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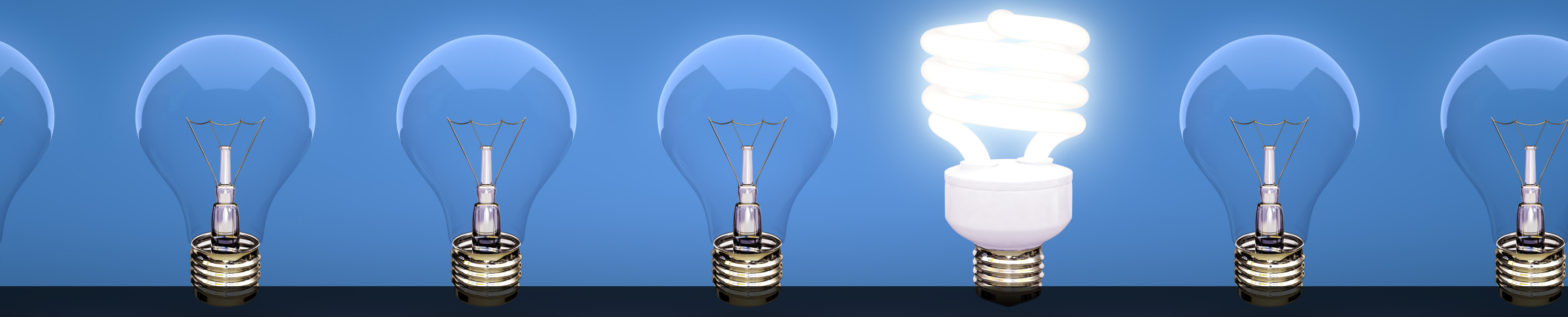

The Cost of Energy Savings and Energy Burdens

(Part I of II: An Overview of Energy - Efficiency Programs)

This brief examines some of the costs and benefits of energy-efficiency programs, and assesses whether they really are cost-effective across socio-economic classes. As we consider the Inland Region's energy needs in part two of this research brief series, we hope that this overview will serve as a backdrop when we reflect on cost-effective solutions to Riverside and San Bernardino Counties' energy challenges.

QUICK FACTS:

- In Riverside County, low- and middle-income (LMI) owner households that were earning 0 - 30% of the area median income (AMI) were spending, on average, 19% of their income on utility bills. They had an average annual expenditure of $2,007 (ACS 2018). On the opposite end of the income spectrum, those making over 100% of AMI have an average energy burden of 2% and an annual expenditure of $2,301. Residents in San Bernardino County on average have lower energy expenditures than Riverside County. Households in San Bernardino County that were in the 0 - 30% of AMI group had an average energy burden of 14% and an annual expenditure of $1,714. Households that made above 100% of the AMI had an average energy burden of 2% and an annual expenditure of $2,177. Renter households from both counties follow similar trends in spending, but generally expend less than owner households.

- Average energy expenditures of households in Riverside County are higher than expenditures of San Bernardino County's households. Moreover, energy expenditures are not proportional to household income. In Riverside County, households in the highest income bracket are spending only 13.6% more on energy costs than the lowest income bracket. San Bernardino County's highest-earning households are spending 23.8% more than the lowest income bracket.

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Introduction

The California Global Warming Solutions Act of 2006 (AB 32) challenged the state to reduce greenhouse gas (GHG) emissions to 1990 levels by the year 2020. California reached this goal in 2016. The state then updated its emissions goal by enacting SB 32 in 2016, which aimed to reduce GHG emissions to 40% below 1990 levels by 2030. Such an ambitious goal requires a multi-pronged implementation approach including a change in energy consumption habits. The state government and many local jurisdictions have implemented mandates, provided incentives, and promoted energy savings to move towards complying with the state's sustainability goals.

Several mandates have been implemented at the federal, state, and local levels of government to curb GHG emissions. At the federal level, mandates such as the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 90.1 and the International Energy Conservation Code (IECC) set minimum requirements that non-residential and residential buildings must adhere to. The ASHRAE applies to commercial and high-rise multifamily residential buildings, while the IECC applies to smaller residential buildings, such as single-family units and small multi-family buildings.

In 1978 California enacted Title 24 which incorporated more stringent energy laws into the state's building codes that at the time went far beyond federal regulations. The energy code can be found in Part 6 of Title 24, which aims to achieve a net zero energy consumption of buildings. In 2007, Part 11 of Title 24, also known as CALGreen, emerged as the nation's first green building standards that were designed to promote sustainable buildings and curb GHG emissions. These standards are updated every three years with progressively stricter energy mandates to meet California's sustainability goals listed in AB 32. As a result of Title 24 and other programs, initiatives, and public information campaigns, California residents' energy consumption has decreased significantly. Today, California residents consume 31% less energy than the average American (California Energy Commission 2022).

Although strategies for energy efficiency have evolved considerably over time, the 2019 standards that currently dictate building requirements demonstrate a shift in strategy in pursuing and achieving energy efficiency. Before 2019 the standards largely emphasized reducing inefficiencies. For example, in the 2016 code, major changes included increasing the efficiency of water heaters and lighting. The 2019 code markedly diverges from previous codes in that renewable energy was introduced as part of the state's decarbonization approach. When comparing buildings built under the 2016 and 2019 code requirements, for example, the addition of solar panels can cut a building's total energy consumption by 53%, whereas the absence of photovoltaic systems reduces consumption by only 7%. There are other significant changes made to the 2019 code as well, such as requiring HVAC systems to include mandatory air filtration requirements, high efficacy lighting requirements, and improvements in building envelopes to prevent air leakages.

It is unclear which populations are likely to reduce their carbon footprint and reap short or long-term monetary savings due to the installation of energy efficient improvements, and which ones might be burdened by increased energy costs. Energy burdens include non-housing costs that can contribute to housing insecurity and negative health outcomes. Some households are likely to bear additional energy burdens due to rising energy costs; they may be either residing in older residential structures that they might own but do not have the resources to make significant energy-efficient upgrades, or rent in structures where property owners make little or no energy-efficient investments.

In a previous ICSD report, not only did we find that affordable housing was in limited supply, but that homes that were affordable and available for low- and middle-income (LMI) households were even more uncommon (Kang 2022). Housing that is affordable to a household means that housing costs do not exceed 30% of the household income. A home that is neither being occupied by a higher income household nor in disrepair is considered available to LMI households. Unavailability of housing is an additional barrier to LMI households since it further limits the supply for certain socioeconomic classes. The limited supply of affordable and available housing force many LMI households to live in housing units that they cannot afford. Thus, having access to affordable energy resources plays a large role in having this basic need within reach to the most disadvantaged communities without adding to the financial burdens that result from housing challenges.
In this brief, we examine the implementation costs of selected energy incentive and improvement programs and building code requirements. We assess who can afford access to energy efficiency compared to those who may be further cost burdened over time. As we consider the Inland Region's energy needs in part two of this research brief series, we hope that this overview can serve as a backdrop when we reflect on cost-effective solutions to Riverside and San Bernardino Counties' energy challenges.

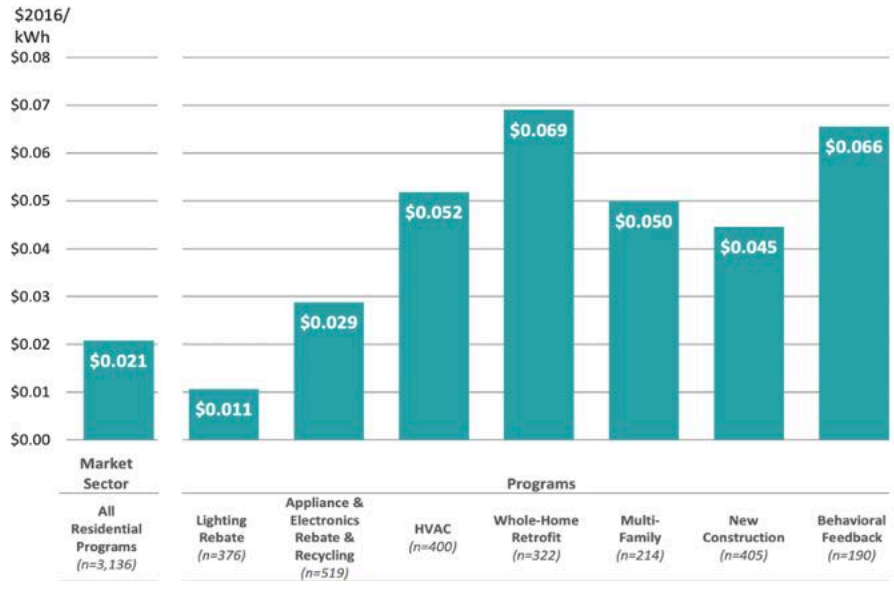
Investing in Energy Efficiency

Cost-Benefit Analysis of Efficiency Programs

Energy-efficiency programs help California make progress towards meeting GHG emissions goals. Such programs are funded by governments and consumers alike, with federal, state, and local government agencies acting as primary funders. To measure the cost-effectiveness of a program, the cost of saving energy (CSE) is a metric used to determine how much it costs to fund a program to save a kilowatt hour of energy. The CSE of a program includes the costs related to providing customer incentives, marketing and outreach, technical assistance, and evaluation, measurement, and verification (EM&V) (Hoffman et al. 2018). Figure 1 compares the costs of different types of energy-efficiency programs provided nationwide by investor-owned utilities (IOUs) during the period between 2009 - 2015. The programs evaluated include lighting rebates, appliance and electronic rebates, HVAC programs, whole-home retrofit programs, multi-family programs, and behavioral feedback. The data originates from utility-reported assessments that were submitted to state regulators. Because the requirements for the assessments varied by state, researchers note that they obtained data with varying levels of knowledge (Hoffman et al. 2013). Figure 1 refers to primary funders as program administrators (PAs). Lighting, appliances, and recycling rebates encourage the use of energy-efficient products. HVAC programs increase energy performance by improving air conditioning. Whole-home retrofit programs provide holistic energy assessments and provide opportunities for improving inefficiencies through upgrades and retrofits. Multi-family programs encourage energy improvements in common areas or tenant units. New construction programs provide technical services to homes being constructed, and behavioral feedback programs gather data from consumers to make assessments (Hoffman et al. 2013).

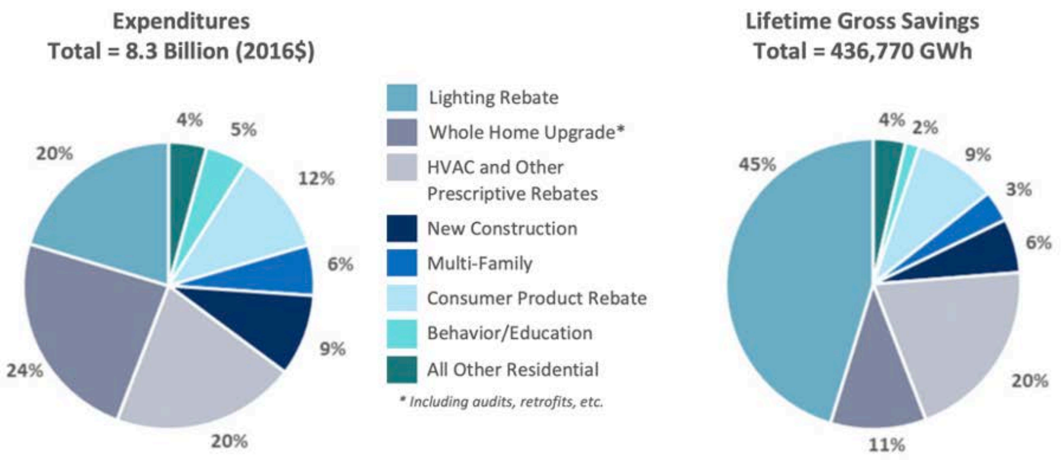
According to data compiled, funding whole-home retrofits results in the highest CSE, while lighting rebates are the least expensive in terms of CSE. The share of lifetime gross savings, which is the energy savings assumed during the lifetime of a measure, indicates how much energy is saved. Figure 2 demonstrates the utility of this measure when compared to expenditures. Analyzing expenditures against lifetime savings indicate that lighting rebate programs are the most cost-effective; 20% of the $8.3 billion budget was dedicated to the program, but it led to 45% of lifetime gross savings. On the other hand, whole-home retrofits exhibit relatively small returns in lifetime gross savings even though 24% of the budget is expended. This type of cost-benefit comparison is useful for determining the cost-effectiveness of programs.

Figure 1. Costs of Saving Energy for Program Administrators - Nationally (2016)



Source: reprinted with permission; Hoffman et al. 2018

Figure 2. Comparing Expenditures to Lifetime Gross Savings (2009 - 2015)



Source: reprinted with permission; Hoffman et al. 2018

Consumer Contribution to Program Expenditures

Incentive and assistance programs are essential for driving changes in energy habits and consumption. But which entities bear most of the funding costs? Although governmental aid provides the foundational support for many programs, consumers also contribute to funding, with these additional costs often included in utility bills. The share that ratepayers contribute to these utility programs has increased in recent years. In the period between 2016 and 2017 alone, consumer contribution to energy-efficiency programs increased by 6% (Consortium for Energy Efficiency 2017). Figure 3 displays the costs for each market sector, and further breaks down the relative contributions of program administrators versus the participants that benefit from such programs, such as consumers. As noted, the costliest on a per unit basis are low-income efficiency programs ($0.145/kWh), and the least costly are residential programs ($0.039/kWh). Low-income and residential entities contributed $0.013/kWh and $0.017/kWh, respectively. Although low-income efficiency programs are the most expensive in terms of CSE, these expenditures comprise only 9% of the total cost of programs for program administrators (see Table 1). According to Table 1, the commercial and industrial (C&I) sectors make up the bulk of the budget and experience the largest share of lifetime gross savings. Residential programs use 31% of the budget and result in roughly 32% in lifetime gross savings. Low-income programs make up the smallest share of the total budget, and they also receive the least in lifetime savings (2%).

Figure 3. Cost Breakdown for Program Administrators and Ratepayers

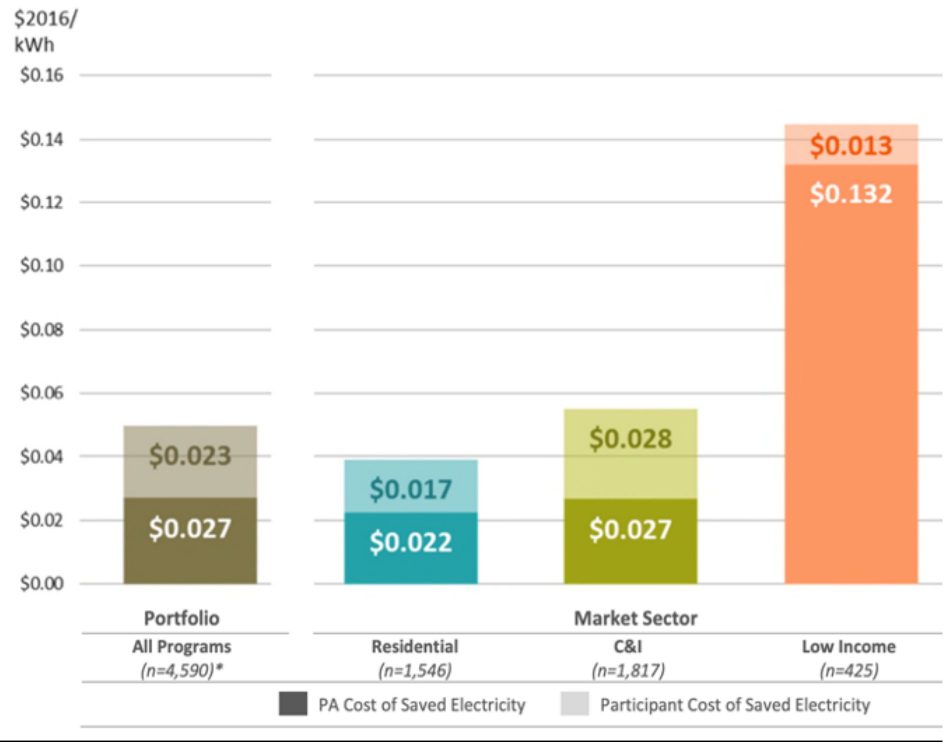


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Table 1. Program Expenditures and Lifetime Gross Savings (2009 – 2015)

Market Sector	Share of Program Administrator Expenditures	Program Administrator Expenditures (Billions 2016$)	Share of Lifetime Gross Savings	Lifetime Gross Savings (GWh)
C&I	50%	13.4	61%	836,241
Residential	31%	8.3	32%	436,770
Low Income	9%	2.2	2%	28,983
Cross Sector/Other	10%	2.7	5%	66,260
Total	**100%**	**26.7**	**100%**	**1,368,254**

Source: reprinted with permission; Hoffman et al. 2018

Investing in Energy Efficiency

Energy expenditures are not proportional to income

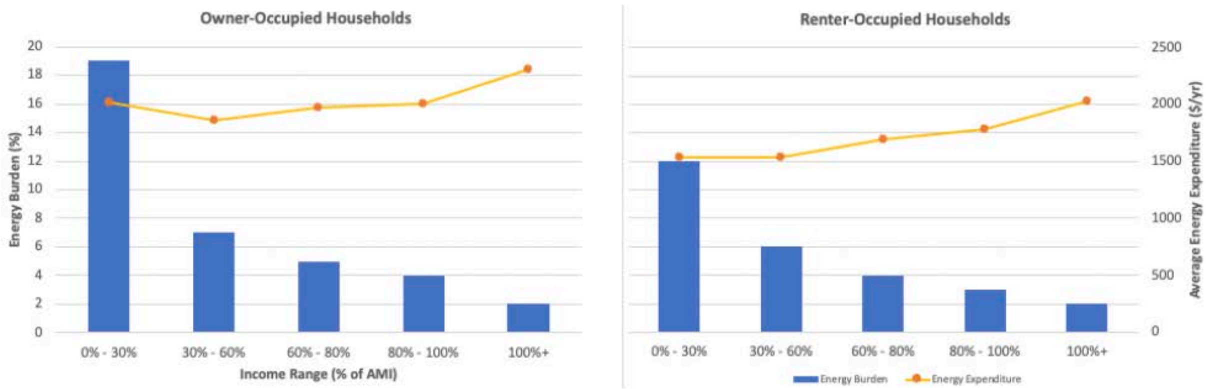
Low- and middle-income (LMI) households spend a higher proportion of their total income on energy bills than any other income group (Drehobl and Ross 2016, Bednar and Reames 2020). This trend is apparent in the Inland Region as demonstrated in Figures 4a and 4b. In Riverside County, 19% of owner households making 0 - 30% of the area median income (AMI) were energy-burdened and spent $2,007 on energy bills (American Community Survey (ACS) 2018). On the opposite end of the spectrum, only 2% of owner households making over 100% of AMI are energy-burdened–this group spends $2,301 on energy bills annually. The annual expenditures between the two extremes of the socioeconomic spectrum yield a percent difference of 13.6%. On the other hand, San Bernardino County's households from the lowest and highest socioeconomic groups have a 23.8% difference in average expenditures. The small percent difference in Riverside County implies that the lowest income bracket is paying almost as much as the highest income bracket, thereby contributing to economic inequities. Residents in San Bernardino County on average have lower energy expenditures than Riverside County. Households in San Bernardino County that were in the 0 - 30% of AMI group had an average energy burden of 14% and an annual expenditure of $1,714. Households that made above 100% of the AMI had an average energy burden of 2% and an annual expenditure of $2,177.

Expenditures of renter households from both counties follow similar trends in spending as owner households, but they generally expend less than owner households. For example, in San Bernardino County, renter households across all income levels spend an average of $1,609 per year, whereas owner households spend an average of $1,878. In Riverside County, renter and owner households have average annual expenditures of $1,715 and $2,025, respectively. Like owner households, the lowest socioeconomic group (0 - 30% of AMI) have the highest energy burdens.

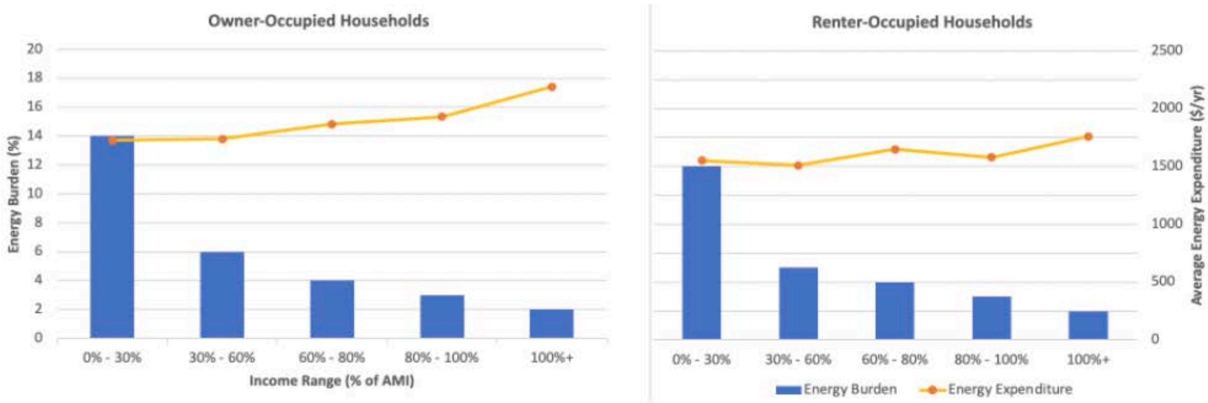
Generally, the larger the income, the more energy is used. This may be attributed to the tendency for high-income households to have larger home sizes. Moreover, higher-income households spend a smaller portion of their income on energy but often have relatively higher consumption rates. This trend holds true for both owner- and renter-occupied households in Riverside and San Bernardino Counties (Figure 4a and 4b). Thus, LMI households could benefit significantly from energy-efficiency programs. However, oftentimes such programs are inaccessible to LMI households due to affordability barriers (Brown et al. 2020). Renters often do not make decisions on the efficiency of appliances they use, and older homes often require upfront costs to install energy upgrades that are too costly for owner-occupied LMI households. Furthermore, the high energy expenditures for those making 0 – 30% of AMI suggest that factors in addition to housing characteristics—such as geographic location, household energy habits, energy policies, and socioeconomic status—may also influence energy consumption (Brown et al. 2020).

Figure 4. Comparing Expenditures and Energy Consumption among Owners and Renters in Riverside and San Bernardino Counties (2018)

a) Riverside County



b) San Bernardino County



Other Factors that Affect Energy Consumption

Housing characteristics are significant drivers of energy burdens. Because LMI households tend to live in older, less energy-efficient homes (Brown et al. 2020, Norton et al. 2017), energy burdens for lower socioeconomic classes are more common than for other income groups. Older homes can often exhibit poor insulation, inadequate air sealing, inefficient appliances, and may also suffer from poor maintenance. Although some retrofitting and weatherization programs exist at no cost to qualifying participants, only about 1.2% of low-income customers participate in energy-efficiency programs (Brown et al. 2020).

Energy consumption is also dependent on the climate of geographic locations. One metric researchers use to measure energy consumption needs due to climate is by calculating the number of "heating and/or cooling degree days" which determines how many degrees a building should be cooled or heated by to maintain a comfortable temperature of 65° F. The type of environment—whether it be urban, suburban, rural, etc.—also influences energy needs. Rural areas often pay higher energy rates relative to urban counterparts (Shoemaker and Gileo 2018), while LMI households in major U.S. cities tend to have higher energy burdens (Drehbol 2016, Fox 2016, Brown 2018).

Achieving energy efficiency often requires the use of more energy-efficient construction materials, improved heating and cooling systems, and efficient appliances, just to name a few. Although these changes greatly improve energy efficiency and result in greater energy savings for residents, these changes often come with upfront costs. For example, a 1980 analysis by the California Energy Commission (CEC) demonstrated that new regulations contributed to a 77% decrease in energy consumption compared to pre-1978 buildings. However, the changes needed to accomplish these savings also added an average of $8,000 to the housing costs (Table 2), an additional 10% to the cost of housing at that time. To give a similar example relevant to today, the addition of photovoltaic (PV) systems such as solar panels on housing units is estimated to decrease energy consumption by 53% (EnergyCodeAce 2020), but they also add roughly $8,400 to the cost of a house (California Energy Commission 2019). The CEC points out that there are financial options available to offset upfront costs while still receiving its benefits. Nevertheless, although improvements may be cost-effective in the long run, incremental costs of line items such as the addition of solar panels, improved HVAC systems, and installation of other energy-efficient appliances may be enough to deter certain socioeconomic groups from having access. One study found that higher-income earners are overrepresented in efficient household appliance programs. Specifically, 48% of the people that invested in efficient household appliances had annual incomes greater than $100,000, but according to the Residential Appliance Saturation Study (RASS), only 25% of households were in this socioeconomic group from 2010 - 2012. For those making less than $50,000, a much smaller percentage (17%) participated in such programs, even though they comprised a greater portion of the population (38%) (Frank and Nowak 2016). Moreover, although low-income utility programs attempt to bridge this gap, they serve only a small percentage of low-income households in the area. Federal programs also fall short when it comes to serving low-income households. For example, the DOE's Weatherization Assistance Program (WAP), which provides no-cost home upgrades to low-income households, has served 7 million households over the past 40 years, but there are currently 36 million households that would potentially benefit from WAP savings. Relatively few houses have been served compared to the amount of low-income households in need due to limited funding, and because some homes are too decrepit to be served by WAP measures. And while funding has increased for WAP in more recent years, the funding pool is still limited in the number of homes that it could serve. Moreover, although the program improved its assessments to give more comprehensive, in-depth analyses of how to improve household energy efficiency, such practice requires significantly more time investments per home, which further reduces the program's capacity to serve more households (Bullen 2018; DOE 2016; Drehobl 2020).

Table 2. Comparing the Costs and Savings of Pre-Code and 1980 Single-Family Homes in Sacramento, CA

Type of Improvement	Pre-Code Era Costs ($)	1980 Single-Family Homes ($)	Difference ($)
Insulation	-	2831	2831
Window Glazing	879	2108	1229
Overhang	-	468	468
Shading	-	360	360
Caulking, Sealing, etc.	-	551	551
Thermostat	82	138	56
Heating System	1360	1360	0
Cooling System	1129	965	-164
Duct Insulation	-	61	61
Water Heater	284	2736	2452
Lighting	97	333	236
Total Costs	$3,831.00	$11,911.00	$8,080.00
Total Energy Savings (1000 BTUs)	187,209	43,025	-144,184
Net Energy Savings (%)			-77%

Source: Horn et al. 1980, adapted from Levinson 2016 pg. 2871

Conclusion

Reducing energy consumption comes at a cost, both for society and governments. Although many programs come with rebates and/or lower energy bills, "discounts" given to program participants are largely funded by government agencies and utilities. These costs are partially covered by ratepayers as well, often via additional charges imposed in utility bills. Half of a program administrator's budget is spent on efficiency programs for the C&I sectors, and programs for these industries give the largest returns—61% of lifetime gross savings. Residential programs are allocated 31% of the budget and yield 32% of the total lifetime gross savings. Although low-income programs have a higher price tag in terms of CSE, they only receive 9% of the budget and gain a lifetime gross savings of 2%.

Cost-benefit analyses of different types of efficiency programs reveal that lighting rebates are the most cost-effective. 20% of the total budget allotted by program administrators nationwide is dedicated to these programs, but they yield 45% of the total lifetime gross savings. Programs related to whole-home upgrades such as installing low-flow shower heads, faucet aerators, and weather stripping, are one of the least cost-effective since they use up 24% of the budget—the largest expense for home efficiency programs but yield only 11% of the total lifetime gross savings.

Studies indicate that most energy-efficiency program participants are often higher-income households, which infer those programs might not be accessible to a significant portion of those contributing to these funds. Progressive building codes also sometimes can have unintended barriers to LMI households, where upfront costs for retrofits (which can yield cost-savings over the long term) may not be affordable to many LMI households. As renters typically do not have much choice over efficient appliances and related energy upgrades to the buildings they occupy, they risk being further burdened by increasing energy costs, which could likely comprise even higher percentages of their income. Landlords are not incentivized to make upgrades for energy efficiency. The Solar for Multifamily Affordable Housing (SOMAH) program addresses these barriers for rental property owners by providing significant financial incentives to landlords. We will explore the details of this program and other opportunities for LMI households in part two of this brief series.

These current challenges in energy security might result in a broadening of wealth inequities. Energy resources are essential non-housing costs that indirectly affect affordable living. As the climate changes, accessible and cost-effective programs that serve LMI households become increasingly important for controlling energy burdens. In the Inland counties, it is projected that the region will have increased cooling needs by 2036 (Roberts, 2018). Energy burdens and incomes are, for the most part, inversely related, but income and energy expenditures are positively correlated. This means that LMI households do not consume as much energy as high-income households, but they are vulnerable to energy insecurity (and perhaps more so to increasing energy costs) than higher-income households.

The socioeconomic characteristics of the Inland region also justify the need for more energy-efficiency programs with high accessibility for LMI households. Riverside and San Bernardino Counties have poverty rates of 13.7% and 16.0%, respectively. These rates are above California's average poverty rate of 12.5% (American Community Survey 2015 - 2019). Moreover, Riverside-San Bernardino-Ontario MSA is one of the MSAs with the highest concentration of households that were not caught up with energy bill payments (Household Pulse Survey, 2022). In Part two of this brief series, we will review the accessibility of the types of efficiency programs available to Riverside and San Bernardino Counties' residents,and additional measures that utilities can take to alleviate energy burdens of lower-income families that need them the most.

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