

Energy Efficiency, Land Use, and Equity

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ABSTRACT

The energy efficiency sector has long focused on technological solutions, even for behavioral and low-income programs. In this article, we argue that energy efficiency policies and programs must include land use reform in order to both radically improve energy efficiency and address systemic inequities.

We start by reviewing how land use has been a foundational source of social and environmental injustice in the United States. We explain how practices such as redlining and single family zoning combined with over-reliance on automobiles have disproportionately harmed people of color and other vulnerable individuals. These policies still lie at the heart of prevailing injustices in disadvantaged communities, including exposure to pollution, higher risk of certain diseases and premature deaths, limited access to essential services and economic opportunity, and higher vulnerability to climate change.

We then outline how these same land use practices are inherently energy inefficient. Single family households use twice the energy of multifamily ones, per resident. It is because of inefficient land use patterns that transportation is the largest source of greenhouse gas emissions in the US. Particularly considering the nationwide shortage of 7 million homes, it is impossible to meet our climate goals without reversing sprawl and reducing car dependency.

We conclude that land use reforms and programs that incentivize urban infill and multifamily homes as well as reduce car dependence are not only an essential tool to meet energy efficiency goals. They also constitute a means to reversing systemic inequities.

Introduction

Energy efficiency programs and policies have long focused on technological measures. Examples include subsidizing more efficient heating, ventilation and air conditioning (HVAC) systems. Even as the sector has expanded into behavioral initiatives, it still focuses on technologies: retro-commissioning, improved building operations, etc.¹ While many programs address technology and safety-related needs of low-income households, they, too, remain focused on equipment replacement, and leave underlying inequities untouched (CPUC 2022).

We argue that to be truly equitable, the energy efficiency sector must embrace land use reform as an essential tool to both improve energy efficiency and address systemic inequities. We start by providing background on the history of land use injustices in the US and discussing some of the land use policies that continue to harm vulnerable communities today. We then explain how resultant development patterns drive up energy use and outline the savings potential that lies in changing them. Finally, we illustrate how current energy programs not only leave this potential untapped, but also perpetuate historic injustices. We provide examples of measures that can both address inherent inefficiencies in land use and serve members of disadvantaged communities. We conclude with general considerations.

¹ See the example of Pacific Gas and Electric Company's 2021 programs. California load-serving entities also engage in codes and standards advocacy and local government partnerships, but these programs, too, focus on technological approaches such as electrification (PG&E 2022).

A summary of land use injustice in the United States

A thorough discussion of all land use injustices is beyond the scope of this paper. In the following, we summarize a few key injustices that are relevant to this study. We further note that, since the arrival of European settlers to what is now the United States, people of color (POCs), especially Native Americans and African Americans, have routinely been denied their human rights. These include the rights to housing and land (see, for example, Wilm, Nelson, and Madron 2022). America's racist foundations continue to shape society and underlie the injustices discussed in the next sections. For a more detailed review, we refer the reader to references such as *The Color of Law* (Rothstein 2017) and the *American Panorama* project (University of Richmond 2022).

Segregated housing and neighborhood demolition. In 1917, the Supreme Court deemed overt zoning-based segregation illegal. In response, many white communities rapidly adopted racial restrictive covenants and single family zoning as tools to maintain segregation (Rothstein 2017).

Racial restrictive covenants are contract provisions preventing a homebuyer from later selling to a non-white (or sometimes non-Christian) person. The Supreme Court found these covenants *unenforceable* in 1948, but housing discrimination was not *illegal* until passage of the Fair Housing Act in 1968 (Woods et al. 2022).

Single family zoning also supported segregation, without mentioning race, because most Black families were unable to afford detached homes (Rothstein 2017). Today, it continues to promote segregation. In Los Angeles and the San Francisco Bay Area, for example, cities with the highest shares of single family zoning are the most white and have the lowest share of Black and Latinx residents (Menendian, Gambhir, and Hsu 2022). Meanwhile, single family zoning now covers 75% or more of the residential land in many American cities (Badger and Bui 2019).²

In the 1930s and 1940s, the federal government mandated segregation in extensive public housing projects, while razing integrated neighborhoods (Kushner 1980). Post-war, government backed suburban developments were typically white-only. White veterans were thus able to build wealth through homeownership, while POCs were denied adequate housing (Rothstein 2017). As part of the postwar "urban renewal" movement, city leaders also disproportionately demolished POC neighborhoods. Urban communities were replaced with freeways, business districts, and major destinations serving white suburban commuters (Digital Scholarship Lab 2022).

Redlining. To combat the Great Depression, in the 1930s the federal government began backing home loans. The federally-sponsored Home Owners' Loan Corporation (HOLC) assigned areas a mortgage risk from "A" (green, "best") through "D" (red, "hazardous" – the source of the term redlining) as shown in Figure 1, with redlined areas generally ineligible for favorable loans. Assessments overtly discriminated based on residents' race and immigration status, and also disfavored multifamily housing and heterogenous development (Nelson et al. 2022).³ POCs were

² In this paper we use the familiar term, single family zoning. However, we note that a single detached residence may house more than one family.

³ While just one of many discriminatory policies, we highlight redlining because it is so well documented and researched. For example, see the assessment of Boyle Heights, where Mx. Gubman's family lived during the redlining period: <https://dsl.richmond.edu/panorama/redlining/#loc=10/34.005/-118.47&city=los-angeles-ca&area=D53&adimage=3/25.642/-144.141>.

thus often unable to secure adequate housing or grow wealth through homeownership. POCs were also discriminated against in purchasing outside of redlined areas (Rothstein 2017).

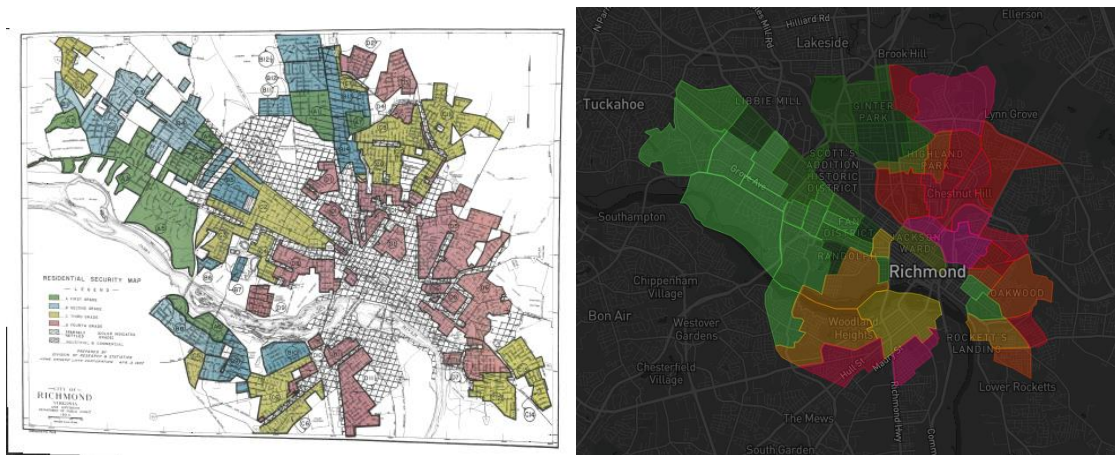


Figure 1. Historical redlining map for Richmond, VA (left), with tracts mapped to today's Social Vulnerability Index⁴ scores for the same region (right). *Source:* DSL and NCRC 2022.

The social and environmental impacts of redlining persist, as shown for the example of Richmond, VA in Figure 1 (DSL and NCRC 2022). Nationwide, residents of formerly redlined areas are disproportionately POCs and low to moderate income (Mitchell and Franco 2018). African Americans, who represent 13 percent of the general population, account for 39 percent of people experiencing homelessness (Henry et al. 2022). Redlined areas also have less greenspace (Nardone et al. 2021), less tree canopy, more impervious surfaces, and are an average of 2.6 degrees Celsius warmer than nearby “A” rated areas (Hoffman, Shandas, and Pendleton 2020). Public health disparities include higher rates of asthma (Nardone et al. 2020), late-stage cancer diagnoses (Krieger et al. 2020a), preterm birth (Krieger et al. 2020b), and air pollution (Lane et al. 2022). Polluting and toxic facilities have also continued to be disproportionately sited in communities of color (Pastor, Jr., Sadd, and Hipp 2001 and Rothstein 2017).

Design for automobile dependency. Freeways and arterials have supported segregation and White Flight, the migration of white families to segregated suburbs, and they were often built by demolishing POC neighborhoods (Rothstein 2017; Digital Scholarship Lab 2022).

These and other car-centric land use policies have pushed the public towards cars as the only viable transportation mode in many areas. Other car-centric policies include residential-only zoning that precludes walkability; excessively wide roads; on-street parking; off-street parking minimums (Shoup 2020); lack of investment in transit, pedestrian, and bicycling infrastructure (Higashide et. al. 2020); widening highways in a misguided attempt to relieve congestion;⁵ and street design guidelines that prioritize “level of service,” or the speed of an individual car passing through, rather than ease of locals’ access to jobs and amenities (Higashide et. al 2020; NACTO 2021; Digital Scholarship Lab 2022). These and other policies have made cars the only convenient transportation mode in many areas – an inequitable outcome particularly given that car ownership skews wealthy and white (Federal Reserve 2021).

⁴ The Centers for Disease Control and Prevention Social Vulnerability Index reflects factors such as poverty, lack of transportation, and crowding, which may reduce ability to weather disasters: www.atsdr.cdc.gov/placeandhealth/svi.

⁵ Due to the principle of “induced demand,” adding car lanes increases the number of trips taken by car and does not decrease congestion (Duranton and Turner 2011; Osborne et al. 2020; RMI 2021).

Car-centrism supports segregated sprawl and exclusion; disadvantages those who cannot afford a car and those for whom driving is more challenging than transit, micromobility, or walking; disproportionately subjects POCs, transit-dependent individuals, and other vulnerable groups to long commutes (Bunten et al. 2022 and Bennet 2018); disproportionately pollutes formerly redlined areas; and results in roughly 35,000 people killed each year in traffic violence, disproportionately POC and seniors (Higashide et al. 2020; NACTO 2021).

Car dependence further disadvantages the 30% of people who are unable to drive, including children, older seniors, and some disabled people (Higashide et al. 2020). Segregated sprawl also exposes POCs and other vulnerable groups to greater climate risks such as extreme heat and wildfire, pollution, and other hazards (Lowrey 2019; Raval 2019; Cal-Adapt 2021).

Cars also represent a lost opportunity for more just land use. In Los Angeles County, 14% of incorporated land is devoted to parking, precluding more equitable land uses (Chester et al. 2015). Figure 2 demonstrates how San José, California – a job center with a massive housing shortage – has historically chosen to prioritize car parking over density (Shoup 2020).

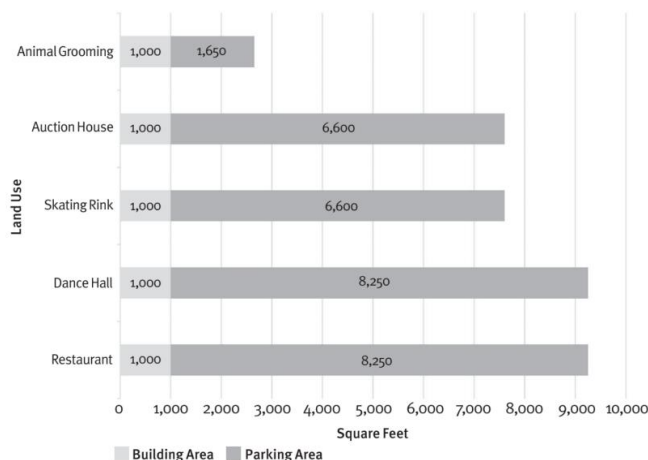


Figure 2. Parking area requirements in San José, CA. *Source:* Shoup 2020.

Opposition to infill housing. Nationwide, there is a shortage of over 7 million homes (Baron et al. 2018). Homeowners’ resistance to urban infill continues to prevent compact development in wealthy cities such as Beverly Hills, Newport Beach, Palo Alto, Pasadena, and Tiburon, California, all of which appealed the state’s housing construction requirements in 2021 (ABAG 2021; Hansen 2021; SCAG 2022). Despite almost universally losing their appeals (ABAG 2021 and Collins 2021), most jurisdictions in California (at all income levels) have failed to adopt housing plans that meet state requirements. They are thus both out of compliance with state law (Perez and Coulter 2022) and continuing to exclude potential lower-income and POC residents.

Climate and energy impacts of single family sprawl

The injustices of segregation, single-family neighborhoods, opposition to infill, and car-centric design combine to yield segregated and sprawling development – and an inherently energy-intensive lifestyle. For a non-rural family with a given electricity mix, the main determinant of their emissions is whether they live in car-oriented single family sprawl, or in a more compact urban environment in which less driving is required (Jones and Kammen 2014;

Subin 2021). As shown in Figure 3, households in outer suburbs and exurbs emit about 1.5 times as much greenhouse gases (GHGs) as similar-income urban and inner suburban households.⁶

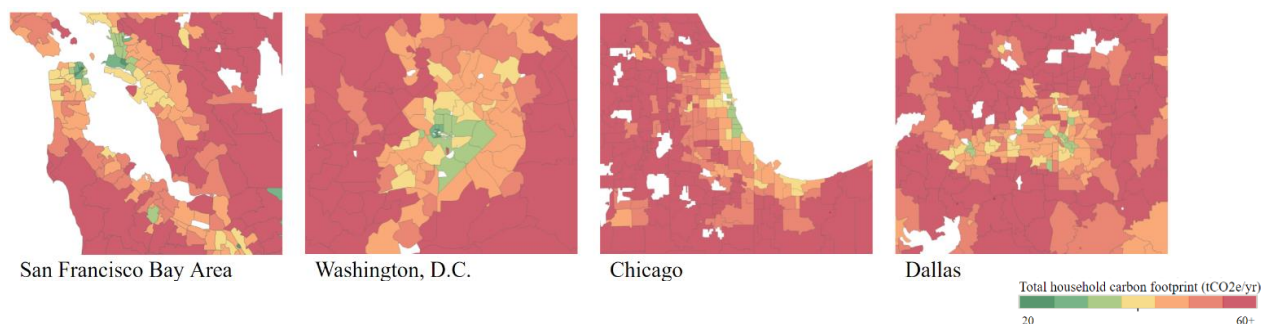


Figure 3. Annual per-household emissions on a consumption basis, for zip codes across diverse metropolitan areas (not controlling for income). *Source:* Jones and Kammen 2014.

Due to larger home size, private yards, and limitations such as parking requirements, minimum setbacks, minimum lot sizes, and maximum floor area ratios (FAR),⁷ single family developments take up a lot of space. Because of this and other factors, the homes consume twice the energy of multifamily households on a per-resident basis (EIA 2018). The amount of space required by single-family developments – along with parking mandates that encourage car ownership (Millard-Ball et al. 2021) – further cements residents’ car dependency.

Because of their large size and weight per passenger, cars are an inherently inefficient mode of transportation. The result is that transportation is the largest source of greenhouse gas emissions in the United States, and those emissions continue to rise (Mangan et al. 2020). Electric cars reduce GHG emissions per person-kilometer, as shown in Figure 4 (TNMT.com 2021), but not as much as other modes such as busses and electric bicycles – and it will take time for the entire fleet of gas-powered cars to be replaced.

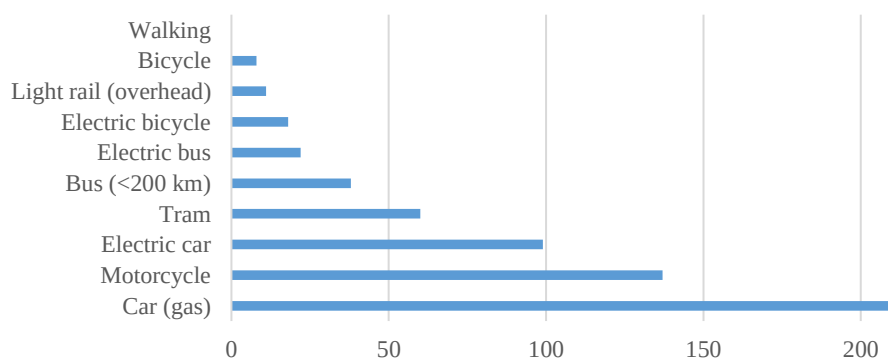


Figure 4. Average carbon emissions by transport type (in grams per person-km).⁸
Source: TNMT.com 2021.

⁶ Calculated on a per household annual consumption basis. In other words, the indirect emissions associated with purchasing objects like furniture are included, and not just direct emissions such as air conditioning. Not controlling for income, households in outer suburbs and exurbs generally emit 3 to 4 times the GHGs of more central locations.

⁷ FAR is the ratio of building floor area to lot area. To achieve a FAR of two, a builder could cover an entire lot with a two-story building, cover half the lot with a four story building, etc. FAR limits thus limit density.

⁸ Emissions vary significantly based on generation mix, occupancy, car weight, etc. See source for assumptions.

Electrification also fails to remedy other negative environmental impacts of car dependence and associated infrastructure, such as the urban heat island effect. Particulate matter from tires and brakes continue to pollute the local environment and cause adverse health outcomes (OECD 2020). Natural and working lands, which serve as carbon sinks and buffers against extreme weather, are destroyed to make way for sprawling greenfield development.

Accordingly, organizations such as the City of Minneapolis (Mangan et al. 2020), the California Air Resources Board (Hague, Kirkeby, and Pennebaker 2021), and the International Energy Agency (IEA 2021) have found that it is impossible to meet our climate goals without reducing car dependency.

The importance of land use is corroborated by the UC Berkeley California Local Government Climate Policy Tool (Jones, Wheeler, and Kammen 2018), which demonstrates that urban infill and reduction in driving are the local climate measures with the highest 2030 savings potential in many urban and inner suburban areas. As shown in Figure 5, if pursued synergistically, the twin land use measures of urban infill and reduced driving (referred to as vehicle miles traveled, VMT) have the most savings potential of all local policies in California.⁹

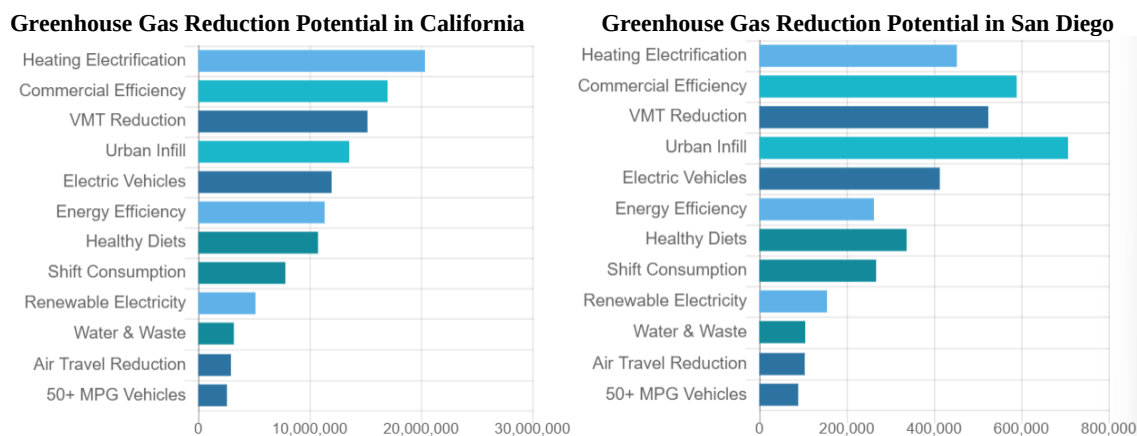


Figure 5. Greenhouse gas reduction potential (in metric tons CO₂e) in 2030 from local policies in California (left) and San Diego (right). *Source:* Jones, Wheeler, and Kammen 2018.

Current energy programs neglect land use and perpetuate inequalities

Despite widespread inefficiencies in land use, the authors are not aware of significant or broad energy efficiency measures to improve land use efficiency. Instead, energy programs have focused on improvements within the framework of an inherently energy-intensive status quo (DSIRE 2022). They include incentivizing a one-for-one transition from gas to electric vehicles or rebates for home improvements. These programs do not only leave the immense energy savings potential of alternative development patterns untapped. They also typically require significant resources (e.g., homeownership, access to capital) or interaction with government or monopoly service providers as prerequisites for participation, which almost certainly disadvantages individuals suffering from the government-backed intergenerational injustices discussed above.

In view of a nationwide housing shortage of 7 million homes, from an energy perspective the question becomes whether that shortage will be addressed by building business-

⁹ This study likely underestimates the potential of urban infill because it assumes that people of similar incomes move in. If more affordable housing is created in exclusionary neighborhoods, the potential savings are even greater.

as-usual sprawl, or by reforming land use to be more energy efficient and just (Baron et al. 2018). While some programs that promote the latter do exist, they are generally not led by energy agencies or utilities (Hague, Kirkeby, and Pennebaker 2021).

Transportation. A review of the DSIRE national energy policy database demonstrates the degree to which today's programs focus on expensive technologies such as electric vehicle charging infrastructure, neglecting land use and related mode shift. For example, there are no programs to support installation of protected bike lanes as a transportation energy efficiency measure (DSIRE 2022). Safe bike infrastructure has been shown to increase bicycle use and enables both more efficient land use and reduced transportation electrification costs (NACTO 2016a; Kraus and Koch 2021). In California, the 2021 Public Utilities Commission decision setting near-term priorities for transportation electrification does not make any mention electric bicycles or the infrastructure necessary for their adoption, even as it acknowledges significant challenges for residents of disadvantaged communities in participating in electric car charging programs (CPUC 2021). There are, however, some incentives for electric bicycle *purchase* in the United States. This is an essential, if still technology-based, approach to mode shift. To date, energy sector stakeholders have launched roughly 22 such pilots or programs nationwide (Bennett et al. 2022).

Similarly, while there are programs for the *purchase* of electric buses, DSIRE does not include any *land use* programs to encourage mode shift to transit, despite their cost efficiency and potentially high impact. Transit-only lanes, for example, allow for higher transit system capacity, faster trip times, and more reliable service with fewer vehicles (NACTO 2016b). Ensuing increase in ridership could yield greater carbon reductions at lower cost than new electric buses, and it can reduce the number of private automobiles on the road that must be substituted with electric cars in order to meet climate goals. Mode shift to transit through measures such as transit-only lanes could also support conversion of private car infrastructure into higher value uses, promoting walkability and inherently lower carbon lifestyles.

By instead focusing almost exclusively on the provision of cars, medium and heavy-duty vehicles, chargers, and compatible rate designs, energy programs continue to reinforce sprawl and its inequities, while failing to promote mode shift to lower-cost, higher efficiency transportation modes that are more likely to serve POCs and other vulnerable groups.

Housing. Today's energy programs also fail to explicitly support mixed use development and higher density housing, despite the energy and climate benefits. As an example, the Puget Sound Energy Multi-Family Efficiency New Construction Grant Program offers incentives for specific technologies and other above-code savings. However, the program does not offer incentives for adding more units, or for locating housing in higher-opportunity areas (DSIRE 2022).

Similarly, the only zoning ordinances and regulations in the DSIRE database relate to the siting of renewable energy facilities. Most of these address larger scale installations, though the City of Austin does allow solar installations to exceed the zoned height limitation by 15%. None of these programs support upzoning or incentivize denser housing as an energy efficiency measure. Given that a multi-family dwelling uses nearly half the energy of a single family one (EIA 2018), zoning policies leave an outstandingly effective energy efficiency opportunity completely untapped, while also failing to address the inequities of historically exclusionary communities and inadequate housing for marginalized groups. Similarly, codes and standards advocacy focuses on appliances and building technologies, rather than support for the land use measures of upzoning and multifamily, mixed-use development (DSIRE 2022).

Ultimately, the status quo approach of pursuing above-code, technology-based savings does not consider the question of who is eligible to participate in programs, and whether these programs perpetuate past injustices and energy inefficiencies, or instead attempt to rectify them. Is it fair and just if energy efficiency portfolios offer rebates based on above-code savings, yet fail to consider that the white homeowner of a large single family home consumes vastly more energy than a POC renter in a nearby formerly-redlined neighborhood?

Instead of continuing to offer efficient appliance rebates to disproportionately wealthy and white single family homeowners, with special carve-outs to also serve the very lowest-income ratepayers, a more just alternative would be to implement new approaches that aim to address this inequality. Such programs could include technical support for zoning changes to easily and rapidly permit dense, inherently energy efficient mixed-use development; assistance in subdividing existing single family homes or adding auxiliary dwelling units; and the dismantling and robust cleanup of unwanted commercial and industrial sites in communities of color to enable conversion to housing or amenities.¹⁰

Urban greening. Finally, while there are numerous green building programs in the database, there are no urban greening programs. One neighborhood greening program that does exist, the Sustainable Solano Vallejo Resilient Neighborhoods Project, was funded via a Pacific Gas & Electric Company community grant rather than via energy efficiency program funding (PG&E 2021).

Greening urban areas is a simple way to moderate neighborhood temperatures, and all nearby residents “participate” passively, without any program enrollment, special HVAC equipment, thermostats, or behavioral changes. Greenspace also improves local quality of life. Such initiatives can be particularly impactful in addressing the lack of greenspace in formerly redlined communities and exurban communities of color.

As long as systemic discrepancies in greenspace and local climate remain, there are also equity implications for traditional energy programs. For example, smart thermostat and demand response programs may be more challenging for participants in formerly redlined communities than for participants in their leafier, green-categorized counterparts.

Conclusion: Taking a holistic, systemic approach

America’s land use injustices have taken place in a manner that is systematic and holistic, and involve the private sector, private individuals, and all levels of government. We have argued that, to make progress in addressing these injustices, we must also act in a manner that is systematic, holistic, and involves all of society. The purview of energy efficiency programs and policies *must* include land use, because if it does not, they will perpetuate the status quo and fail to address – or may even exacerbate – injustice.

Holistic and systemic land use efficiency initiatives have the advantage of being highly efficient, scalable and inclusive upstream measures. They do not necessarily require existing resources – whether time, money, or homeownership – to benefit, and thus better serve marginalized groups that lack such resources. Examples of equitable energy efficiency measures that we discussed include transit-only bus lanes, a network of physically protected micromobility lanes, neighborhood greening, increasing building height limits, and streamlining building permits for dense, mixed-use development.

¹⁰ See, for example, the work of the Center for Creative Land Recycling, <https://www.cclr.org/resources>.

At the same time, it is important not to repeat past mistakes of top-down planning by privileged individuals that ignores the needs of underserved individuals and communities. A community may not feel an immediate need for bike lanes – community members may instead prefer slower car speeds and improved crosswalks that support pedestrian safety. In more remote, car-dependent suburbs, residents may need a stronger emphasis on electric cars, but they may also wish for better-timed transit connections. Listening to community members is essential to understanding which options – all of which increase transportation energy efficiency – best address past disinvestment and are most needed in a given neighborhood.

A systemic approach to addressing inequity also means taking a systemic approach to community input. Often, the individuals who have the time and energy to participate in local outreach processes are those with the most privilege: white, retired homeowners. If outreach does not specifically account for that skew, it risks perpetuating privilege. Programs and policies should solicit and incorporate the needs of those too often overlooked: POC, women, children, and those who cannot afford to live in an exclusionary neighborhood, but would like to, if only it were affordable.

When local residents say a proposed new height limit is too tall, that must be balanced against the overwhelming interest of families that might be able to live in the area instead of commuting from an hour away. When new housing is limited to “transit-oriented development” or busy arterial streets, this leaves on the table the integration of exclusionary communities that are more than half a mile from a transit stop yet require much less driving and air conditioning than homes in a new exurb. Likewise when drivers express concern about converting parking into transit lanes, their convenience must be balanced not just against the potential increase in transportation efficiency, but also against convenience of the typically lower-income and POC individuals who do not own a car or primarily depend on transit, as well as the independent transportation needs of older seniors, children, and those disabled people who cannot drive.

Finally, whenever considering land use measures in underserved communities, tenant and resident protections are essential. Well-meaning programs must not repeat the patterns of the urban renewal movement, demolishing communities of color. Likewise, tenants may need support to remain in neighborhoods experiencing increasing housing prices. Support could include stronger protections against eviction, various forms of rent and vacancy control, disincentives for short-term housing speculation, and legal support.

Ultimately, some people must drive, and some people prefer to live in remote locations. However, making it both technically possible and widely affordable for everyone else to live in compact, walkable and bikeable communities with clean air, functioning infrastructure, and access to jobs and amenities could have an immense impact on energy efficiency and carbon emissions. As a direct consequence of the United States' racist (and sexist, ageist, and ableist) heritage, few such communities exist in the country today. It is incumbent upon all of us to consider how, as energy and climate professionals, we can direct our work such that it supports investment in communities of color, whether urban or suburban, to help them transform toxic land use into socially, environmentally, and economically beneficial land use. And it is equally incumbent upon us to support growth and desegregation in exclusionary neighborhoods, to increase access to both economic opportunity and low-carbon lifestyles.

Technology substitution is not sufficient to accomplish this important work, and in fact can perpetuate existing patterns of privilege. To address underlying social and environmental injustices, we must begin to view transit, active transportation, multifamily infill housing, and more flexible zoning as essential energy efficiency measures.

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