Hard	CT/O	N	N
H4	26	1	1/1	<1990 ^d	Closed	Hard	CT/O	N	No FAU
H5	108	1	3/1	1925	Closed	Hard	CT/O/B	Y	No
H6	119	2	2/2.5	1991	Semi-open	Hard L1, carpet on stairs & L2	CT/O/B	Y	Y
H7	226	2	5/3	1990	Open	Hard L1, carpet on stairs & L2	CT	N	Y
H8	219	2	4/3	1990	Open	Hard L1, carpet on stairs & L2	CT	Y	Y
H9	139	2	3/2.5	1986 ^e	Semi-open	Hard K, other rooms carpeted	CT/O/B	Y	Y

^a L1 = level 1 or first story; L2 = level 2 or second story; K = kitchen.

^b CT = cooktop; O = oven; B = broiler (top of oven compartment).

^c Small room below kitchen connected via stairwell at back of kitchen (house on hill).

^d Building was renovated and expanded in 1990. Original year of construction was not determined.

^e Home was retrofitted for energy efficiency with extensive air sealing, insulation and windows; it thus has characteristics of a new, energy efficient home.

Table 2
Natural gas cooking appliances in study homes.

ID	Cooktop type	Cooktop burner type	Burner firing rate (kbtu/h)					
			Left front (LF)	Right front (RF)	Left rear (LR)	Right rear (RR)	Oven	Broiler
H1	Range	Sealed	9.5	16.2	14.2	5	18	15.5
H2	Range	Sealed	9.5	17	14	5	18	15.5
H3	Range	Open	9	9	9	9	18	None
H4	Range	Open	9	9	9	9	18	None
H5	Range	Sealed	12	12	9.2	9.2	18	15
H6	Range	Sealed	9.5	9.5	9.5	9.5	16	13.5
H7	Counter	Sealed	12–14 ^a	14–16 ^a	5 ^a	5 ^a	Elec.	Elec.
H8	Counter	Sealed	9.5	14.2	11	5	Elec.	Elec.
H9	Range	Sealed	9.5	12	9.5	5	16	12

^a Estimated. Cooktop specifications were not obtained for this home.

Table 3
Range hoods in study homes.

ID	Type	Make/model	Airflow from product literature (L/s)		Sound level from product literature (Sones)	
			Low speed	High speed	Low speed	High speed
H1	Vented range hood	Vent-A-Hood B200 MSC	Not listed	531	Not listed	6.5
H2	Microwave with exhaust fan	Electrolux FGMV174KFB	85	142	Not listed	Not listed
H5	Vented range hood	Zephyr Cyclone AK6500	142	142	1.5	5
H6	Microwave with exhaust fan	GE Space-maker JVM140	Not listed	230	Not listed	5.5
H7	Non-venting range hood	Broan QS3	Not listed	109	0.3–0.5 ^b	4.5–5.5 ^b
H8 ^a	Vented range hood	Kenmore 233.516891	50	76	Not listed	6
H9 ^a	Vented range hood	Broan 42000E	50	76	Not listed	6

^a The hoods in H8 and H9 are the same product, sold under different nameplates.

^b Varies with vent geometry.

Table 4
Burner operating procedures used for most experiments in homes H2 to H9.

Burner	Simulated Activity	Description
Cooktop	Boil (Simultaneous with Sauttee)	Add 4L cold tap water to 5L stainless steel pot with 23 cm diameter base. Place uncovered on largest cooktop burner. At start, set burner to high. When water reaches rolling boil, cover and turn down burner to just below boiling. Maintain this condition to complete 30 min total burn.
	Sauttee (Simultaneous with Boil)	Place stainless steel fry pan with 30.5 cm diameter base on second largest burner. At start, set burner to high. At 2 min from start, slowly add 1L cold tap water. At 6 min from start, turn burner to medium setting. Adjust burner down as needed to avoid boiling. Stop burner at 30 min total burn.
Oven	Roast	Remove top oven rack and place bottom rack to allow 5L stainless steel pot to fit into oven. At start, set oven temperature to 218 °C (425 °F). When oven reaches set point (or after 20 min if set point not yet reached), place uncovered pot containing 1L water on bottom oven rack. Maintain this condition for 30 min; then turn oven off and remove pot. (Note: total burn time varies with time to reach set point temperature.)
Broiler	Broil	Remove top oven rack and place bottom rack to hold 5L stainless steel pot 13 cm below broiler burner at top of oven. At start, set oven to “broil” with oven door ajar. After 20 min, place 5L pot containing 1L water into oven. With door ajar, maintain this condition for 15 min; then turn burner off, remove pot, and close door.

and confirm acceptability of the planned placement of monitoring equipment (for electrical capacity). The host then left the home to return at the agreed time.

Study homes were used for varying duration as summarized in [Supplemental Table S1](#). When experiments were conducted during consecutive days with the host residing during the intervening night, all instruments were shut down at the end of the first day then restarted when the host left the home the following morning. When the home was accessible for a night-day sequence, monitoring instruments operated continuously overnight.

The protocol prior to starting cooking experiments included set-up and airflow checks of air quality instruments, recording information about the home and appliances, and measurements to characterize range hood performance (if it vented to outdoors). Experiments were conducted with all windows closed and interior doors open with two exceptions. It was discovered mid-way through experiments at H4 that there was a bathroom window open about 15 cm; the window was left in this position for all experiments in H4. In H8 there was a large opening in the master bathroom ceiling, related to a home construction project; this was addressed by keeping the door to the master bath closed throughout experiments in H8.

Each experiment included the following elements. (1) Air movement and mixing in the home was driven either by extant temperature and pressure variations or by operation of the forced air unit (FAU). (2) If present, the venting range hood was either operated or not. (3) The simulated cooking procedure was followed. (4) Following the end of the cooking procedure, and range hood use if it was part of the experiment, ventilation and mixing in the home were held in the same condition for 60–90 min or more, to enable analysis of mixing and decay. When the FAU was used, in most cases it was started approximately 10 min prior to the cooking activity, and operated until the mixing condition was established for the next experiment. For experiments involving range hood use, the hood was started approximately 1 min prior to the start of cooking, and remained in operation until 5 min after the cooking procedure ended. Range hoods were most commonly operated on the highest setting, though lower settings were used in several experiments. Excluding one experiment in H1 in which the range hood was started 15 min after the end of a cooking procedure, mixing and decay periods varied from a minimum of 54 min to a maximum of overnight.

2.4. Air quality measurements

Instruments continuously monitored the concentrations of carbon dioxide (CO₂), carbon monoxide (CO), nitric oxide (NO), nitrogen oxides (NO_x), total number concentration of particles greater than 6 nm (PN), number concentrations of particles in 6 size bins from 0.3 μm to 10 μm, and the estimated mass of PM_{2.5} via forward light scattering. Temperature and relative humidity were also monitored. The instruments used to measure each of these parameters are noted in [Supplemental Table S2](#) with performance specifications provided in [Table S3](#). Photos of the instrument carts deployed in a kitchen and a bedroom are provided as [Figs. S1 and S2](#). The values reported for NO₂ are based on the difference between measured NO_x and NO, and likely include HONO [\[32\]](#); for simplicity, we refer to the NO₂ value reported by the instrument as NO₂ throughout this report.

Air quality monitoring occurred in two primary locations and one secondary location in each home. The primary locations were the kitchen and a bedroom or hallway location far from the kitchen. The bedroom area location (henceforth described simply as bedroom) was used to determine an approximate lower bound of combustion pollutant concentrations and potential exposures. The kitchen and bedroom locations had nearly identical collections of

instruments, mounted on mobile carts. The kitchen cart was situated to ensure that the air inlet was no closer than 2 m from the closest cooktop burner in all homes other than the small apartment H4, in which this distance was slightly less than 2 m. The devices on the cart sampled air at heights of roughly 1.4–1.65 m. The third monitoring package was installed on a table in a common room (living room, dining room, great room) closer to the kitchen, or connected to the kitchen in an open floor plan. Air quality data were recorded at 1 min or more frequent intervals.

Particle instruments for the kitchen and bedroom carts were operated side-by-side in a lab test chamber to confirm consistency prior to deployment. CO₂ instruments were calibrated after the field study and calibration factors were applied to the raw data. CO instruments were used as received new from the manufacturer, without an independent calibration. The NO_x and NO₂ analyzers were single-point calibrated at the start of the field study, then checked for zero and span calibration in the laboratory prior to most home deployments. Despite this, it was observed that in most homes, the NO and NO₂ (NO_x–NO) concentrations were offset between instruments at times when the home was thought to be well mixed. The observed differences between the two NO_x analyzers were used to determine an offset adjustment. Because the NO concentrations reported by the bedroom instrument were consistently in line with data obtained from nearby regulatory monitoring sites, at times when the homes were not impacted by indoor NO_x emissions, the offset was typically applied to the NO_x analyzer on the kitchen cart.

2.5. Range hood performance characterization

Measurements were made to quantify airflow and sound characteristics of all the venting range hoods in the study. The capture efficiency (CE) of cooking burner combustion products was measured for five of the six venting hoods. CE could not be determined for the hood in H1 because the range hood vent was inaccessible to make the required exhaust CO₂ measurements.

Exhaust air flow from each range hood was measured using a balanced-pressure flow hood method described by Ref. [\[38\]](#). A calibrated and pressure-controlled variable-speed fan (Minneapolis Duct Blaster, Energy Conservatory¹) was connected to either the exhaust inlet (preferred approach) or outlet. The Duct Blaster was connected at each site using a custom transition constructed with cardboard and tape. Using a pressure sensor, the Duct Blaster fan was controlled to match the flow of the exhaust fan while maintaining neutral pressure to the room at the exhaust inlet. The pre-calibrated speed versus flow relationship of the Duct Blaster provided the flow through the exhaust fan.

Sound levels were measured using the AudioTools app (version 8.9.X) from Studio Six Digital² on an iPhone6. We used the “Real Time Analyzer” tool, a 1/3-octave band analyzer, which provides sound pressure (in decibels, dB) as a function of frequency. The sound pressure distribution was measured for background conditions (hood off) and for each available range hood speed when the house was in quiescent condition, i.e. with no air quality monitoring devices operating. We report the A-weighted total sound pressure (dBA) reported by the app as a summary statistic. Additionally, we applied the procedure that is used to determine the sound level reported by the Home Ventilation Institute (HVI) in their Certified Home Ventilating Products Directory; the calculation procedure is described in HVI Publication 915, available on the HVI web site.³

¹ www.energyconservatory.com.

² www.studiosixdigital.com.

³ www.hvi.org.

Capture efficiency (CE) refers to the fraction of pollutants emitted from the cooking burner (and cooking, when applicable) that are removed by the venting range hood before mixing into the air of the kitchen. CE can be estimated by calculating both the mass flow of CO₂ exiting through the range hood, and the mass generation rate based on fuel composition and the assumption of complete combustion [28]. In this study, we used a simpler approach that compares the flow of CO₂ through the hood under the normal operating condition to the flow of CO₂ when a foil curtain is used to extend the hood over the cooktop to ensure perfect or nearly perfect capture. This approach assumes no change in airflow between the conditions, meaning the CO₂ mass flow changes proportionally with the CO₂ concentration. CE is calculated using CO₂ concentrations measured under the normal operating condition (C_N) and with the hood extended to create nearly perfect capture conditions (C₁₀₀), and background concentrations with the cooking burners off (C₀), as shown in Equation (1).

$$CE = (C_N - C_0) / (C_{100} - C_0) \quad (1)$$

CO₂ concentrations in the exhaust from the range hood were measured using a PPSystems EGM-4 analyzer drawing from the ducting above the range hood. An example of the setup for this procedure, from H8, is shown in Supplemental Fig. S3.

2.6. Attributing concentration profiles to individual cooking events

The primary objective of this study was to quantify the impact of using NGCBs on pollutant concentrations. However, in order to complete as many experiments as possible in the limited time available in each house, the interval between experiments was not long enough to allow concentrations to return to background levels before the next experiment. Therefore the analysis included a *disentanglement* procedure, in which the data for each analyte were decomposed into estimated concentration profiles for each cooking event.

Disentangling the data for a particular cooking event involved four steps: (1) fitting a first-order decay model to the experimental data during each interval between NGCB operation; (2) using this model to predict how the previous cooking event would have evolved, had the current event not taken place; (3) using the same model to predict how the current cooking event would have evolved, had the next event not taken place; and (4) finding the difference between the two, in order to estimate what the current event would have looked like in the absence of other events.

Fig. 1 shows an example. The measured data is shown in solid blue. Here we wished to find the concentration profile for the second of the three cooking events shown (hood and FAU on). We projected the profile (dashed purple line) from the preceding cooking event (hood and FAU off), past the start of the event being analyzed. Similarly, we projected the profile (dashed orange line) of the second event to remove the effects of the following experiment. The difference between the orange and purple projections gives the disentangled profile for second experiment with hood and FAU operating (solid green line).

In selecting intervals for fitting data, we considered the movement of pollutants across zones of the house, as indicated by the dynamics of the two measured locations. In general, we waited until the two series “came together” – ideally by reaching or approaching the same concentration, and alternately by starting to follow the same downward trend. For the distant location, the decay interval often extended past the start of the simulated cooking event.

The decay rate was estimated in a three-step process using a least-squares approach to fit the measured data to a pseudo-first

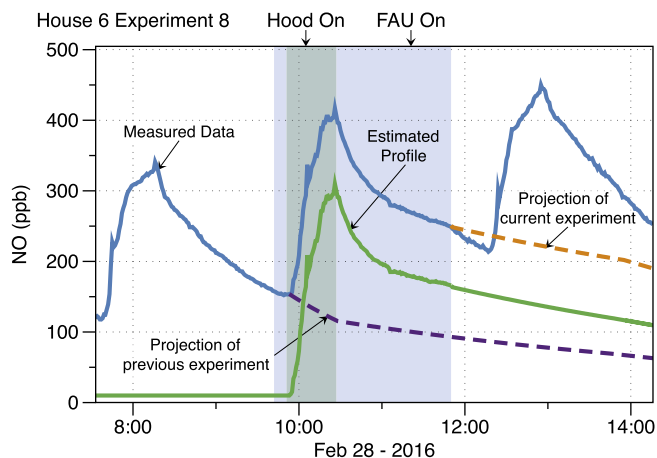


Fig. 1. Disentangling kitchen NO data.

order decay model. The first step was to fit the data to a model that had both the decay rate and the background concentration as variable parameters. The background represents the indoor concentration that would result from outdoor pollutant entry and indoor losses (including air exchange for all pollutants, and deposition for NO₂ and PN). In the second step we estimated a constant background concentration taking into account the estimated background parameters from all experiments that had the same mechanical airflow conditions (e.g. central mixing fan on or off) during the same day as well as any other pertinent concentration measurements (e.g. at the beginning or end of the day). In the third step, we again fit the decay rates to the data, but this time using the estimated constant background concentration. For the experiment shown in Fig. 1, the background was set at 10 ppb and the resulting fit gave a decay rate of 0.17 h⁻¹. The appendices to the project report [27] include plots of measured concentrations for all experiments and show the data intervals that were used to fit the decay rates.

This extrapolation and subtraction procedure was applied separately for CO₂, NO, NO₂, and PN, in the kitchen and bedroom, as data were available. The measurements and extended concentration profiles were analyzed to determine the highest 1 h average concentration of each pollutant at each location, and also to find the integrated concentration over 4 h.

2.7. Estimating emission factors from ambient concentrations

We used the highest 1 h concentrations to estimate fuel-normalized emission factors for NO₂, NO_x, and PN, using the method described previously [25]. Briefly, this approach calculates the emission rate of CO₂ from natural gas combustion, and uses the measured concentration ratios for each pollutant to CO₂ to calculate an emission factor. For NO_x and NO₂, the calculation proceeds according to Equation (2), where the first term on the right side is the ratio of NO or NO_x to CO₂, and the second term is a property of the fuel; we used 1.1 mol CO₂/MJ fuel based on Singer et al. (ibid). By convention, NO_x emissions are calculated using the molar mass of NO₂, 46 g/mol.

$$E_i \left[\frac{ng}{J} \right] = \left(\frac{\frac{mol\ i}{mol\ air}}{\frac{mol\ CO_2}{mol\ air}} \right) \left(\frac{mol\ CO_2}{MJ\ fuel} \right) \left(\frac{g\ i}{mol\ i} \right) \left(\frac{MJ}{10^6 J} \right) \left(\frac{10^9 ng}{g} \right) \quad (2)$$

Equation (3) was used to calculate PN emission factors.

$$E_i \left[\frac{\#}{J} \right] = \frac{\left(\frac{\#}{\text{cm}^3 \text{ air}} \right) \left(\frac{23600 \text{ cm}^3 \text{ air}}{\text{mol air}} \right)}{\left(\frac{\text{mol CO}_2}{\text{mol air}} \right)} \left(\frac{\text{mol CO}_2}{\text{MJ fuel}} \right) \left(\frac{\text{MJ}}{10^9 \text{ J}} \right) \quad (3)$$

3. Results

3.1. Base case measured pollutant concentrations

To elucidate some of the major themes seen in the data, sample results for base conditions with no mechanical ventilation are presented in Fig. 2 and Fig. 3. These plots present data for NO₂, NO, PN, and CO₂, in both the kitchen and bedroom area monitoring locations. Fig. 2 presents data from Day 1 in H3. As expected, kitchen CO₂, NO, NO₂ and PN increased quickly as burners fired at maximum settings: cooktop burners set to the highest flame, or oven or broiler burner firing continuously. Concentrations remained elevated throughout the simulated cooking events as the cooktop burners were adjusted to medium-low, oven burners cycled to maintain temperature, and broiler burners fired continuously. The kitchen traces show more short-term variability owing to their proximity to the source. After the burners were switched off at the end of each simulated cooking event, concentrations in the

kitchen started to decay as pollutants mixed throughout the house and were removed by ventilation and infiltration, and NO₂ and PN were removed by deposition. With each burner use, concentrations in the bedroom started to rise after a short delay, indicating the transport time from the kitchen to the distant location. Bedroom concentrations increased over a time interval that was similar in duration to burner use, but shifted later in time. For NO and CO₂, concentrations decayed slower in the bedroom than in the kitchen, presumably due to lower rates of outdoor air directly entering the bedroom, compared to the kitchen. For PN and NO₂, each of which deposit indoors at rates that are fast enough to compete with air exchange as a removal process, the kitchen and bedroom concentrations decayed at approximately the same rate in the two rooms.

Day 1 in H5 shows a somewhat different pattern (Fig. 3). In this house, the distant bedroom had less indoor air exchange with the kitchen. Following the start of an emission event without the FAU operating, the bedroom concentrations increased more slowly, and reached peak levels that were much lower than in the kitchen. Concentrations in the kitchen and bedroom converged for NO and almost converged for CO₂ only in the first and fourth experiments. Decay rates in the kitchen and bedroom were similar.

The absolute concentrations, relative dynamics and peak concentrations, and the effect of FAU operation on the relative dynamics of pollutants in the kitchen and bedroom varied widely across homes. In general, as the delay increased, so did the difference between the kitchen and bedroom area peak concentrations.

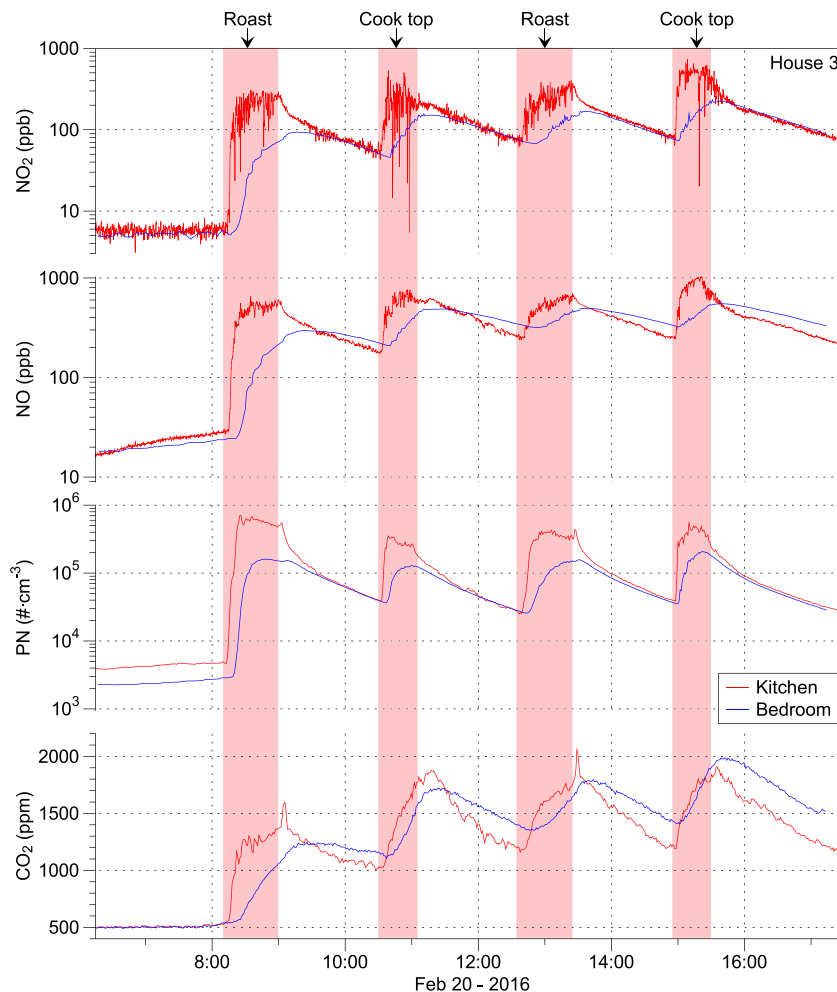


Fig. 2. Air pollutant concentrations on Day 1 in H3.

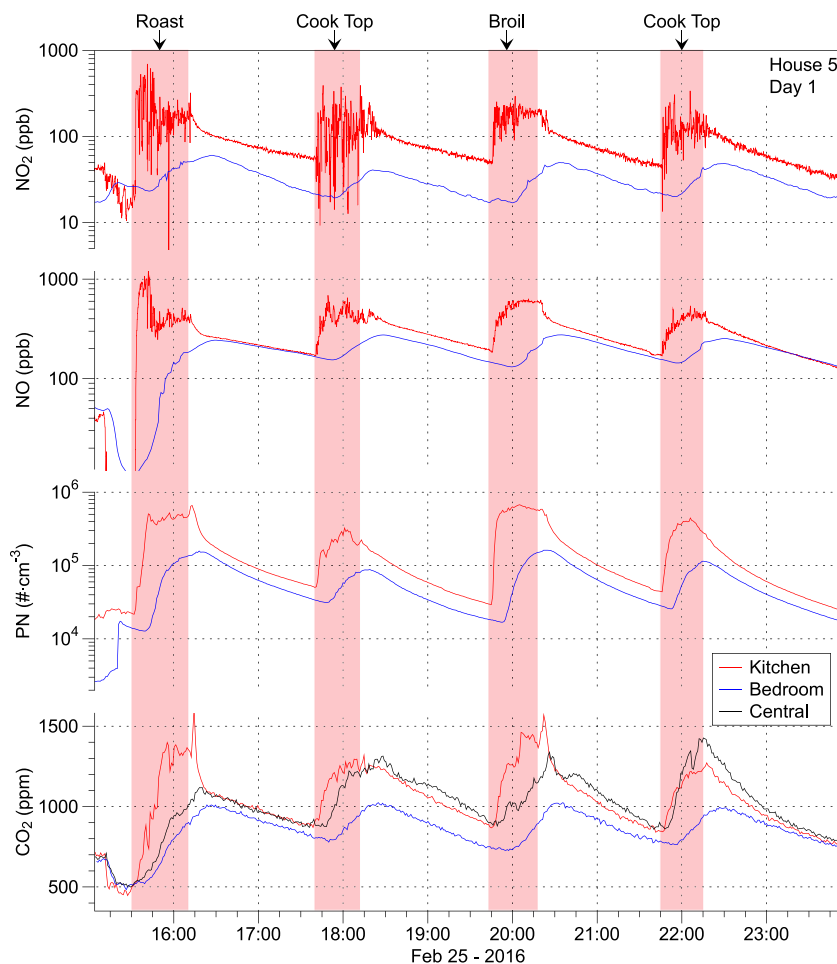


Fig. 3. Air pollutant concentrations on Day 1 in H5.

The closest coupling without FAU use occurred in H4, H7, and H8. The coupling in H4 is explained by it being a small, 2-room apartment. H7 and H8 are newer homes with open floor plans that resulted in closer connections between spaces. FAU operation substantially increased PN decays in H9, which had a high-performance (MERV13) filter installed in the FAU. In the single FAU experiment in H6 (on Day 2), NO₂ decays were much faster than they were in the experiments without the FAU operating; this suggests removal of NO₂ in the air handler.

3.2. Time-integrated pollutant concentrations under base conditions

Summary results for all experiments with base conditions of no mechanical mixing or exhaust (no FAU or range hood use) are provided in Figs. 4 and 5. These figures show the highest 1 h and 4 h time-integrated concentrations in the kitchen and bedroom locations following each simulated cooking event. The homes are grouped according to the opening between the kitchen and the rest of the home, and ordered by increasing home size. Data are presented for NO, NO₂, and PN.

Overall, concentrations of each pollutant varied widely both across and within homes. Concentrations of all analytes were higher in H4, the small apartment, than in other homes. As expected, bedrooms had substantially lower pollutant concentrations than kitchens, across all homes except for the two-room apartment, H4, and the open floor plan house, H8. For NO and NO₂, there was

no obvious trend across homes associated with the burner used in the simulated cooking event (cooktop, oven or broiler). For PN, there were several homes that had much higher concentrations when using the oven or broiler burner compared to the cooktop, but no homes in which the cooktop produced substantially higher PN than the oven or broiler. Unsurprisingly given its very small size, H4 had the highest concentrations of NO and NO₂. That H4 did not have higher PN concentrations than other homes suggests that the variance in PN emission rates had a larger impact than variations in home size. The data also indicate a trend of higher kitchen concentrations in homes with enclosed kitchens (H1, H3, H4, and H5) relative to homes with semi-open kitchens (H6 and H9) or open floor plans (H2, H8, H9). The trio with open floor plans included the two largest homes, which also contributed to the generally lower concentrations observed in those homes.

The plot of highest 1 h concentrations shows the EPA acute threshold concentration of 100 ppb NO₂ over 1 h. Four of the nine homes had kitchen levels exceed this benchmark, and two other kitchens had 1 h NO₂ concentrations of at least half this value. Three of the nine homes had bedroom NO₂ levels exceed 50 ppb. This suggests significant exposures may occur for anyone at home when natural gas burners are used for even a single, substantial cooking event. It is important to note that these concentrations are attributed only to the cooking event; NO₂ entering the home with outdoor air would add to occupant exposure.

For the vast majority of experiments, there were negligible increases in CO and PM_{2.5}. We limited quantitative analysis for these

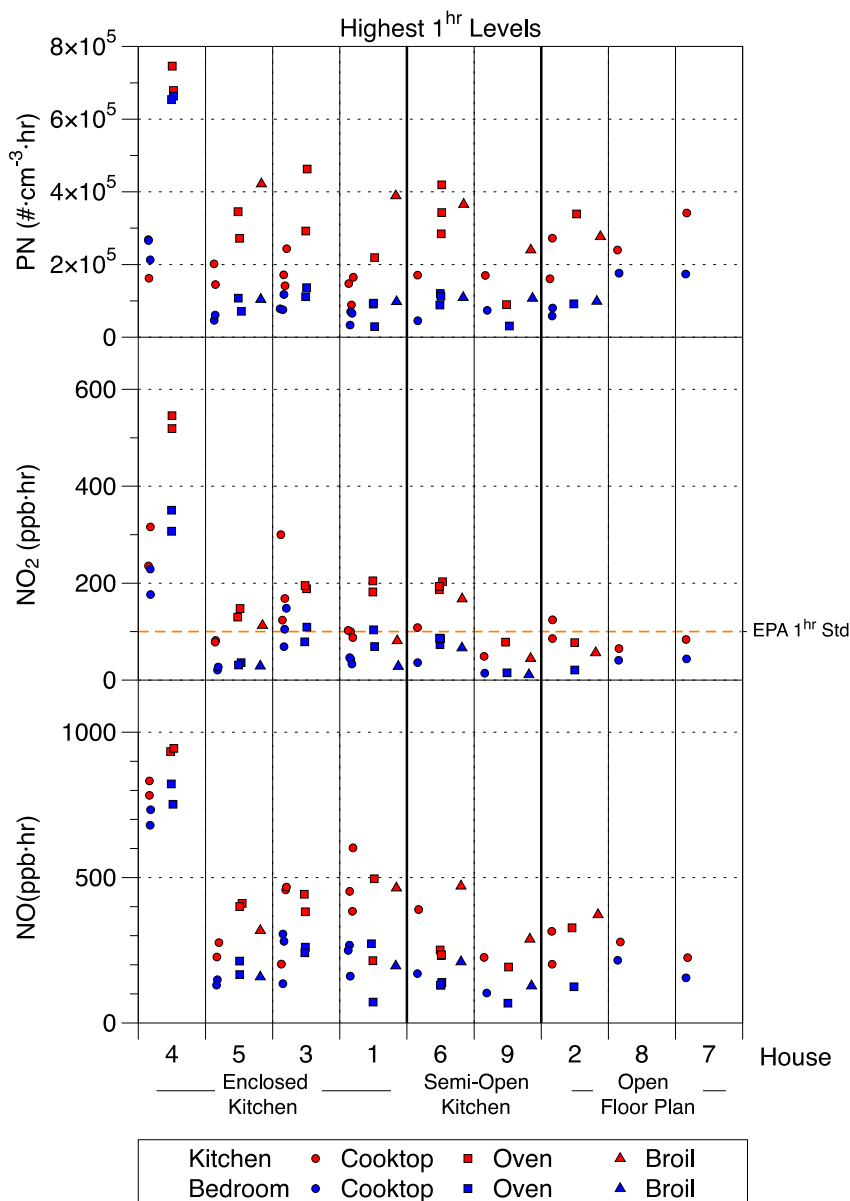


Fig. 4. Highest 1 h time-integrated concentrations in kitchen and bedroom resulting from use of natural gas burners in simulated cooking activities.

pollutants only to those cases in which concentrations were observed to increase by a substantial amount, set arbitrarily as 9 ppm for CO and $20 \mu\text{g m}^{-3}$ for $\text{PM}_{2.5}$. These thresholds were exceeded only in the kitchen and during only three experiments each for CO and $\text{PM}_{2.5}$. Results for these experiments are provided in Table 5. Elevated $\text{PM}_{2.5}$ occurred only with oven/broiler use, not cooktops. The assumption is that the $\text{PM}_{2.5}$ was formed from organic deposits in the oven that were volatilized during oven use and condensed into or onto particles.

3.3. Repeatability

Summary results for replicate experiments are provided in Table 6 (Full results are in Supplemental Tables S3 and S4.). Replicates were most consistent for NO and least consistent for PN. For NO, NO_2 , and PN, replicates showed similar consistency for 1 h and 4 h results. By contrast, CO_2 had much more variability in 4 h vs. 1 h results.

3.4. Effect of FAU use

Table 7 presents summary results for the experiments in which the air handler of the forced air heating system (FAU) was operated starting approximately 10 min before cooking and through the decay period. Full results are available in Supplemental Table S5. The experiments with FAU use are compared to experiments with the same cooking activities with no FAU use. From the basic physical consideration that it increases mixing, we expect the FAU to reduce kitchen concentrations and increase bedroom concentrations relative to the same cooking activity with no mixing – unless there are losses in the forced air system (e.g. removal by a furnace filter). The trend of a larger increase in the bedroom relative to the kitchen is evident in the highest 1 h CO_2 , NO, and NO_2 in two H1 experiments, the experiment in H6, and the CO_2 and NO_2 data in H8. Concentrations in the kitchen either decreased or increased very slightly (which is expected from variability in emissions), whereas concentrations in the bedroom were dramatically higher

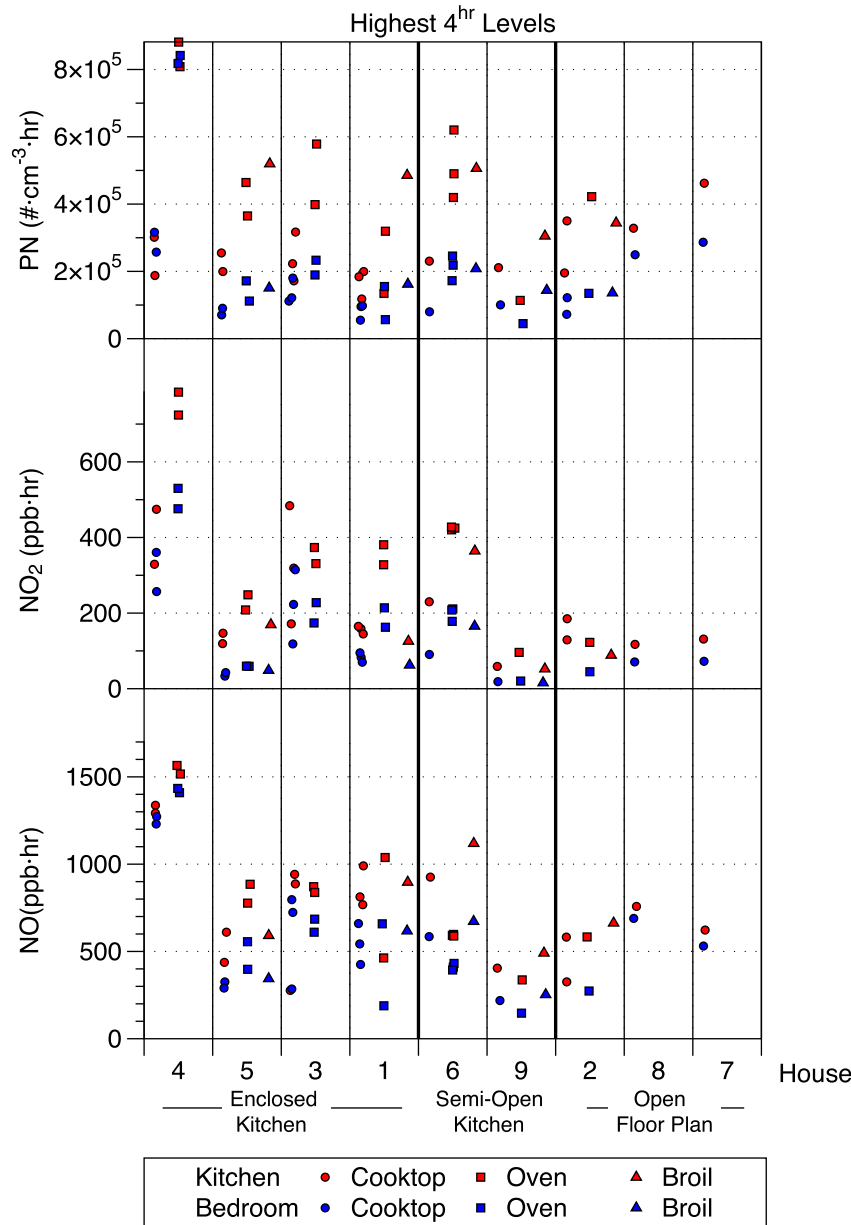


Fig. 5. Highest 4 h time-integrated concentrations in kitchen and bedroom resulting from use of natural gas burners in simulated cooking activities.

Table 5

CO and PM_{2.5} time-integrated concentrations in experiments meeting criteria of CO rising at least 9 ppm and PM_{2.5} rising at least 20 $\mu\text{g m}^{-3}$.

Expt	Burner	FAU	Parameter [units]	Highest 1 h	Highest 4 h
H402	Oven	No	PM _{2.5} [$\mu\text{g m}^{-3}\text{ h}$]	238	378
H404	Oven	No	PM _{2.5} [$\mu\text{g m}^{-3}\text{ h}$]	86	131
H603	Broiler	No	PM _{2.5} [$\mu\text{g m}^{-3}\text{ h}$]	24	53
H402	Oven	No	CO [ppm h]	9.5	21.7
H403	Cooktop	No	CO [ppm h]	8.6	17.7
H405	Oven	No	CO [ppm h]	7.4	11.5

with FAU operation. The PN results for FAU use in H1 don't follow this trend, but in H6 there was still a much larger increase in bedroom PN vs. kitchen PN when the FAU operated. The trend was not apparent in the FAU experiments in H7 and H9. The experiment in H2 had only CO₂ and PN data to compare. Overall, there was not a consistent trend of FAU impacts in this study.

Table 6

Summary Statistics for relative deviations ($n = 2$) and relative standard deviations ($n = 3$) of highest concentrations for replicated conditions.

	CO ₂		NO		NO ₂		PN	
	B	K	B	K	B	K	B	K
<i>1h time-integrated concentrations</i>								
Mean	19%	13%	12%	12%	23%	17%	30%	29%
SD	18%	14%	8%	15%	11%	20%	11%	19%
N	6	7	5	7	5	7	6	7
<i>4h time-integrated concentrations</i>								
Mean	26%	18%	13%	17%	18%	20%	31%	27%
SD	32%	21%	12%	20%	15%	15%	16%	19%
N	6	7	5	7	5	7	6	7

The lack of a clear trend across all the data collected for this study does not mean that FAU use does not impact pollutant spatial

Table 7
Percent change in highest 1 h pollutant concentration from baseline with no forced air to conditions with FAU mixing fan on.

Cooking		CO ₂		NO		NO ₂		PN	
Burner	Experiments	B	K	B	K	B	K	B	K
BR	H102/H113	28%	–15%	13%	–27%	63%	8%	–31%	–45%
OV + CT	H106/H114	19%	1%	16%	–14%	24%	3%	–40%	–32%
CT	H202/H204/H207	24%	6%	–	17%	–	9%	13%	25%
CT	H602/H604	81%	–20%	67%	–18%	64%	–22%	139%	40%
CT	H701/H703	–21%	–5%	–15%	2%	5%	9%	–23%	–29%
CT	H801/H804	–23%	–6%	–24%	–22%	–31%	–7%	–29%	–
OV	H901/H908	–9%	–12%	6%	–16%	37%	–4%	–83%	–67%
CT	H902/H903	34%	19%	33%	22%	29%	42%	–45%	3%

distributions in homes. Rather, the results suggest that the mixing effect was of the same order of magnitude or less than variations caused by other factors, including emission rate and variability of non-mechanical mixing, for the homes studied.

3.5. Spatial variations

The calculated time-integrated concentrations in the kitchen and bedroom were compared for each experiment to quantify the

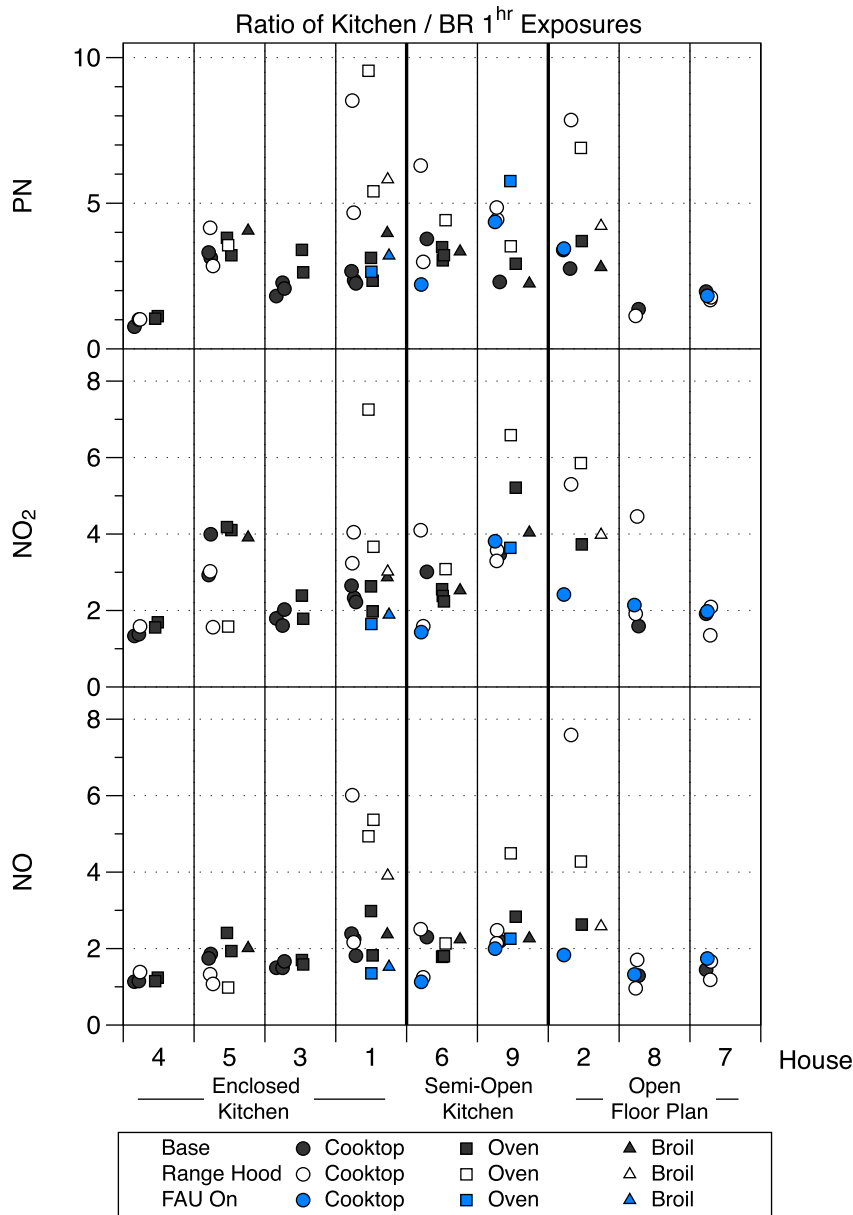


Fig. 6. Kitchen-to-bedroom ratios of highest 1 h time-integrated concentrations.

potential spatial variations in cooking pollutant exposures in homes; results are shown in Fig. 6 and 7. Across the sample, the least pronounced spatial variations occurred in the small two-room apartment (H4) and two of the homes with open floor plans (H8 and H7). Spatial variations of highest 1 h NO in these three homes were almost all in the range of 1.3–2.1 (there was one outlier in H8). The greatest spatial variations for 1 h NO₂ were in H9, the two-story 1990s home retrofitted for deep energy savings: K/BR ratios for NO₂ in this home were 3.3–6.6. For many of the homes, the kitchen to bedroom ratios were somewhat higher for the highest 1 h compared to the 4 h time-integrated concentrations. This is consistent with the difference between the two locations being largest during the period during and just after cooking. Within each home, spatial variations for NO (and CO₂, not shown in the figures) were smaller than for NO₂ and PN. This occurred because NO₂ and PN were removed during transport.

3.6. Emission factors

Calculated emission factors for NO₂, NO_x, and PN are shown in Fig. 8. The emission factors derived from the simulated cooking experiments can be compared with those presented for samples of burners in two earlier reports: (1) a compilation of data from studies completed prior to 1990, mostly from the 1970s and early 1980s [34]; and (2) a study that reported emission factors for previously used appliances including 13 cooktops, 12 oven burners and 6 broiler burners that were first sold in 1992–2007 and tested at ages 2–17 years [25]. Note that NO₂ emission factors from the 25 gas ranges reported by Ref. [16] are included in the compilation [34].

NO_x emission factors determined in the current study ranged from 28 to 64 ng/J, with most of the data between 30 and 45 ng/J, and a geometric mean of 40. These are a bit higher than the

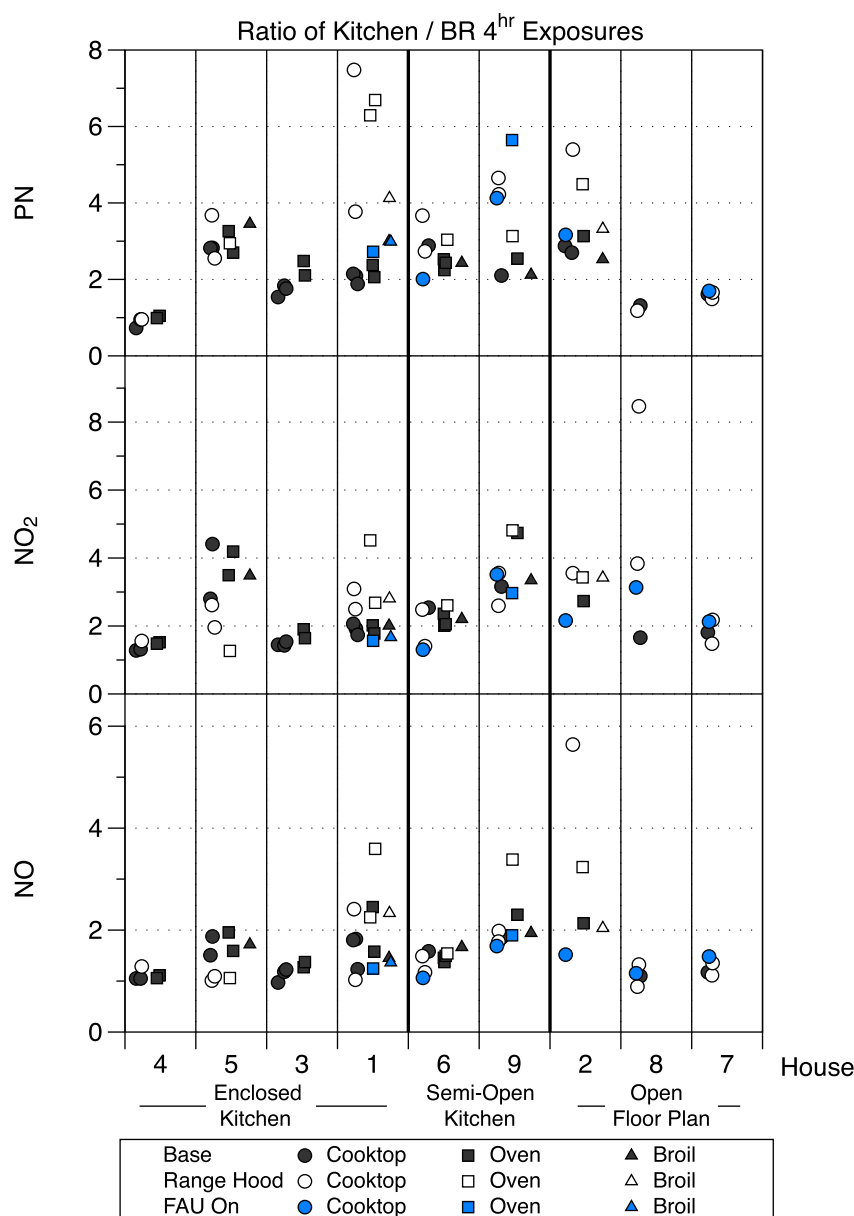


Fig. 7. Kitchen-to-bedroom ratios of highest 4 h time-integrated concentrations.

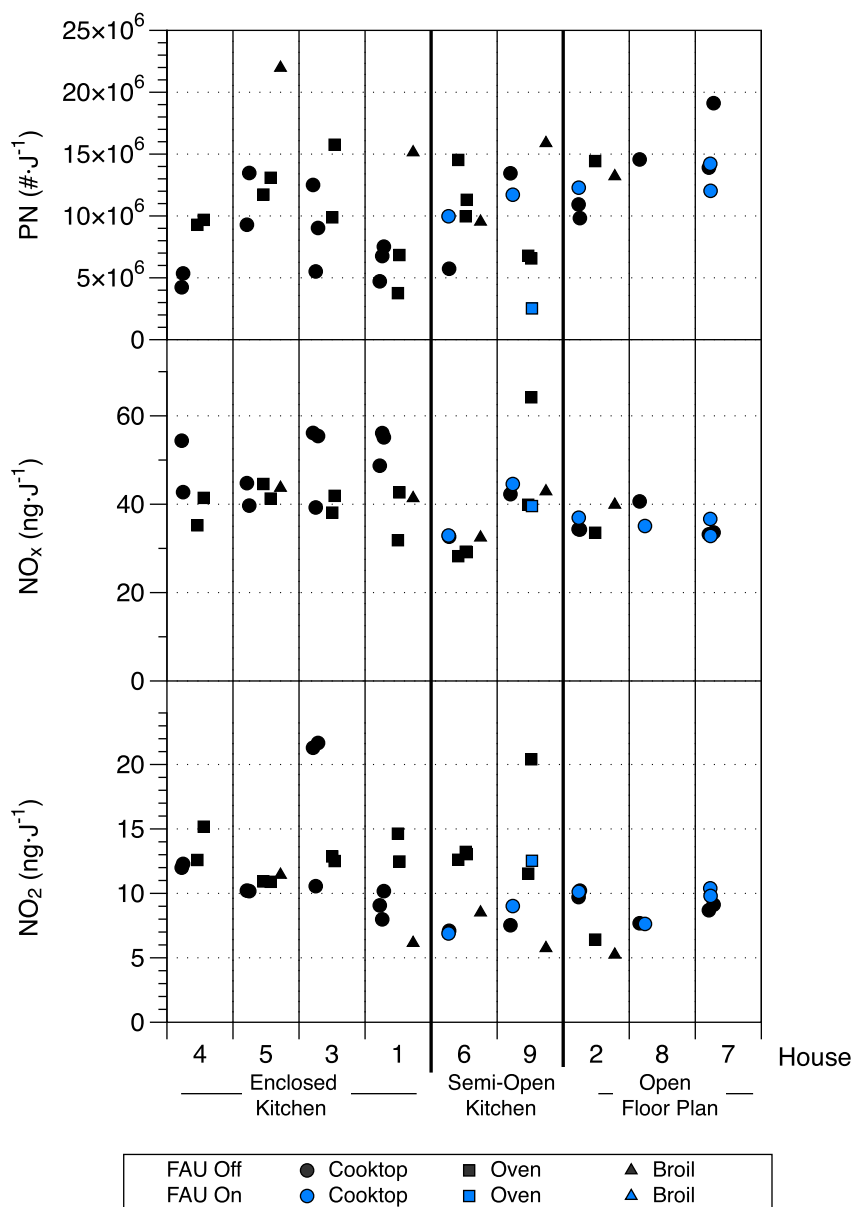


Fig. 8. Emission factors calculated from ratios of highest 1 h NO_2 , NO_x , and PN to highest 1 h CO_2 . Mass emission rates for NO_x calculated using a molecular mass of 46 g/mol by convention.

emission factors reported by Singer et al. [25], which ranged from 17 to 47 ng/J with most of the data between 30 and 36 ng/J, and the results reported by Traynor et al. [34], which had a geometric mean of 32 ng/J. Most of the NO_2 emission factors calculated in the current study were between 5 and 15 ng/J, with a geometric mean of 10.3 ng/J. The prior study [25] reported similar results with 28 of the 31 burner sets having NO_2 emissions within the range of 5–15 ng/J.

The biggest difference between the current results and previously reported emission factors is for PN. In this study, the calculated PN emission rates ranged from $2.5 \times 10^9 \text{ J}^{-1}$ to $2.2 \times 10^{10} \text{ J}^{-1}$ with a geometric mean of $1.0 \times 10^{10} \text{ J}^{-1}$. In the prior study [25], PN emissions were much more variable. The highest emission factors for each burner type were in the same range as those determined in the current study: 1.4×10^{10} , 0.5×10^{10} , and $2.6 \times 10^{10} \text{ J}^{-1}$ for CT, OV and BR burners respectively. But for each burner type reported in the earlier study, there were many more burners with PN emission factors below the lowest values reported for the current study. This

difference may result from the cleaning, pre-conditioning, and more repeat experiments in the earlier study. This hypothesis is based on the idea that particles were formed by volatilization of organics compounds deposited on cooktop, oven or broiler burner surfaces, as reported in a study or particle emissions from electric burners and hot surfaces [40].

3.7. Measured range hood performance

Measurements of range hood performance parameters are presented in Table 8. Consistent with a prior in-home study [28], the measured airflows were substantially below rated values for five of the six installed hoods. Interestingly, the estimated sound ratings (in sones) were lower than the rated values for many of the hood settings.

Table 9 presents the estimated capture efficiencies measured with the new field test method described in Section 2.5. Consistent with a prior field study (ibid), the performance of several of the

Table 8
Measured performance parameters of range hoods in study homes.

Home ID	Type	Measured flows [L/s] (% of rated flow)		Measured sound [dBA] (Calculated Sones)		Bkg [dBA]
		Low speed	High speed	Low speed	High speed	
H1	Hood	66 ^b	148 (59%)	57.3 (3.0)	59.2 (3.7)	30.1
H2	Microwave	66 (78%)	76 (54%)	63.9 (4.6)	72.1 (6.2)	36.8
H5	Hood	135 (98%)	153 ^b	58.9 (4.0)	66.7 (4.8)	28.9
H6	Microwave	43 ^b	49 (45%)	59.2 (3.6)	62.5 (4.6)	30.7
H8 ^a	Hood	20 (40%)	30 (40%)	54.0 (2.2)	58.2 (3.7)	32.9
H9 ^a	Hood	39 (79%)	19 (64%)	54.1 (2.0)	61.4 (3.7)	39.8

^a The hoods in H8 and H9 are the same product, sold under different nameplates.^b Performance information not provided with product literature.**Table 9**
Measured capture efficiency of range hoods in study homes.

Home ID	Hood type	Low speed		High speed	
		Front burners	Back burners	Front burners	Back burners
H1	Hood	NM ^a	NM ^a	NM ^a	NM ^a
H2	Microwave	25%	>95%	35%	>95%
H5	Hood	61%	68%	72%	84%
H6	Microwave	31%	88%	31%	93%
H8 ^a	Hood	59%	68%	65%	80%
H9 ^a	Hood	25%	74%	36%	75%

^a Not measured; there was no way to access the range hood exhaust duct without aesthetic damage.

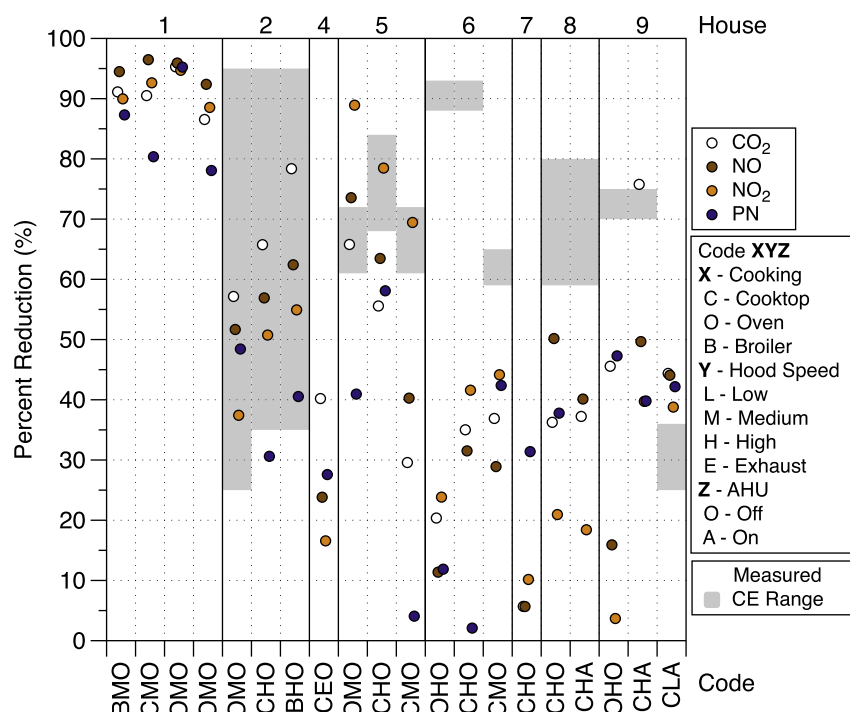
hoods was dramatically different for the front and back cooktop burners. For most ranges, the performance of the back cooktop burners is a good indicator of capture for oven emissions.

3.8. Effect of range hood use

The effects of operating a venting range hood during cooking are presented in Fig. 9. This figure presents the percentage reduction in

the highest 1 h concentration, calculated as the difference between experiments with range hood use and analogs without range hood use. Included in this figure are the calculated reductions from using the bath fan as the only available exhaust device in H4, and the recirculating range hood in H7.

Broadly, these results indicate that use of range hoods can yield substantial reductions in cooking burner pollutant concentrations both in the kitchen and throughout the house. The impact of using a

**Fig. 9.** Percent reductions in highest 1 h kitchen concentrations calculated by comparing experiments with range hood use to analogous experiments without range hood use. Shaded grey areas show the range of capture efficiencies measured for the hood at the flow rate used in the experiment, as presented in Table 9.

venting range hood was larger than the variability of the experimental method, producing net reductions in all cases. The most benefit was seen in H1, which had a range hood with large capture volume and a measured airflow of 108 L/s. This hood, which produced reductions mostly in the range of 80–95%, was of similar design to hoods that showed very high capture efficiency in prior studies [3,28]. The next most effective hood, in house H5, also had characteristics shown to enhance performance [28]: it fully covered the front burners and had airflow substantially above the benchmark of 95 L/s.

The only other hood with reductions mostly exceeding 50% was the over-the-range microwave in H2, which had an exhaust fan that moved 76 L/s at high speed. Prior studies [3,15,28] have found over the range microwave exhaust fans to vary widely in their capture efficiency, in large part explained by variations in airflow but likely also relating to disadvantageous geometry. The reductions observed for H5 were consistent with those measured for hood H2 operating at similar airflow in Singer et al. [28]. The range hoods in H6, H8 and H9 had calculated reductions of 0–50% with more than half of the results falling in the top half of that range. These hoods had lower airflows and did not cover front burners fully. The bath fan in H4 reduced concentrations by 15–40% across the measured species, suggesting a modest benefit that could have been caused by method variability. The recirculating range hood in H7 showed small net reductions ($\leq 10\%$) for NO₂, NO, and CO₂, and a larger reduction for PN ($\sim 30\%$). All were within the variability of replicate experiments.

The effects of airflow, burner position, and particle size on range hood effectiveness for PN have been discussed [15,20]. In measuring particles down to 2 nm, Rim et al. found that removal effectiveness was lower for 2–6 nm particles than for particles > 6 nm. Since a large number of particles are in the lower size range, that effect is expected to reduce the overall effectiveness reported by Rim et al. relative to what would be reported for 6 nm and larger particles, as measured in this study. The “A” hood in the Rim et al. study was similar in design and airflow to the hood in H8 and H9 in this study. The roughly 40% reductions in cooktop-emitted PN calculated with range hood operation in those homes is roughly midway between the 31 (6%) for front burners and 54 (9)% for back burners reported by Rim for Hood A. The “B” hood tested by Rim et al. was similar in design to the hood in H5 in this study and the measured airflows of the hood in H5 were between the medium and high flows measured for Hood B in Rim et al. Yet the effectiveness for PN was substantially lower in H5 than reported by Rim et al. for their Hood B. The apparent difference may simply result from the greater variations in PN associated with the in-home experiments conducted in this study.

4. Concluding recommendations

Based on the findings of this field study and the related, prior work referenced herein, the authors offer the following policy recommendations. Efforts should be made to increase awareness (a) that natural gas cooking burners are a source of air pollutant emissions into homes, and (b) that these pollutants can be controlled with an appropriately-sized venting range hood or other kitchen exhaust ventilation.

Building standards should require that range hoods have airflows of at least 95 L/s and cover front burners or preferably demonstrate performance through a standard test [37]. Since the performance of most hoods is much better when cooking on the back cooktop burners, this practice should be encouraged to improve safety. Since cooking with electric burners also produces pollutants, kitchen exhaust ventilation should be available in all homes, and operated as a precaution whenever cooking occurs.

Acknowledgments

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Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.buildenv.2017.06.021>.

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STATE OF MICHIGAN

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

In the matter of the application of **DTE
ELECTRIC COMPANY** for authority to
increase its rates, amend its rate schedules
and rules governing the distribution and
supply of electric energy, and for
miscellaneous accounting authority

Case No. U-21534

ALJ Sally Wallace

PROOF OF SERVICE

I, Mark N. Templeton, certify that an electronic copy of the Official Exhibits DAO-201 to DAO-213 sponsored by Yunus Kinkhabwala (Part 5 of 10) on Behalf of Soulardarity and We Want Green, Too was served on the following on September 12, 2024.

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The statements above are true to the best of my knowledge, information, and belief.

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