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A comparative analysis of US state-level policies and programs to advance energy justice

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Abstract

The US energy system is undergoing massive changes that have environmental, technological, and societal implications. Decisions and actions taken now will dramatically alter the trajectory of our future energy system. Though new technologies can lessen the dangers of anthropogenic climate change, an effective and sustainable transition requires addressing social justice issues¹ as a priority. To this end, many states have implemented policies and programs that address energy justice. A formal survey of state-level energy justice policies and programs is needed to better understand the methods used to assist communities targeted and the impacts of these efforts. Such an analysis should include an analysis of the metrics used to judge the effectiveness of the enacted policies and programs. In this paper, we analyze the energy justice policies and programs of seven different US states. From this analysis, we identify three important aspects of state energy policies. First, most policies and programs do not articulate their goals, nor cite metrics to judge their successes. This lack of transparency and accountability is a major roadblock to truly just solutions. Second, states focus on a very narrow range of solutions for energy justice issues. The most prevalent being utility bill assistance, which does not address the systemic and enduring challenges faced by many low-income or historically marginalized communities. Lastly, comprehensive energy policy does not acknowledge and address housing, employment, education, and healthcare inequities that exacerbate energy system inequities. The work presented in this paper sheds light on the progress of state-level energy justice policies and programs across the United States, and we argue more work needs to be done to understand best practices in energy justice policymaking.

1. Introduction

The US energy system is undergoing massive changes that have environmental, technological, and societal implications. The decisions and actions taken now will drastically alter the trajectory of our future energy systems. Environmentally, emissions from the energy sector contribute to climate change [1, 2] and air pollution, which continues to contribute to public health burdens [3], especially for marginalized communities [4]. Socially, our current energy system retains significant injustices where goods and services consumed by affluent groups yield negative externalities that disproportionately impact historically marginalized and disproportionately impacted groups [4]. Thus, although new renewable and energy efficiency technologies are increasingly cost-effective [5], reliable [6], and have the potential to combat the dangers of anthropogenic climate change, an effective and sustainable transition requires addressing social justice issues raised by the power sector [7].

Based on the United States' philosophy of environmental justice, energy justice is characterized by three tenants: distributional, recognition, and procedural justice [8–10]. Distributional justice analyzes the

unequal distribution of benefits and burdens associated with the energy system and manner the in which inequities are resolved [8, 10]. Recognition justice identifies specific communities which were previously marginalized by processes associated with the energy system and how they are being recognized moving forward [8, 10]. Procedural justice seeks to understand the processes by which these inequities are remediated including equitable engagement in energy governance matters by all stakeholders in non-discriminatory manner, along with full information disclosure by governmental and utility agencies [8, 10–13]. As we transition towards a more sustainable energy system, an adherence to energy justice is key if we want to both provide all households with modern and affordable energy services and ensure the benefits of future energy systems are justly shared with previously marginalized communities [14, 15].

New United States federal policy has emphasized the importance of not only a renewable, but also of a just, energy transition in which energy investment benefits disadvantaged communities [16]. Much of the current literature available on energy justice policy focuses on the national level programs. For example, there are multiple reviews of the impacts of the Low-Income Home Energy Assistance Program (LIHEAP) [9, 17, 18] and the Weatherization Assistance Program (WAP) [19–21]. The Low-Income Household Water Assistance Program (LIHWAP) is another federally funded program created in response to the COVID-19 pandemic, however we found no national level reviews of this program. Beyond this, several European nations have conducted both national-level energy justice analyses [22–24] and global-scale analyses [25].

These national-level energy justice analyses indicate two important features of successful energy justice policies: community involvement and regionally specificity [9, 10, 19, 26–28]. Large-scale nationwide policies suffer from a lack of specificity when it comes to addressing unique community needs, the ability for communities to clearly articulate these needs, and their ability to affect the creation of rules and policies. In this work, we seek to analyze more targeted, state-level energy justice policies and programs.

To our knowledge, little work has been done in this area [9], though there has been some research on individual state policies [29] and programs [19, 30], with the most comprehensive work thus far conducted by Carley *et al*, which cataloged the energy justice policies across the United States. This work analyzed the geographic scope and spatial distribution of policies across different regions in the United States and also categorized these policies into one of five program types: collective action, infrastructure expansion, assistance, workforce/jobs, or democratization [31].

While this work inventoried energy justice policies across the United States, it did not seek to evaluate the mechanisms used by these policies to enact change. Furthermore, it did not analyze how state energy offices and utilities execute their WAP, LIHEAP, LIHWAP, nor utility assistance programs. Each of these are critical components of state-level energy justice efforts especially given that these policies represent a substantial amount of federal and utility monies that are being invested into energy justice programs.

The aim of this paper is to analyze energy justice-focused policies and programs enacted by state governments and utilities. In this study we examine the purpose and impact of these policies by answering the following questions:

1. Which communities did/do these programs target?
2. What methods did/do these programs use to impact the targeted communities?
3. Who is funding the program?
4. Which metrics did/do these programs use to measure success?
5. How effective/accessible have these programs been based on the aforementioned metrics?

Section 2 of the report outlines the policy and program search methodology along with the selection of case study states. Section 3 gives an overview of the energy justice policies and trends from each selected state. Section 4 discusses the finding to the questions posed above along with other findings from the analysis.

2. Methodology

We employ a two-part methodology to understand how different state governments and utilities have approached energy justice issues. In the first part, we outline a search methodology to identify all relevant policies and programs. In the second, we formulate a case study selection process.

2.1. Energy justice policy and program search methodology

Our analysis was based on a thorough online search for relevant policies and programs enacted by state governments and utilities. We then analyzed each policy or program identified by asking the five questions stated in the Introduction. Following this we synthesized the data from these questions and evaluated the results. These steps are outlined below.

Table 1. Case study state characteristics.

State	Population (millions) ^a [32]	Urban percentage ^b [33]	IECC climate zone [34]	Renewable energy generation ^c [35]	Political leaning ^d
WY	0.58	64.8	6B, 7	22%	Republican [36]
GA	10.7	75.1	2A, 3A	7%	Republican [37]
TX	29.1	84.7	1A, 2A, 3A, 2B, 3B, 4B	26%	Republican [38]
CA	39.5	95.0	2B, 3B, 4B, 5B, 6B, 3C, 4C,	36%	Democratic [39]
NC	10.4	66.1	3A, 4A, 5A	13%	Republican [40]
VT	0.64	38.9	6A	76%	Democratic [41]
CO	5.7	86.2	4B, 5B, 6B, 7	33%	Democratic [42]
US	311.4	80.7	1A, 2A, 2B, 3A, 3B, 3C, 4A, 4B, 4C, 5A, 5B, 5C, 6A, 6B, 7, 8	20%	2020: Democratic 2016: Republican 2012: Democratic 2008: Democratic 2004: Republican

^a Population estimate in 2020.

^b As defined as people living in US Census Bureau urban areas in each state.

^c Percent of state-wide solar, wind, and hydroelectric energy generation.

^d Based on last five presidential election results.

The initial online search was conducted by three researchers from May 2021 to September 2021 to develop a database of state-level energy justice policies and programs. This database was revised and updated through June 2023. These online searches relied on the use of several key words within different online domains. These domains included publicly available search engines, regional, state, and local news sources, regional, state, and local policy websites, and the websites of utilities and their affiliated organizations. The key words used to search for relevant policies and programs included *environmental justice*, *energy justice*, *energy equity*, and *energy assistance*. It is important to note that a search would routinely start with one of the key words mentioned above or at a website of interest and through further investigation the search would morph given the unique language and terms used by each entity analyzed.

For each policy or program we found, we attempted to answer the five questions stated in the Introduction. Through this analysis, we were able to identify the purpose of each and, if possible, the impact created. Tables 1–7 in the supporting information provide the complete set of policies and programs we found, along with the answers to our questions. It is important to note that we only searched through publicly available websites.

While we recognize that the information to answer some of our questions probably exists, but is perhaps not publicly available, we did not actively seek permission to view this data from their sources. As stated previously, procedural justice is marked by data accessibility and full disclosure by state agencies and utilities [13]. We also recognize that our review was not a comprehensive review nor was it fully replicable given the dynamic searching process. For this reason, we encourage our scholarly peers to continue to review these policies and programs, monitor how these programs and their answers to our questions evolve to best serve communities at the frontlines of energy injustices.

2.2. Case study selection process

To gain a general understanding of energy justice policies and procedures across the United States, we elected to do a detailed analysis of seven of the 50 states for this study. Our selection process focused on achieving a diverse group of states representing varying population sizes, levels of urbanization, climates, renewable energy generation, and political leaning (table 1). The states we chose are Wyoming, Georgia, Texas, California, North Carolina, Vermont, and Colorado. While these states may not provide a perfectly representative sample of the entire nation, we believe that they provide valuable points of comparison which are considered in section 4. Furthermore, we believe the conclusions we draw from the case studies will be of value to and motivate subsequent research and analysis of energy justice initiatives, especially in the states we chose not to examine.

3. Case studies

This section provides an overview of existing energy justice policies and programs enacted by state governments and utilities. While LIHEAP, LIHWAP, and WAP are federally funded, each state is charged with

the administration of the funds they receive via these programs. Therefore, we include how each state chooses to use these funds in our analysis. Each section concludes with a basic synthesis of the results from each state analysis. We present a comparative analysis of all the states in section 4. We begin with a review of the states with the least aggressive energy justice policies and proceed to states with more ambitious programs.

3.1. Wyoming

Wyoming's state government has taken no obvious legislative or executive action to address energy justice issues. No energy justice programs exist, except for the federally funded Low-Income Energy Assistance Program (LIEAP)⁴, WAP, LIHWAP, and a single non-profit, Energy Share of Wyoming. Energy Share of Wyoming was established in 1986 'to help people in hardship circumstances with energy-related emergencies' statewide and is funded by private donations and several Wyoming utilities [43]. In 2020–2021, Energy Shared gave a total of \$142 081–469 households, for an average of approximately \$303 per recipient [43]. According to the US Census Bureau, these 469 households represent less than 2% of Wyoming's households in poverty [44]. Three of these four programs, the LIEAP, LIHWAP, and Energy Share of Wyoming, help pay residents' utility bills [45]. The third, WAP, improves the energy efficiency of qualifying households in Wyoming [45].

Based on our analysis of Wyoming energy justice policies and programs, we found that Wyoming's government and utility regulatory bodies have not placed significant focus on energy justice issues. That being said, Energy Share has tracked and shared the amount of contributions they have received, along with the number of successful applications and total monies dispersed to the applicants. Finally, Wyoming's policies and programs focus only on home weatherization and utility bill assistance.

3.2. Georgia

Georgia's state government does not appear to independently provide any programs in support of energy justice beyond the federally funded LIHEAP, LIHWAP, WAP programs. Many of Georgia's utility providers offer some financial assistance to vulnerable populations, especially to senior citizens [46], although no statewide obligation requires Georgia utilities to do so. Additionally, Georgia's power utilities, along with state and local governments, significantly fund two statewide energy justice programs run by independent nonprofits. The Heating Energy Assistance Team, Inc. program receives funds from multiple public and private sources to distribute energy assistance funds to vulnerable Georgians to pay for gas heating bills, however their website is no longer active [46]. The second is Project SHARE, which is operated by the Salvation Army and is 'largely funded through the monthly donations of Georgia's utility customers—most notably, Georgia Power customers' [47]. Project SHARE, beyond LIHEAP support, provides emergency assistance in utility bill payments for those 'facing a temporary crisis that threatens their home' [47]. While Project SHARE does share some annual statistics of the total amount of aid given and the number of impacted Georgians, the program also assists residents with housing, employment, health, and safety issues beyond the scope of energy justice [48]. Therefore, it was impossible to disaggregate the monies going specifically to utility bill assistance.

Like Wyoming, Georgia goes little beyond federal programs to address energy justice issues. LIHEAP and all utility- and nonprofit-based programs simply help residents pay their energy bills and information on the scale of this assistance was not found. Similarly, the federally funded WAP is Georgia's only program attempting to address home weatherization improvements. Unlike Wyoming, of the programs that are available to Georgians, no formal metrics are readily published online to enable evaluation of non-federally funded energy justice efforts in the state. But like Wyoming, the focus of these programs is restricted to home weatherization and utility bill assistance.

3.3. Texas

Similar to the previous states, Texas disburses federal funds through LIHEAP (which is administered by the Comprehensive Energy Assistance Program), LIHWAP, and WAP. Of these three, in its annual file worksheet, the Texas WAP does report the current year's anticipated, the previous year's anticipated, and previous year's actual number of weatherized units and estimated energy savings. In 2021, 564 of an estimated 1269 (44%) units were weatherized using this program. Beyond these programs, Texas has taken some legislative steps to address energy justice issues. Texas Senate Bill 1434, which was enacted in 2011, established rules governing funding that transmission and distribution utilities were mandated to provide to 'low-income energy

⁴ The Low-Income Energy Assistance Program (LIEAP) is Wyoming's version of Low-Income Home Energy Assistance Program (LIHEAP).

efficiency programs' each year [49]. Along with this, Texas Senate Bill 1976, which was signed into law in 2017, authorized utilities to establish their own additional low-income customer benefit programs [50]. It also directed the Texas Department of Health and Human Services to work with the Texas Public Utility Commission (PUC) to support any efforts to provide assistance to low-income customers, primarily through the development of a database which automatically enrolls eligible Texas residents [50]. Along those lines, we have counted 32 of Texas' 250 retail energy providers that have created programs of their own that support energy justice initiatives [51, 52]. These programs seem to provide broader range of energy justice benefits compared to the limited scope of the nonprofit-type programs supported by utilities in Wyoming and Georgia. The Texas PUC issued a new policy in July 2019 to clarify the parameters of the collaborative low-income customer database effort and to specify the process for any retail energy provider seeking access to it for a low-income customer benefit program.

Based on our analysis of Texas energy justice policies, we found that state lawmakers have shown some commitment to help residential energy consumers pay their electric bills beyond what is already provided by LIHEAP. Unfortunately, Texas has not enacted similar levels of programs to bolster the federally funded WAP or LIHWAP. Though these programs expand the capabilities of the Texas state government and the states' utilities to identify vulnerable residents, the same energy justice issues, home weatherization and utility bill assistance, are addressed as the states reviewed previously. Like Georgia, Texas does not publicly provide any formal metrics to track the impact of their non-federally funded programs.

3.4. California

California has taken significant steps to go beyond the federally funded WAP and LIHEAP programs. California was the first state to use LIHEAP funding to bring solar photovoltaic systems to low-income communities, with the solar for all California program launched in 2010. This program was expanded in 2013 to include the installation of solar water heating systems in low-income houses. The success of this program helped jumpstart the California Solar Initiative (CSI) which was established in 2016 by California Assembly Bill 217 [53].

CSI catalyzed solar photovoltaic development statewide, but several features of this initiative have energy justice implications. First, CSI is funded through a utility bill surcharge of which low-income customers are exempt [53]. Second, this act led to the creation of the Single-family Affordable Solar Homes (SASH) Program and the Multifamily Affordable Solar Housing (MASH) Program, both of which provided incentives to low-income single family homeowners and income-qualified multifamily building owners served by investor-owned utilities, beyond those generally available through CSI [54, 55].

After the success of the solar for all California pilot program, the state's Department of Community Services and Development created the Low-Income Weatherization Program (LIWP). This program, which is separate from the federally funded LIHEAP and WAP, receives its funds from California's cap-and-trade auction proceeds. As of 2022, LIWP has received more than \$182 million since its launch in 2014 [56]. Beyond weatherization and energy efficiency upgrades, LIWP help low-income households with solar photovoltaic systems, with special provisions for farmworker and multifamily households [57].

Beyond these programs, the California Public Utilities Commission operates three of its own energy justice-focused programs. The first and second, the California Alternate Rates for Energy (CARE) program and the Family Electric Rate Assistance (FERA) program provide monthly discounts on energy bills for income-qualified households [58–60]. In addition, the FERA program provides direct installation weatherization and energy efficiency improvement services to eligible low-income households at no cost [58]. The third, the Energy Savings Assistance (ESA) program, provides free weatherization upgrades to households who meet the CARE eligibility requirements [61].

California has clearly made energy justice a priority, as is evident by the sheer number of programs available, the types of technologies available through these programs, and how they are funded. California has also created various programs to augment traditional weatherization and energy efficiency programs to include photovoltaic systems and solar water heating. Additionally, California has found novel ways to fund these programs beyond the support provided by federal programs. Additionally, some of these programs provide annual reports or impact evaluations. These include the LIHEAP Household Report [62], the WAP State Plan [63], the SASH Semi-annual Progress Report [64], the MASH Semi-annual Progress Report [65], the LIWP Impact Report [57], and the ESA Monthly and Annual Reports [61]. While most of California's energy justice policies and programs focus on home weatherization and utility bill assistance, the funding of solar photovoltaic systems through LIHEAP, SASH, MASH, and LIWP give additional energy autonomy and resilience benefits to marginalized communities.

3.5. Vermont

Vermont, like other states, implements federally funded Energy Assistance Program⁵ (EAP), Water Assistance Program⁶, and WAP programs. In addition, Vermont has also adopted a wide array of related programs and policies to address different energy justice issues. One, the thermal efficiency task force weaves the EAP and WAP into ‘an integrated and comprehensive statewide whole-building approach to thermal energy efficiency’ with an explicit ‘focus on low- and modest- income Vermonters’ [66]. In 2007, Vermont’s government amended 10 V.S.A. § 581 to state that ‘it shall be goals of the state: [...] to increase weatherization services to low-income Vermonters by expanding the number of units weatherized, or the scope of services provided, or both, as revenue becomes available in the home weatherization assistance trust fund’ [67].

On a strategic level, in 2015 the state passed 30 V.S.A. § 202b, which obligated its Department of Public Service to issue the 2016 Vermont Comprehensive Energy Plan and to update it every six years with input from a diverse array of community stakeholders [66]. The plan addresses a variety of energy justice issues. First, it calls for the equitable distribution of the benefits and burdens of the energy system with a focus on the high upfront costs of energy efficiency and fuel switching [66]. Second, the plan directs the state government to be aware of priced-based energy policies that could become regressive (e.g. electric vehicle rebates which are only accessible to high-income households) and to increase energy justice mitigation measures commensurately [66]. Next, the plan stipulates that the government must pay attention to barriers, participation, and the varying needs of all residents, especially low-moderate income households and renters, in the energy transition [66]. Lastly, the plan recognized other noneconomic issues such as the health impacts of the energy system on vulnerable citizens [66].

Through their legislative actions, Vermont lawmakers gone beyond the states previously analyzed in addressing a wide range of energy justice issues. Not only has the state augmented federal funding for utility bill assistance, home weatherization, and energy efficiency improvements, but it has also recognized how governments can impact energy justice in other ways. First, Vermont addressed the health implications of equitable energy access. Second, it addressed an economic issue other than energy bill assistance in the understanding of how energy subsidies can discriminate based on their formulation. Though it is crucial that Vermont has acknowledged these issues, they have not yet implemented programs to address these issues. Finally, as with the other states, we did not identify any metrics by which Vermont evaluates the effectiveness of its non-federally funded energy justice programs.

3.6. North Carolina

Like Vermont, North Carolina has gone beyond home weatherization and utility bill assistance in addressing the state’s energy justice issues. Like other states, one of North Carolina’s three primary utilities, Duke Energy, has its own programs, especially for elderly and disabled customers, to increase energy affordability in its territory alongside the federal LIEAP⁷, LIHWAP, and WAP programs [68]. However, at the direction of Executive Order 80, the North Carolina Department of Environmental Quality and the North Carolina State Energy Office developed the state’s Clean Energy Plan [69, 70]. It established six goals, the first being equitable energy access and a just transition with corresponding distributional, recognition, and procedural justice strategies [69]. Second, the plan calls for workforce development for low-income communities which are displaced by new clean energy developments [69]. Third, the plan stresses the need to include historically marginalized communities in the decision-making process, creating economic opportunities for individuals in those communities and developing new utility rate classes for low-income ratepayers [70, 71]. Guided by the plan, the North Carolina Utilities Commission has ushered more stakeholders and community organizations into the development of the latest utility rate case alongside Duke Energy [71]. The commission directed the stakeholder group to explicitly consider many rate options, including the development of a new income-based rate structure at Duke Energy [71]. Furthermore, in 2020, Executive Order 143 established the Andrea Harris Social, Economic, Environmental, and Health Equity Task Force to develop inclusive policy proposals with input from minority groups, including the development of the Clean Youth Apprenticeship program which prepares students for a clean energy economy [72].

Unlike other states, North Carolina is making sweeping changes to recognize marginalized communities. North Carolina is empowering marginalized communities by giving them a seat at the table. Offering these groups far more agency and self-determination in the energy sector will increase the likelihood that the new system will address energy justice issues in the future. Along with this, North Carolina has addressed an economic issue beyond utility bill assistance by recognizing the impact of displaced energy communities

⁵ The Energy Assistance Program is Vermont’s version of the Low-Income Home Energy Assistance Program (LIHEAP).

⁶ The Water Assistance Program is Vermont’s version of the Low-Income Hot Water Assistance Program (LIHWAP).

⁷ The Low-Income Energy Assistance Program (LIEAP) is North Carolina’s version of Low-Income Home Energy Assistance Program (LIHEAP).

along with making commitments to workforce development for these and other marginalized communities. Unfortunately, the directives from the Clean Energy Plan have yet to lead to tangible change. Furthermore, like most of the other states studied above, North Carolina appears not to have identified any metrics by which to evaluate the effectiveness of its existing non-federally funded energy justice programs, nor do these programs go beyond utility bill assistance and home weatherization.

3.7. Colorado

Colorado combines several notable features found in some of the other states studied above, making it the most advanced state when it comes to addressing energy justice. In addition to utilizing the federal LEAP⁸, LIHWAP, and WAP programs, Senate Bill 20B-003, authorized \$5 million to be set aside for a LIEAP to be administered by the non-profit Energy Outreach Colorado. These monies are to be used with private and public donations for utility bill assistance and home weatherization programs [73, 74]. Colorado has also taken various steps to affect a more equitable transition to renewables for low-income households. Similar to California, Colorado expanded the scope of the federal programs by receiving approval from the US Department of Energy in 2015 to include rooftop solar photovoltaic as a part of its WAP offerings [75, 76]. The state's trailblazing Community Solar Gardens Act of 2010 (House Bill 10-1342) includes provisions giving subsidized access to low-income ratepayers [77]. Additionally, after recognizing that low-income households were paying toward the state's renewable energy standard yet not receiving any direct benefits, Colorado's PUC required the public utility Xcel to provide 20 megawatts of solar to low-income customers through multiple avenues (primarily community solar gardens) between 2017 and 2019 [78]. This program returned significant portions of the low-income customers' renewable energy standard fees to pay for their own solar installations. It also established new low-income considerations for larger community solar program bids [78].

To mitigate pollution and climate effects of fossil-fueled energy, Colorado has passed laws that both recognize and empower burdened communities to establish their own regulations. For example:

- Senate Bill 19-181 changed the state Oil and Gas Conservation Commission's mission from fostering oil and gas extraction to regulating extraction to protect public health and the environment. It also gives authority to local jurisdictions to implement regulations that are stricter than statewide rules [79].
- House Bill 19-1261 created a new commission to identify rules and policies that reduce greenhouse gas emissions and pollutants statewide, but with a focus on the most affected disadvantaged communities [80].
- Senate Bill 21-272 directs Colorado's PUC to take consideration of disadvantaged communities and low-income households when adopting any rule change [81]. House Bill 21-1266 expands on this measure, further defining the impacts of greenhouse gases and pollutants on disadvantaged communities, and mandates the reinvestment of monies generated by pollution penalties, into disadvantaged communities [82].

And in a novel move by a state, Colorado passed House Bill 19-1314, which led to the Colorado Just Transition Action Plan [83]. It focuses on Colorado's vulnerable communities that rely on fossil fuel energy industries, laying out several potential support strategies that Colorado could adopt [83].

Colorado has gone beyond other states by addressing the greatest number of energy justice issues. Like California, Colorado expanded the funding and scope of the energy assistance and home weatherization programs to include solar photovoltaic systems. Like Vermont, Colorado not only identified health issues associated with the energy system but also passed legislation to give local jurisdictions the power to mitigate the pollution that can lead to these issues. Lastly, in House Bill 19-1314, Colorado addressed workforce-related energy justice issues impacting residents in energy justice communities. However, like most other states, Colorado does not have any metrics to evaluate the success of these different non-federally funded programs and policies.

4. Discussion

The purpose of this study was to evaluate the purpose and impact of state government and utility energy justice policies and programs and to determine how they addressed these five questions:

1. Which communities did/do these programs target?
2. What methods did/do these programs use to impact the targeted communities?
3. Who is funding the program?

⁸ The Low-Income Energy Assistance Program (LEAP) is Colorado's version of the Low-Income Home Energy Assistance Program (LIHEAP).

4. Which metrics did/do these programs use to measure success?
5. How effective and accessible are these programs based on the aforementioned metrics?

Note that while we address each of the five questions above, we do not address them in order. What follows is a summary of the most important findings.

First, there is a general lack of metrics or goals across the non-federally funded policies and programs analyzed and even fewer evaluations based on these metrics. While the LIHEAP, WAP, and LIHWAP programs mandate state reporting as a part of their grant funding [84–86], of the non-federally funded energy justice policies and programs that we examined, only eight of 25 had publicly stated metrics or goals. Therefore, to answer question 4, over two thirds of energy justice policies and programs identified in our analysis do not have any stated metrics. The lack of specific metrics makes it impossible to know the purpose of these policies and programs and if they are truly addressing energy justice issues. Furthermore, only three of the 25 policies and programs that we examined publicly shared any outcomes from the work they did. Thus, for over 85% of these policies and programs it was impossible to answer question 5, given the lack of reporting. Without any metrics or reporting of those metrics, it was impossible to determine the effectiveness of these programs and any potential barriers that households face in accessing these programs.

This lack of reporting is a fundamental barrier to energy justice and a glaring procedural justice issue. Sovacool notes in *Global Energy Justice* that ‘the availability of information [is] [...] a condition of participation and informed consent’ [7]. Others agree. Palast, Oppenheim, and MacGregor state that ‘transparency in information and procedures should be taken into consideration so that there can be positive results for all’ [87]. While Kravchenko contends that ‘maximum disclosure and transparency of governmental files should exist’ [88]. If states truly seek energy justice for their residents, publicly available goals, metrics, reporting, and evaluations are essential.

Beyond this, states should also consider the types of goals and metrics used to judge their policies and programs. Currently, the metrics used by state-level energy justice initiatives are almost exclusively confined to the number of households weatherized, the estimated energy savings, or the installed capacity of residential solar photovoltaic systems. While these metrics indicate that things have improved, from a distributional justice perspective they do not demonstrate that any energy justice issue has been resolved [10].

Given the widespread deployment of smart meters, it is possible to develop a wide array of new energy justice metrics based on this detailed household consumption data. For example, a household’s cooling slope is the amount of additional energy required to cool a household given a 1°F increase in outdoor temperature [89]. This metric could be used to identify the least efficient households, inform program eligibility, help identify appropriate interventions for individual households. This data would also allow these metrics to go beyond household demographics to measure behavior changes. Given the increase in extreme weather events due to climate change [90], access to and the use of cooling technologies are critical reduce heat-related mortality and morbidity during heat wave [91, 92]. Being able to measure which households are choosing to not turn on their cooling technologies during these warm periods can help point to households facing energy insecurity issues or who could benefit from weatherization or AC efficiency upgrades [93]. Behavior response pre- and post-program interventions can also be measured. One example is the use of the energy equity gap metric which measures the outdoor temperature when a household turns on their heating or cooling systems. A household which has been weatherized may choose to turn their cooling system on sooner knowing that their system will not need to run as much to maintain the cooler indoor temperature [94]. In some cases, an increase in energy use is an indication of success, as with the increased utilization of cooling during a heat wave, and in other cases decreased energy use is the desired outcomes, as with weatherization. The nuance of these outcomes cannot be captured by a single, generalized metric.

Beyond economic and behavioral indicators, states can also look to other metrics to judge the effectiveness of their energy justice policies and programs. Monitoring air quality in vulnerable communities is an important distributional justice issue given the siting of renewable energy generation stations and the decommissioning of fossil fuel power plants [95, 96]. Along with this, metrics could focus on employment, according to 2020 National Solar Job Census conducted by the Solar Energy Industries Association female, Black, and Latino workers were all underrepresented in this field [97, 98]. Therefore, we call for states to both broaden the metrics and goals that they outline for their energy justice policies and program and ensure that these metrics are appropriate to measure the success of these initiatives.

Second, most state-level energy justice policies are similar in the issues they address. With some notable exceptions, most policies and programs analyzed target utility bill assistance, home weatherization, or energy efficiency improvements while ignoring a wide array of other energy justice issues impacting their residents.

California, Colorado, North Carolina, and Vermont are the only states that address issues other than the ones noted above.

First, California and Colorado include the funding of solar photovoltaic system in their energy justice policies and programs. These systems give marginalized communities more energy agency along with the ability to avoid, minimize, adapt, and recover more quickly from an energy disruptions [99]. Second, Vermont's Comprehensive Energy Plan acknowledges the regressive nature of some government subsidy programs, which funnel tax money generated by all citizenry to only a select few who are able to participate (e.g. electric vehicle rebates). Third, Colorado, North Carolina, and Vermont have created policies to address the negative health issues created by energy-related activities, which are borne predominately by marginalized communities. With Colorado, backing local governments if they see fit to increase the stringency of local pollution laws. Fourth, North Carolina has incorporated procedural justice into their energy policy by bring more communities to the decision-making process for utility rates and inclusive policies. Finally, Colorado and North Carolina have stated plans to address energy justice issues within the workforce by supporting workers and families in energy-vulnerable communities.

Therefore, in answering question 1, the communities that are targeted by most state-level energy justice policies and programs are those households with incomes below a certain threshold that qualify for utility bill assistance or households with poor housing conditions that qualify for home weatherization or energy efficiency improvements. In answering question 2, the primary method for combating energy injustices is through home weatherization and utility assistance programs. That being said, California, Colorado, North Carolina, and Vermont have augmented to some degree the households impacted by their energy justice policies and programs along with the type of assistance that they offer.

Third, funding for state-level energy justice policies is still dominated by federal funding. To answer the third question, California was the only state to develop a novel system to generate funding for energy justice related policies by using the proceeds from the cap-and-trade auctions to support the LIWP along with a utility bill surcharge to support the CSI. Similarly, Colorado, Vermont, and North Carolina have also pledged support to various energy justice efforts through budget allocation. All other states rely on federal funding, funding from utilities, private donations, or subsidization to support their energy justice efforts. Given this constraint, it is not surprising that there is a lack of support for issues beyond utility bill assistance and home weatherization.

Fourth, energy justice policies tend to focus on the economic impacts of the energy system and not on the underlying systemic issues. Though these systemic issues cannot be changed by energy policy alone, it is important to note that housing, health, and employment factors all impact and are impacted by the energy system. More comprehensive energy plans could recognize these interconnections and advocate for their inclusion as a part of their overall energy justice strategy.

Lastly, of the states we analyzed, political leaning followed by increased renewable energy generation capacity are the most important for determining the breadth and depth of energy justice policies and programs. Colorado, California, and Vermont which all lean more liberal have the most robust state-level energy justice portfolios. While North Carolina may be the exception leaning more conservatively, it is important to note that the two executive orders which have spurred most of the energy justice policies in this state have come from a democratic governor [100]. While this may not come as a surprise, it is nevertheless important challenges to recognize in our progress towards energy justice for all. Along with this, Vermont, Colorado, and California, which have all invested significantly into various energy justice initiatives, have the largest shares of renewable energy production of the states we analyzed [35]. We postulate that investment in and siting of these technologies along with the phasing out of fossil fuel power plants brings energy justice issues to the forefront. Finally, we initially hypothesized that states with increased environmental burden due to the extraction and burning of fossil fuels would have more emphasis on energy justice given the adverse health impacts experience by their residents. However, given the findings of Thind *et al* and this work, there does not appear to be a link between these two characteristics [101]. It appears that other state characteristics such as population size and distribution, climate, and region do not seem to impact the energy justice policies and programs of the states we analyzed.

Though many states are taking steps to address energy justice, much work still needs to be done. This study is an initial attempt to shed light on the types of energy justice issues addressed by state governments and utilities. This report explored only seven of the 50 states. To get a more complete picture of the state-level energy justice policies and programs across the United States, we recommend the remaining states be analyzed as well. Such a more thorough analysis may identify other systemic drivers of energy justice and suggest other best practices in energy justice policymaking.

Data availability statement

All data that support the findings of this study are included within the article (and any supplementary files).

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- Jesse Geiger: investigation, writing—original draft, writing—review and editing.
- Patrick Gibbs: investigation, writing—original draft, writing—review and editing.
- Morgan Bazilian: conceptualization, methodology, supervision, writing—review and editing.
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Conflict of interest

The authors whose names are listed immediately above certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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