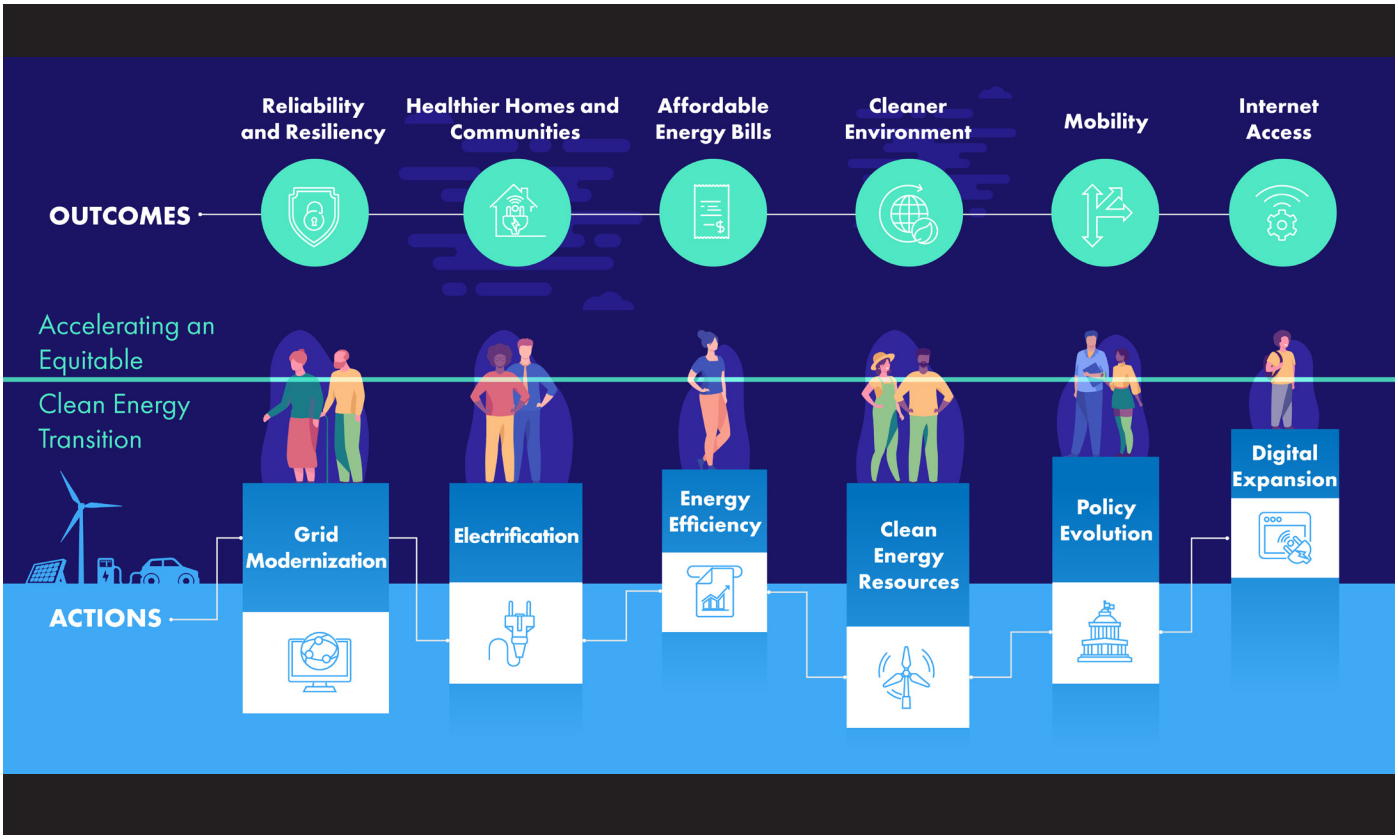
MEASURING ENERGY JUSTICE



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Abstract

As the just transition garners increased attention in energy policy and research, the development of methods for measuring energy justice has seen a significant rise in demand over the last decade. The task of tracking and potentially standardizing aspects of justice opens debate over the importance of social, economic, environmental, and cultural factors that may vary by community, class, race, gender, or geography. Policies and programs intended to increase energy equity necessitate accountability mechanisms to verify their success. This report provides an overview of scholarship pertaining to energy justice measurement as well as the small but growing number of efforts by state governments to develop and implement energy justice metrics. The investigation of public documents finds that the vast majority of states lack mechanisms for measuring energy justice. Although numerous states possess documents recommending their creation, only three have developed concrete metrics relating to energy justice. Often underscoring the lack of human-centered research in the energy field, contemporary energy justice scholarship provides numerous examples of metrics that advance justice outcomes using differential and multicriteria approaches.

Introduction

As the US economy embarks on a major shift toward a decarbonized energy system, discussion around the distribution of negative and positive externalities of energy and climate policy within historically marginalized communities is growing. Although the surge in popular consciousness is relatively new, energy inequity is not: longstanding racial and economic disparities in energy burden and energy insecurity are well documented (Drehobl et al., 2020). Research demonstrates that state and federal programs intended to mitigate high energy costs for low-income residents fall short in meeting overall need (Hernández and Bird, 2010; Bednar and Reames, 2020). Despite the rapidly growing market for renewable energy, communities of color and those in the lowest income brackets are frequently excluded from the benefits of these advancements (Sunter et al., 2019). Implications of the clean energy transition for American workers also remains uncertain, as unionization rates for workers in the solar and wind industries amount to about half of those in the fossil fuel sector (NASEO and EFI, 2020). Worker concerns about the transition also include the wage differential between the renewable and fossil fuel sectors as well as the geographic redistribution of jobs. More broadly, the push for rapid decarbonization is closely connected with equity concerns for many frontline and Indigenous communities, who hold that strategies used to limit global average temperature rise such as carbon offsets and "net-zero" emissions targets are prolonging legacies of colonialism and environmental violence while failing to meet critical emissions reductions (see Cadena et al., 2019; Stabinsky et al., 2021). Prominent Indigenous rights and climate justice groups across the United States assert that governments and corporations must focus on the equitable phaseout of fossil fuels as their fundamental priority, further begging the question of energy equity (Stabinsky et al., 2021).

While federal, state, and local governments develop plans to address the climate crisis, researchers and community stakeholders have undertaken efforts to establish discrete metrics to measure the state of BIPOC (Black, Indigenous, and People of Color), working-class, and frontline communities throughout the energy transition. This report explores the development of energy equity metrics and tools in energy justice scholarship and at the state level to analyze the status of energy equity measurement and identify potential opportunities for metric improvement and expansion.

Discussion of energy equity metrics requires clear differentiation between equity and equality. Unlike equality, commonly used to describe the provision of equal resources and rights for all people, equity includes the rectification of historical and systemic injustices (Martín and Lewis, 2019). Equity ends present exclusions and disparities and counteracts the historical legacies of those disparities through the implementation of reparations and the redistribution of power and resources. In addition to establishing fundamental

rights such as equal treatment under the law and freedom from bias, often associated with *equality*, equity redresses both present and historical disparities (Martín and Lewis, 2019). Martín and Lewis use water utility rate-setting to distinguish the two: although equal treatment would make rate fees the same for all individuals regardless of identity, equitable treatment would go further by redressing both past wrongs and current disparities. This distribution of cost is predicated on the assumption that "the gaps are a symptom of a longer-running, chronic condition," and that "Inequity is cumulative, and equity, therefore, cannot be achieved through one singular action" (Martín and Lewis, 2019, p. 2).

Further, energy justice is achieved through the amelioration of energy inequity. Lanckton and DeVar (2021) define energy justice by intertwining the concept of equity with community participation in the energy system. They denote it as "the goal of achieving equity in both the social and economic participation in the energy system, while also remediating social, economic, and health burdens on marginalized communities" (Lanckton and DeVar, 2021, p. 6). Further, this goal "must be at the forefront of renewable energy policy considerations. Justice depends on equity, and equity depends on history. In order for climate policy to be equitable, it must address and remediate historic harms" (Lanckton and DeVar, 2021, p. 6). Even with distinctions in semantics, it should be noted that terms may take on different meanings across literature. Further, establishing definitions does not necessarily impact the actual materialization of energy injustice. Although definitions can help conceptualize equity and inequity, they do not serve as tangible solutions, nor do they guarantee that people comprehend energy justice issues.

Energy equity metrics serve as a framework for evaluating actions taken to increase energy equity. Lanckton and DeVar (2021) use "equity indicators" and "metrics" interchangeably, defining them as:

> *quantitative measures of equity more broadly in a given community, municipality, state, or country. They are metrics which can be used to establish the state of equity at a given point in time, and are therefore effective tools for collecting baseline measurements and setting long and short-term goals regarding equity. (p. 7)*

They also underscore the importance of using metrics for evaluating programs and initiatives that utilities implement to address inequity. Although useful for providing a snapshot of energy equity in a particular area, indicators are also "important tools for assessing whether and to what degree utility actions are effective," making utility actions and equity indicators "two ends of a logic model" (Lanckton and DeVar, 2021, p. 7).

It should be noted that these definitions are frequently evolving, particularly given the rapid evolution and growth of the energy justice research field. Although some metrics may be viewed as an avenue for measuring a qualitative phenomenon using quantitative data (Preziuso et al., 2021), some scholars add that metrics should encompass direct changes in policy or the legal system rather than solely changes in quantitative measurements (Heffron and McCauley, 2018).

Key Findings

- Metrics and tools for measuring energy equity are limited, reflecting equity and justice as evolving topics that have only recently gained spotlight in national energy policy and research.
- California, Illinois, and Washington have established distinct energy equity metrics, and several other states are working to develop their own. Six have policies or reports recommending their creation.
- Existing scholarship offers several methods for measuring energy equity and justice through both quantitative and qualitative indicators. Most methods use a multicriteria analysis to capture the state of energy equity from a systemic perspective, accounting for the needs of consumers, workers, nearby community members, and greater society.
- Scholars suggest that the dominant methodologies traditionally used in energy research do not provide the tools necessary for adequately assessing human implications of the energy system, identifying energy justice as an analytical framework to meet these needs.

Objectives and Methods

The guiding questions for this research were (1) What is the status of energy equity metric development in the United States? (2) What specific metrics are currently used to measure energy equity by US state governments, energy scholars, and other stakeholders? Research was conducted through an assessment of state websites, policies, reports, and academic literature. Sources included state utility commission webpages, state department of energy or energy office webpages, state climate action plans, and state energy strategy reports. Key words and phrases searched include energy *equity metric, energy equity, energy justice, energy burden, low-income, just transition,* and *disadvantaged community*.

One notable limitation of this report pertains to information accessibility. The assessment of utilities commission and energy office websites for all 50 states, the District of Columbia, and Puerto Rico highlights numerous technological challenges. Utility commission websites for West Virginia, Louisiana, Alabama, and Arkansas currently lack search bar features. Search bars are also absent from the Oklahoma State Energy Office and the Virginia Department of Energy websites. Many websites surveyed continue to rely on outdated user interface and web design components. These obstacles sometimes created challenges for this report by inhibiting access to potential resources related to energy equity and may exacerbate energy justice issues more broadly by hindering public access to information. Future work may consider these challenges to public transparency.

It should also be stated that this report, undertaken in the fall of 2021, is not a complete overview of energy equity–related metrics currently in use or development in the United States. Given that the concepts of energy justice and equity are only beginning to penetrate mainstream energy scholarship, it is highly likely that there are other noteworthy examples of metrics, particularly among grey literature (literature published informally), that go unmentioned in this report.

The Rise of Energy Justice Scholarship

As decarbonization progresses, discussions surrounding the energy transition have become increasingly grounded in the concept of a "just transition." However, defining justice and establishing qualitative and quantitative measurements to evaluate the status of the transition have proven complicated, particularly due to differing conceptions of the public good. Energy, environmental, and climate scholars lack consistency in their definitions of justice, and there is a demonstrated need to integrate normative conceptions of justice with empirical research concerned with the energy transition (Heffron and McCauley, 2018; see also Galvin, 2019; Sovacool, 2014). Further, utilities and regulators have only recently begun to address energy justice and equity issues. Given that the just transition is centered on shifting from an extractive fossil fuel economy to an equitable regenerative economy (Lanckton and DeVar, 2021), definitions of energy, climate, and environmental justice—and the development of corresponding metrics—have the potential to serve as tools for social and economic change.

The absence of metrics for measuring energy equity reflects a research gap, as energy justice becomes an area of increased focus in energy research, having grown rapidly over the past decade (Jenkins et al., 2020). Existing energy justice scholarship heavily engages with three core tenets, derived from previously established thought on environmental justice: distributional, procedural, and recognition justice (McCauley et al., 2013). Underlying this logical framework is a growing effort to incorporate analysis on an ethical or moral basis into energy research. As such, energy justice as an analytical framework has emerged as an alternative to the predominant methods used in energy research.

Some scholars (Lutzenhiser and Shove, 1999; Sovacool, 2014; see also Hillerbrand et al., 2021) suggest that the pervasive disciplines in energy research—engineering, economics, and physics—may obscure the moral and political facets of the energy system. Lutzenhiser and Shove (1999, p. 217) find that this results in a "blind spot" that "masks the human elements of sociotechnical systems." To address this limitation, Sovacool and Dworkin (2015) recommend energy justice as an analytical tool because it requires people to consider the energy system in terms of its human impact rather than just its technological implications. For instance, energy justice:

> *reminds us that the selection between energy technologies is about more than merely hardware. As we... transition to renewable energy, the biggest challenge will be determining how we make this transition, and more specifically who gets to make it, and who has to pay for it. This is not a question that can ever be answered by economics or engineering alone. Such disciplines can tell us how large energy reserves may be or how much energy fuels may cost today, but they treat supply as a function of geologic availability or of price and demand, not of morality. Economics offers an excellent set of tools for estimating costs and benefits, but tells us little about who benefits and who suffers. (p. 437)*

Heffron and McCauley (2018) draw similar criticisms and identify a need for clearer and more unified definitions of justice within climate, energy, and environmental (CEE) research. Further, they attribute the need for justice-focused CEE research to broader issues with the underlying assumptions of traditional energy research:

> *One of the problems for the transition is the focus of CEE research and the economic focus of the transition. Traditional economics has not really delivered positive 'just' outcomes for society. If anything, it has significantly added to societal inequality; and in terms of traditional economics, it is held here that the neo-classical school of thought still dominates economic policy-making and this echoes with research done in the fossil fuel community too. (Heffron and McCauley, 2018, p. 75)*

Heffron et al. (2015) elaborate on this phenomenon in their work on the "energy trilemma," which refers to the tension of competing environmental, political, and economic demands in the development of energy law and policy. Heffron et al. (2015) find that the electricity sector can address energy justice by breaking from its neoclassical economics underpinnings and prioritizing energy security and environmental goals to protect society's long-term wellbeing. They also suggest that research should conceptualize energy justice in both the present and future to adequately account for the needs of future generations. In other words, they assert that the prioritization of energy justice in economic modeling (or any research using a discount function) necessitates a discount rate of zero.

Metrics from Energy Scholarship

Although equity and justice issues are only beginning to command the attention of energy researchers, the effort to incorporate these concepts into modeling and measurement is slightly more advanced in energy scholarship in comparison to the state policy setting.

Energy burden remains a long-used metric for energy justice. Typically represented by the percentage of annual gross household income spent on energy utilities (Drehobl and Ross, 2016), energy burden is used to study energy poverty and affordability. Despite its pervasiveness, many scholars highlight the limitations of traditional energy burden measurement and advise against reliance on any singular metric as an indicator for energy poverty (see Herrero, 2017; Thompson et al., 2017; Agbim et al., 2020; Deller et al., 2021). One area of complexity relates to the threshold used to define *burden*. Since Boardman's (1991) use of 10 percent income-expenditure as the metric for energy poverty, the threshold value has remained an area of active debate. Numerous studies have pointed to geographical variations in energy poverty that complicate the use of a universalized energy burden metric (Liu and Judd, 2019; Liddell et al., 2012). For example, twice-median energy expenditure—which serves as the basis for the 10 percent threshold—has been found to vary significantly by region, indicating the need for more localized measurements (Liddell et al., 2012). Income-expenditure metrics such as energy burden may also overlook significant energy expenditures that go into aspects of household costs not accounted for in utility bills (Herrero, 2017). Further, some studies suggest that subjective energy burden (that is, whether households feel that they can afford energy) may be more suitable for identifying occurrences of energy poverty that the traditional energy burden metric (that is, objective energy burden) cannot (Agbim et al., 2020; Waddams Price et al., 2012). Measuring energy burden is further complicated by the disparity between actual and required energy expenditure, which may be more pronounced if a household is facing other budgetary pressures or is facing utility debt (Herrero, 2017; Thompson et al., 2017). These shortcomings underscore the importance of developing metrics that consider the complexities of energy justice.

The growing body of energy justice scholarship attempts to account for the multifaceted nature of energy justice issues. Stacey and Reames (2017) offer a novel mechanism to evaluate the social equity implications of energy policy. Energy efficiency programs have become increasingly fundamental to state energy policy in recent years, but the scarcity of measurement tools for energy justice and equity make it difficult to determine their social and economic impacts. The Energy Efficiency Equity Baseline (E3b) is a quantitative metric to measure social equity outcomes of energy efficiency programs. Using the E3b, Stacey and Reames (2017) calculate "the gap between equitable and actual levels in utility program investments and [h]ousehold energy savings" (p. 4). For example, to measure disparities in utility investments, the E3b is calculated by multiplying the sum of program investments for low- and high-income residents by the proportion of low-income residents in the region. The difference between the E3b and actual spending determines the investment deficit or surplus. This calculation is done for each utility and energy type. Stacey and Reames' (2017) analysis of Michigan's state energy efficiency policy between 2010 and 2016 using the E3b reveals severe disparities, demonstrating that equitable policy investments do not necessarily lead to equitable outcomes (p. 9). Stacey and Reames (2017) note that their results highlight the "need for further alignment in policy, regulatory processes and the underlying mechanisms for measuring costs and capturing b[e]nefits in order to achieve socially equitable outcomes" (p. 9).

Other scholarship suggests certain advantages of using a broader framework to measure the equity implications of the energy system. Fortier et al. (2019) use a social life cycle assessment (LCA) to measure energy justice considerations. They divide metrics into four stakeholder categories: workers, local communities, electricity consumers, and greater society (Table 1). This categorization reflects the need to analyze impacts "systemically across the lifecycle of an energy system or energy transition" and underscores the importance of considering energy justice for "the people who develop the machines, participate in decision-making, and consume the energy" (Fortier et al., 2019, p. 212). Their methodology includes quantitative, qualitative, and semi-qualitative metrics.

Table 1. Metrics from Fortier et al. (2019)

Electricity Customers
Yes/no: Do electricity consumers have a choice in the utility company or in generation methods used by their utility?
Yes/no: Do consumers have a mechanism to provide feedback to their utility?
Yes/no: Do electricity consumers have free access to objective information about energy use and sources of electricity?
Yes/no: Does the electric utility act to address consumer feedback or complaints?
Yes/no: Are all charges and possible penalties transparently described as part of a consumer's electric bill?
Scale: What is the relative burden of penalties associated with late or missing payments?
Yes/no: Does the burden of penalties significantly differ across populations served by the utility?
Yes/no: Does the cost of electricity relative to household income significantly differ across populations served by the utility?
Yes/no: Does the number of brownouts over time differ across populations served by the utility?
Yes/no: Are the capital costs prohibitive for different populations to gain access to lower operational costs for electricity provision?
Local Community
Scale: the extent to which the local community was involved and recognized in the decision to begin operations in an area
Yes/no: Is the percentage of the local community that is displaced different by population group in the area?
Scale: the extent to which relocation of local community members is involuntary
Quantification of the percentage of the workers who reside in the local community and who did not migrate to the local community for employment at the company
Quantification of the number of meetings with individual community groups or leaders prior to a company's decision-making that could affect a local community
Quantification of the percentage of the resources in an area, including land, used by the company that are owned by members of the local community
Yes/no: Does the local community still retain access to raw materials extracted at a site or have access to the final product (electricity) generated at a site?
Scale: extent to which the activities of a company either positively or negatively affect the local community's sense of place and cultural heritage
Quantification of the health and safety impacts on local community members by the activities of the company
Yes/no: Is company information available in all local languages?
Yes/no: Is company information easily accessible for local community members?
Yes/no: Does the company have and enact policies that show respect for local culture including observance of cultural events?
Quantification of the number and duration of protests of the company and the number of protesters that are from the local community

Table 1 (continued). Metrics from Fortier et al. (2019)

Workers
Percentage of labor that is child labor
Percentage of labor that is unpaid
Yes/no: Are employees paid at known and regular intervals?
Yes/no: Are there deductions on employees' wages that were enacted for reasons beyond an employee's control?
Quantification of wage gaps by sex, gender, nationality, cultural group, and race
Percentage of workers earning a living wage based on their location
Percentage of workers earning the legal minimum wage
Percentage of workers with benefits such as health insurance
Quantification of the number of workplace accidents resulting in injuries or death over a period of time
Yes/no: Are appropriate safety education and training provided to employees?
Yes/no: Is the appropriate safety equipment for workers' activities consistently available and accessible to employees?
Yes/no: Do workers have the right to unionize?
Yes/no: Are employees unionized?
Quantification of the average and maximum numbers of hours worked per week by workers at different levels
Quantification of the number of holidays and other paid time off available to workers annually
Yes/no: Are workers free to end their employment and not tied by debt to a company, lack of mobility, monopoly of employment in the region by the company, or the company holding onto their legal documentation?
Society
Yes/no: Is the technology used accessible and affordable to developing countries?
Yes/no: Are research and development results disseminated without barriers or monetary charges?
Yes/no: Are the companies and actors involved connected to violent conflicts, including war?
Yes/no: Have the companies and actors been sued or fined for, or known to be involved in, corruption and unethical practices?
Scale: What is the extent to which the activities along the life cycle of the electrical energy system have contributed to economic progress for different geographic regions or nations?
Yes/no: Are the companies involved promoting the use of low-carbon energy systems over conventional fossil energy systems at their respective stages in the life cycle?

Lanckton and DeVar (2021) outline metrics to measure the equity efforts of utilities. They provide four categories for equity metrics: Energy Access and Affordability, Procedural Justice and Democracy, Economic Participation and Community Ownership, and Health and Environmental Impacts (Table 2).[1] Each section contains a set of "equity indicators" that are concrete metrics used to measure the success of specific "utility actions" (Lanckton and DeVar, 2021, p. 7). For example, under the category of Energy Access and Affordability, utilities should undertake a variety of actions, including funding energy assistance programs, limiting energy bills to a percentage of gross income, and decoupling revenue from sales. Some of the indicators suggested for measuring the equity outcomes of these efforts include a decrease in households without electricity, a decrease in energy burden, and an increase in cost savings (Lanckton and DeVar, 2021, p. 13).

Preziuso et al. (2021) categorize metrics into three groups: target population identification, investment decision-making, and program impact assessment metrics. Unlike Lanckton and DeVar's division of metrics into four categories reflecting community needs, this grouping reflects different processes of program or policy implementation. Each of these categories includes specific metrics with corresponding "data points" (Table 3). While covering numerous aspects of energy justice, these metrics focus most heavily on energy affordability. This differs from Lanckton and DeVar's highly multidimensional approach to energy equity issues, which encompasses factors such as income distribution, community engagement, and ownership.

Heffron et al. (2015) produce a metric that is markedly distinct from other examples. Their Energy Justice Metric (EJM) pays particular attention to the state of the energy trilemma and encompasses parameters for encapsulating the three aspects of the trilemma into one measurement. Their focus on the energy trilemma stems from the notion that energy justice provides a solution by challenging the imbalance between economic, environmental, and political considerations in the creation of energy law and policy (Table 4). They note: "It is significant that it is a just and equitable balance and not simply an efficient balance that is the aim of energy justice. This represents a move away from solely having economic thinking drive policy aims" (Heffron et al., 2015, p. 169). The EJM uses a ternary plot to indicate the status of the trilemma relative to an "ideal" dot, which represents the point in which the trilemma is most balanced. The EJM can provide three different measurements: a country EJM, an EJM for a type of energy infrastructure (such as gas or nuclear), and an EJM that can be integrated into an economic cost model. It considers distinct parameters for economics, politics, and environment and puts no discount on cost "so that future generations are treated as ethical equivalents to contemporary ones" (Heffron et al., 2015, p. 172). This structure differs starkly from other metrics. While it considers factors not traditionally encompassed in economic modeling, the EJM delivers a value that can be translated into cost to feed directly into economic models (Heffron et al., 2015, p. 172). Another difference between the EJM and other metrics relates to the intended focus of measurement. Unlike many other metrics, which typically include various data points for a given population, the EJM measures an entire system in aggregate. This systemic analysis of the energy system resembles the logic of the social LCA proposed by Fortier et al. (2019).

Although varying in scope, the metrics detailed above attempt to address the many facets of energy injustice. Lanckton and DeVar (2021), Fortier et al. (2019), and Preziuso et al. (2020) highlight the multidimensional nature of energy justice, indicating a shift away from energy burden as the paramount form of measurement. The recent scholarship also tends to focus on measuring differential impacts and outcomes for historically marginalized demographics. Examples include measurements such as "Does the burden of penalties significantly differ across populations served by the utility?" (Fortier et al., 2019) and "Distribution of HDI scores across population subgroups" (Preziuso et al., 2020). This emphasis resembles a broader methodological shift toward distributional analysis in recent scholarship (see Cong et al., 2021; Reames, 2020).

[1] See Appendix A for a more extensive version of the utility actions proposed by Lanckton and DeVar (2021).

Table 2. Metrics from Lanckton and DeVar (2021)

Energy Access and Affordability	
Corresponding Utility Actions: • Energy Assistance • Reliability • Energy Efficiency • Renewable Energy • Internet and Telecommunications • Transportation -Equity Across Communities	Decrease in share of households (or population) without electricity or commercial energy, or heavily dependent on non-commercial energy
	Decrease in share of household income spent on fuel and electricity (energy burden)
	Decrease in household energy use for each income group and corresponding fuel mix
	Decrease in utility rate individual equity score
	Increase in access and proximity to community facilities, services, and infrastructure in neighborhoods with the highest percentage of low-income residents and people of color
	Increase in customer cost savings in $ saved
	Increase in percent of population living within a reasonable distance from a heat island mitigation feature that provides localized cooling through tree canopy cover, green roofs or green walls; white roofs or cool roofs; and/or light-colored pavement or groundcover
Procedural Justice and Democracy	
Corresponding Utility Actions: • Community Engagement • Accessibility • Assessments and Tools • Data and Information • Recognition Justice and Framing	Increase in local survey responses indicating that residents believe they are able to have a positive impact on their community
	Increase in appointments to local advisory boards and commissions that reflect the gender, racial, and ethnic diversity of the community
	Increase in diversity of racial, ethnic, [gender], and geographic composition of planning organization boards
	Increase in percent of community members in a population engaged in energy policy rule-making proceedings
	Increase in funding for participants of rule-making proceedings, particularly marginalized and vulnerable communities
	Increase in percent of community recommendations that were meaningfully incorporated into final energy rules, policies, and/or decisions
	Increase in percent of utility actions and projects engaged in with prior consent and consultation with Indigenous communities
Economic Participation and Community Ownership	
Corresponding Utility Actions: • Hiring, Recruitment, and Compensation • Education, Training and Development • Utility Culture • Supply and Contracting • Community Ownership • Community Impact	Decrease in Gini coefficient
	Decrease in income inequality "95/20" ratio
	Decrease in percentage of residents living below the poverty line
	Decrease in percentage of women, men, children, and additional subgroups of residents living below the poverty line
	Increase in local energy generation in GWh generated per year
	Increase in percent of energy resources/assets owned or controlled by women and equity business enterprises
	Increase in percent of energy resources/assets owned or controlled by the local community
Health and Environmental Impacts	
Corresponding Utility Actions: • Project Development • Evaluation of Needs • Environmental Justice	Decrease in accident fatalities per energy produced by fuel chain
	Decrease in metric tons (MT) of criteria pollutants
	Decrease in GHG emissions in metric tons of CO_2 ($MTCO_2$), GHG intensity ($MTCO_2$/MWh)

Table 3. Metrics from Preziuso et al. (2021)

	Metric	Needed Data Points	Description
Target Population Identification	Program Equity Index	• Energy assistance offered	Distribution of program benefits across populations
	Program Accessibility	• Eligible population data • Income data	Distribution of program eligibility across population groups
	Energy Cost Index	• Median annual energy bill	Distribution of energy cost across populations
	Energy Burden Index	• Median annual energy bill • Annual median income	Distribution of energy burden across populations (i.e., 6% is considered high, 10% is considered severe)
	Late Payment Index	• Late energy bill payment rate	Distribution of late bill payment habits across populations
	Appliance Performance	• Appliance maintenance cost	Distribution of access to energy efficiency measures
	Household-Human Development Index	• Health Status • Education level • Income	Distribution of HDI scores across population subgroups
	Metric	**Needed Data Points**	**Description**
Investment Decision-Making	Community Acceptance Rating	• Numeric representation of community satisfaction	Surveys of community acceptance and support for investment
	Program Funding Impact	• Percent budget for advancing equity	Percent of investment funding supporting disadvantaged communities
	Energy Use Impacts	• Health and environmental impacts due to investment	Distribution of health and environmental impacts of energy investments across populations
	Energy Quality	• Investment impact on frequency of electric outages	Utility Data
	Workforce Impact	• Investment generated jobs	Community benefits from investment (participation from low-income groups, local business contracts)
	Metric	**Needed Data Points**	**Description**
Program Impact Assessment Metrics	Program Acceptance Rate	• Percent of population enrolled in program	Program enrollment after receiving information (i.e., information dissemination, transparency, community trust, etc.)
	Energy Savings (MWh)	• Energy use over time	Energy use savings in disadvantaged communities after program implementation
	Energy Cost Savings ($)	• Energy cost over time	Energy cost savings in disadvantaged communities after program implementation
	Energy Burden Change	• Household income • Energy bill	Percent reduction in energy burden after program implementation (EE, weatherization, rate design, wage changes, etc.)
	Change in HDI Score	• Household income • Quality of life	Wellbeing and quality of life improvement after program implementation

Table 4. Metrics from Heffron et al. (2015)

Economics	Cost-benefit analysis for new energy infrastructure
	Cost of subsidies for energy source extraction, development and operation
	Cost of energy to disposable income ratio
	Cost (benefit) of import/export of energy supplies
Politics	Cost of fluctuation and instability in energy supplies
	Cost (benefit) of import/export of energy supplies
Environment	Cost (benefit) to (from) public health service from energy sources
	Cost of the effect of environmental pollutants from energy sources
	Cost of CO_2 tax
	Cost of accidents (in. fatal accidents) to workforce and public
	Cost of loss of amenity to local communities direct and indirect from energy sources

Energy Equity Development in the United States

There are several federal programs that address issues related to energy inequity. Notable examples include the Low-Income Home Energy Assistance Program (LIHEAP), which provides financial assistance for energy costs to low-income households, and the Weatherization Assistance Program (WAP), a direct payment program that provides aid to low-income households through weatherization home improvements and upgrades. The Department of Energy (DOE) also offers the Low-Income Energy Affordability Data (LEAD) tool, which provides low- and middle-income household energy data at the state, county, city, and census tract levels. Similar to the scope of WAP and LIHEAP, LEAD focuses on energy affordability issues rather than energy equity more broadly, providing data on factors such as monthly energy expenditure, energy burden, and homeowner status. Recent efforts to address energy inequity at the federal level have also come from the Biden Administration's 2021 executive order establishing Justice40, which directs 40 percent of benefits from federal climate investments to disadvantaged communities. Although these examples indicate a growing effort to advance energy equity, current research suggests a major need for improved national data collection to better identify energy equity disparities and effectively evaluate policies and programs attempting to address them (Carlock et al., 2021).

Much like the federal level, few states have established energy equity metrics. A small number, however, are in the process of developing them. Others have produced reports that recommend their creation but have not announced development efforts. California, Illinois, and Washington are currently ahead of other states in establishing metrics and provide distinct examples of what metrics may encompass.

State Energy Metrics: California, Illinois, and Washington

California

California is the only state that has developed explicit "energy equity" metrics. In October 2015, California enacted the Clean Energy and Pollution Reduction Act, SB 350. In addition to setting new decarbonization goals, the Act called attention to the issues of energy equity and accessibility (Cal. State. S., 2015). SB 350 required the California Energy Commission (CEC) to investigate the obstacles low-income communities face in benefiting from the clean energy transition.

Since the passage of SB 350, the CEC has conducted two studies on this topic: *Low-Income Barriers Study, Part A* (2016), and *Low-Income Barriers Study, Part B* (2018). The former includes 12 recommendations for approaching community barriers to clean energy

investment, one of which is the creation of metrics to measure the performance of programs arising from the Barriers Study. According to the Barriers Study, these metrics would serve multiple purposes: "ensure low-income customers are being served"; "set a statewide baseline, advance energy savings, and track performance"; and "track employment and job quality impacts of clean energy programs" (CEC, 2018, p. 6).

In 2018, the CEC published *Energy Equity Indicators Tracking Progress*, which established the following nine indicators (CEC, 2018, p. 4):

1. High Energy Bills
2. Energy Efficiency
3. Rooftop Solar
4. Electric Vehicles
5. Health and Safety Issues Abated
6. Energy Resilient Communities
7. Clean Energy Jobs
8. Small Business Contracts
9. Amount Invested: Innovation

Each indicator is accompanied by at least one specific metric (Table 5). *Tracking Progress* highlights three overarching objectives of the energy indicators: access, investment, and resilience. Although the report was updated in 2018, the extent to which the state of California has implemented these metrics remains unclear.

Table 5. Metrics from California Energy Commission (2018)

Tracking Progress Metrics	
High Energy Bills	• Number of multifamily/single-family accounts with August electricity bills of $300 or more • Energy burden (average energy expenditure over average income) • Frequency and temperature of extreme heat days (days with a high temperature above 101.9°F
Energy Efficiency	• Residential energy savings (net reported GWh) • Level of participation in energy efficiency programs (number of households per 1,000 people per ZIP code in IOU service area participating in program) • Level of IOU energy efficiency investments (amount of investment per 1,000 people in given service territory)
Rooftop Solar	• Solar capacity per capita (number of installed kilowatts on rooftop photovoltaic system capacity per thousand people per ZIP code in IOU territory) • Investment in other renewable self-generation technologies (average investment per 1,000 people per ZIP code of other renewable self-generation technologies)
Electric Vehicles	• Number of electric vehicles (EV) per ZIP code • Number of cumulative plug-in EV sales by county • Clean Vehicle Rebate Program (CVRP) incentive opportunities (uptake level of CVRP funding per census tract) • Investments from Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP) in EVs (amount of ARFVTP funds invested for EV infrastructure by county)
Health and Safety Issues Abated	• Asthma (percent of emergency department visits due to asthma per county) • Heat-related illness (number of emergency room visits due to heat per 10,000 people)
Energy Resilient Communities	• Average interruption durations • Fire threat level • Access to microgrids
Clean Energy Jobs	• Number of clean energy jobs by county • Percent of clean energy jobs by population per county
Small Business Contracts	• Percentage of state government contract dollars awarded to small businesses and microbusiness • Number of clean energy small business and microbusinesses within 30 miles of ZIP code
Amount Invested: Innovation	• Energy Commission EPIC technology demonstration and deployment funding invested by census tract

Illinois

Illinois is also leading efforts to establish energy equity metrics and offers an example of metrics specifically related to economic participation in the just transition. In September 2021, Illinois passed the Climate and Equitable Job Act (SB 2408), a state energy plan that includes over $115 million of funding for clean energy job development (Ill. Gen. Assemb., 2021). SB 2408 has multiple implications for energy metrics creation. It includes the creation of a nonprofit organization, the Illinois Clean Energy Jobs and Justice Fund, to develop metrics that ensure equitable distribution of clean energy economy benefits (Ill. Gen. Assemb., 2021, pp. 140–150). SB 2408 goes further in the development of metrics in its plan for the evaluation of the new Clean Job Workforce Network Program. Different "hub sites" administering the clean jobs program are required to submit data on the individuals participating in the program on a quarterly basis. These measurements include the following (Ill. Gen. Assemb., 2021, pp. 12–13):

1. Demographic data of program participants
2. Demographic data of participants placed in positions, and whether participants were placed in union, non-union, or non-union via temporary agency positions
3. Worker acquisition and retention statistics
4. Demographic distribution of wages and benefits
5. Demographic data on the percentage of workers with full-time employment
6. Qualitative data on pertinent workplace and program issues

SB 2408 also creates the Clean Energy Contractor Incubator Program, creating 13 contract incubators that will develop small businesses in the clean energy sector. Similar to the Clean Job Workforce Network Program, the Incubator Program is required to report data on program success.

While mandating metrics specifically tied to clean energy job creation, SB 2408 also addresses energy equity more broadly. It explicitly states that its purpose is to ensure an equitable distribution of benefits of the clean energy economy through the expansion of clean energy financing opportunities for BIPOC, low-income, and environmental justice communities and businesses (Table 6). This includes payment assistance for solar and energy efficiency upgrades, no-cost and low-cost loans for minority-owned businesses, and the accelerated distribution of private capital into clean energy markets. SB 2408 requires the Board of Directors of the Illinois Clean Energy Jobs and Justice Fund to develop and implement metrics to track the program's adherence to meeting this goal.

Washington

In 2019, Washington state passed the Clean Energy Transformation Act (HB 5116), committing to 100 percent self-generating clean energy by 2045. HB 5116 features several forms of metrics focused on energy equity (Table 7). The Act requires the expansion of energy assistance programs by mandating that utilities meet 90 percent of current energy assistance need by 2050. To track the expansion of energy assistance programs, HB 5116 requires the Washington Department of Commerce to collect data for each electric utility on

Table 6. Metrics Used for the Clean Job Workforce Network Program Under Illinois' Climate and Equitable Jobs Act (2021)

Clean Job Workforce Program Metrics
Demographic data, including racial, gender, residency in eligible communities, and geographic distribution data, on Program trainees entering and graduating the Program
Demographic data, including racial, gender, residency in eligible communities, and geographic distribution data, on Program trainees who are placed in employment, including the percentages of trainees by race, gender, and geographic categories in each individual job type or category and whether employment is union, non-union, or non-union via temporary agency
Trainee job acquisition and retention statistics, including the duration of employment (start and end dates of hires) by race, gender, and geography
Hourly wages, including hourly overtime pay rate, and benefits of trainees placed into employment by race, gender, and geography
Percentage of jobs by race, gender, and geography held by Program trainees or graduates that are full-time equivalent positions, meaning that the position held is full-time, direct, and permanent based on 2,080 hours worked per year (paid directly by the employer, whose activities, schedule, and manner of work the employer controls, and receives pay and benefits in the same manner as permanent employees)
Qualitative data consisting of open-ended reporting on pertinent issues, including, but not limited to, qualitative descriptions accompanying metrics or identifying key successes and challenges

energy burden, energy assistance need, and reported energy assistance on a biennial basis.

HB 5116 also requires utilities to submit clean energy implementation plans (CEIPs) every four years, which serve as enforceable plans to ensure compliance with the state's clean energy commitments. As part of their CIEPs, utilities must establish customer benefit indicators. The CIEPs must include at least one indicator in each of the following categories (Content of a clean energy implementation plan, 2020):

1. Energy benefits
2. Nonenergy benefits
3. Reduction of burdens
4. Public health
5. Environment
6. Reduction in cost
7. Energy security
8. Resiliency

Not unlike Illinois' SB 2408, which establishes energy equity metrics from a workforce perspective, both of HB 5116's data requirements primarily address energy equity from a consumer standpoint. Nonetheless, Washington has continued working on energy equity, and recent developments indicate the potential for a more comprehensive set of metrics in the future.

Following the passage of HB 5116, Washington updated its state energy strategy in December 2020, designating a chapter to the development of an equitable clean energy economy. The chapter focuses on the equitable distribution of economic opportunities and service options, reduction of energy burden, integration of health disparity metrics in energy planning, energy sovereignty for Indigenous Tribes, procedural equity in program design, and affordable housing (Washington State Department of Commerce, 2021). It also calls to "Embed Equity in the Design of Clean Energy Policies and Programs" and establishes that governments should evaluate policy using a "framework for equitable policy design." It recommends a specific "action" associated with this section, noting that "Local communities and advocacy organizations in turn need to hold policy makers and government officials accountable when policies fail to meet these criteria" (Washington State Department of Commerce, 2021, p. 26).

In its chapter on electrification, Washington's energy strategy recommends that the state "Develop Tools for Equitable Energy Distribution and Deployment" (Washington State Department of Commerce, 2020, p. 126). More specifically, it calls on Washington's Department of Commerce to explore the creation of energy equity indicators: "the indicators should include both outcome and process measures. Outcome measures, such as increasing renewable energy in communities, must be supported by community engagement process metrics to hold state agencies accountable for increasing meaningful engagement with communities" (Washington State Department of Commerce, 2020, p. 126). Although the document was published in December 2020, no metrics appear to be formally adopted reflecting these suggestions.

Metrics in Development

Although few states have established metrics, a small but significant number are moving to follow the paths of California, Illinois, and Washington. New York and Connecticut are currently in the process of establishing metrics related to energy equity, while Oregon, Ver-

Table 7. Metrics Used for Energy Assistance Programs Under Washington's Clean Energy Transformation Act (2019)

Energy Assistance Program Metrics
The estimated number and demographic characteristics of households served by energy assistance for each utility and the dollar value of the assistance
The estimated level of energy burden and energy assistance need among customers served, accounting for household income and other drivers of energy burden
Housing characteristics including housing type, home vintage, and fuel types
Energy efficiency potential: 1. The amount and type of energy assistance and the number and type of households, if applicable, served for programs administered by the utility 2. The amount of money passed through to third parties that administer energy assistance programs 3. Subject to availability, any other information related to the utility's low-income assistance programs that is requested by the department

mont, Wisconsin, Maine, North Carolina, and Rhode Island have produced reports or policies recommending their creation.

New York's 2019 Climate Leadership and Community Protection Act (CLCPA), which set new state emission reductions standards, calls for the creation of metrics to measure energy impacts in low- and moderate-income communities. The Act directs the New York State Energy Research and Development Authority (NYSERDA) and investor-owned utilities (IOUs) to "develop and report metrics for energy savings and clean energy market penetration in the low and moderate income market and in disadvantaged communities, as defined in article seventy-five of the environmental conservation law, and post such information on the authority's website" (N.Y. State S., 2019, p. 18). The extent to which NYSERDA and state IOUs have developed these metrics is uncertain.

Connecticut is also in the process of developing metrics. In September 2020, the Connecticut Department of Energy and Environmental Protection (DEEP) launched the Equitable Energy Efficiency (E3) Proceeding. E3 aims to explore and improve equity in the state's ratepayer-funded energy efficiency programs by defining equity, establishing metrics, and increasing inclusion and participation of "underserved communities" (DEEP, Final Determination, 2021, p. 1). In the summer of 2021, DEEP published an "E3 Progress Report," which identified three actions underlying its goal to "Develop metrics and goals to assess equitable distribution of energy efficiency funding" (DEEP, Progress Report, 2021, p. 4). The actions consist of the following (DEEP, Progress Report, 2021, p. 4):

- Broaden the current MPP [Matching Payment Program] metric to potentially cover medical and financial hardship customers, and include more ambitious targets to scale up the percentage of participating customers on an annual basis.
- Establish a baseline E3b level for Eversource and United Illuminating based on the most recent available data and establish a goal of at least maintaining the E3b figures for each utility on an annual basis.
- Based on the analysis of equity indicators described in Goal 2, and in consultation with the DEI [diversity, equity, and inclusion] Consultant, DEEP may recommend the development of new equity metrics.

Evidence from New York and Connecticut indicate that metrics in both states will likely cover specific consumer issues rather than tackling energy equity from a multidimensional standpoint. New York's CLCPA focuses specifically on metrics for energy savings and participation in the clean energy market, while public documents from Connecticut's E3 Proceeding indicate a focus on energy efficiency. Both metrics proposals are limited in scope in comparison to California's indicators, which cover various facets of energy equity.

Recommended Metrics

While the states mentioned above have either established energy equity metrics or are in the process of doing so, there are numerous states that have produced reports or laws that recommend their development. The status of metrics among states in this category varies. Some have simply suggested metrics as a recommended course of action in their energy or climate reports, while others already collect data relevant to energy equity but have yet to integrate this data collection into formalized metrics.

Metric development in **Oregon** began after Governor Kate Brown issued Executive Order 17-20 in 2018, which called on the state to establish a timeline for net-zero energy building standards. Following the executive order, Oregon organized the Low Income Utility Program Working Group. The working group, intended to make recommendations to the governor regarding energy justice issues, convenes community organizations, utilities, legislators, and local jurisdictions. Its report, published in December 2018, suggests that the state "Give utilities the authority to create low-income programs and require annual reporting on data and metrics" (Oregon Public Utility Commission, 2018, p. 15). This recommendation focuses on energy burden and its association with specific demographic groups. According to the report, Oregon Housing and Community Services should "annually collect data on energy burden including its intersections with demographic data such as race, age, and disability" (Oregon Public Utility Commission, 2018, p. 15). In addition, the "Housing and Community Services should also work with the interagency Built Environment Energy Working Group to complete a biennial equity and access analysis" (Oregon Public Utility Commission, 2018, p. 15). Despite this conclusion, there is little documentation of further work to establish or regulate these metrics in Oregon.

In 2020, **Vermont** passed the Global Warming Solutions Act (Act 153), which sets state greenhouse gas emissions standards and creates a Vermont Climate Council. Act 153 tasks the Climate Council with developing a state Climate Action Plan, which is currently under development (Bradley, 2021). Act 153 also establishes four subcommittees to advise the Council: The Rural Resilience and Adaptation Subcommittee, the Just Transition Subcommittee, the Cross-Sector Mitigation Subcommittee, and the Agriculture and Ecosystems Subcommittee. Core responsibilities of the Just Transition Subcommittee are centered on equity concerns. According to the text:

> *This subcommittee shall focus on ensuring that strategies to reduce greenhouse gas emissions and to build resilience to adapt to the effects of climate change benefit and support all residents of the State fairly and equitably. This subcommittee shall ensure that strategies consider the disproportionate impact of climate change on rural, low income, and marginalized communities and that programs and incentives for building resilience are designed to be accessible to all Vermonters and do not unfairly burden any groups, communities, geographic locations, or economic sectors. This subcommittee may adopt a measurement tool to assess the equitability of programs and strategies considered by the Council (Vt. Gen. Legis., 2020, p. 11).*

Although Act 153 suggests the implementation of an energy equity metric as a potential task for the Subcommittee to undertake, meeting notes from recent Subcommittee meetings provide little evidence that this goal has been pursued (Vermont Agency of Administration, 2021).

In **Maine**, the Governor's Office of Policy Innovation and the Future appointed the Center for Sustainability Solutions at the University of Maine to develop an equity report to assess the work of the Maine Climate Council. The report recommends the construction of metrics to measure the success of policy to ameliorate inequity, stating: "Those administering the Climate Action Plan should be responsible for guiding implementation of equity-focused policies and ensuring that all policies that are implemented continue to take equity into consideration. This can be done by setting explicit goals in terms of equity outcomes, and building metrics for measuring progress into the implementation process" (Silka et al., 2020, p. 8).

The report does not delve further into energy equity metrics but outlines a framework for assessing equity outcomes of climate mitigation and adaptation strategies. The framework consists of three categories: social impacts, types of vulnerable populations, and participation and inclusion (Silka et al., 2020, p. 5). Although this framework is separate from the development of specific energy equity metrics, these categories shed light on a potential equity assessment framework the state might use to assess energy programs.

Wisconsin's 2020 Governor's Task Force on Climate Change Report lays out a series of recommendations regarding the clean energy transition. The report states that communities will benefit from the development of "accurate metrics and data that could support the development of new Focus on Energy or utility-sponsored programs. These programs could help shift or reduce the energy peak, align energy efficiency with carbon-reduction goals, and align energy consumption with zero-carbon generation" (State of Wisconsin, 2020, p. 30).

Similarly, **North Carolina**'s 2019 Clean Energy Plan includes metric development. To address energy inequity and affordability issues, the report recommends that the state "Include non-energy equity-focused costs and benefits in decisions regarding resource needs, program design, cost-benefit analyses, and facility siting" (North Carolina Department of Environmental Quality, 2019, p. 114). The document outlines several strategies to implement this recommendation, one of which is to "Add equity metrics and elements to program delivery, such as EE programs. In doing so, consider the appropriate definitions of household energy burden, energy poor households and other key terms as discussed above" (North Carolina Department of Environmental Quality, 2019, p. 114).

In **Rhode Island**, former governor Gina Raimondo issued Executive Order 20-01 in January 2020, establishing Rhode Island's new goal of 100 percent renewable energy dependency by 2030 and requiring the state's Office of Energy and Resources (OER) to conduct an economic analysis for the transition. The analysis, produced in conjunction with the Brattle Group, outlines strategies for meeting the 100 percent by 2030 goal. According to the report, "we propose to identify and track metrics that indicate progress toward community-identified equity outcomes. Community engagement will drive development of qualitative and quantitative equity measures that can also inform program design. Critical to this effort is direction from communities regarding their visions for participation in the clean energy transition" (Murphy et al., 2020, p. 69). The report cites data on workforce diversity, low- and moderate-income worker participation in clean energy programs, and utilization of utility bill support programs as metrics already being tracked that should be leveraged in the process of energy equity metric development. Further:

> *Additional metrics may include but are not limited to energy burden, demographic information, participation in public workshops and decision-making processes, and others. While we present currently tracked metrics and potential new metrics, we ultimately turn to community partners for additional guidance on how to identify and track metrics focused on addressing systemic racism and historic inequities. These metrics may fall outside of what may be seen as normal energy metrics, such as housing indicators, health data, and technological access; however, in an effort to incorporate an intersectional approach, following community guidance and best practices from other states will be critical (Murphy et al., 2020, p. 69).*

Since the publication of *Road to 100% Renewable Electricity* in December 2020, Rhode Island's OER has yet to publicize additional work on metric development.

Discussion and Conclusions

Despite the longstanding history of energy justice issues in the United States and existing energy justice research, the development of energy equity metrics remains nascent at both the national and state level. California's *Tracking Progress* offers nine energy equity indicators, each accompanied by one or more metrics. The extent to which these metrics have been implemented for program or policy analysis, however, is unclear. Illinois' SB 2408 offers another example of metrics for energy equity in the context of clean energy jobs programs. It also requires the development and implementation of broader energy equity metrics, including those for tracking the racial justice impacts of the Act. Further, Washington's HB 5116 requires utilities to establish and report data pertaining to different customer benefit indicator areas. Although this requirement focuses on equity from a consumer standpoint, Washington's recent state energy strategy suggests the potential creation of additional metrics using a broader equity lens. New York and Connecticut have undertaken efforts to create metrics related to energy equity but limit their scope to the ratepayer perspective. Finally, six other states have produced reports or policies suggesting the development of metrics but have yet to act on those recommendations.

Numerous measurement frameworks have arisen from energy justice scholarship over the past decade, ranging from quantitative, micro-level analyses of specific energy policies to broad, systemic analyses using both quantitative and qualitative data. The E3b, of the first category, is a quantitative baseline developed by Stacey and Reames (2017) to measure the socioeconomic impacts of specific energy policies or programs. They use the E3b to evaluate energy policy impacts of Michigan's Energy Waste Reduction programs by measuring the disparities of program investments and household energy savings between different income groups.

Most frameworks from current energy justice scholarship offer a multicriteria assessment of energy equity. Preziuso et al. (2021) and Lanckton and DeVar (2021) provide large sets of metrics across various categories to assess policies and utility actions. Their metrics intend to serve as accountability mechanisms for energy policies, programs, and utilities. Fortier et al. (2019) also measure energy justice from a broad perspective, analyzing different stakeholder groups in the energy system through a social LCA. Lastly, Heffron et al. (2015) measure the severity of the energy trilemma as a framework for quantifying the state of energy justice.

The creation of these frameworks has spurred conversation about the limitations of methods traditionally used in energy research. Many prominent energy justice scholars suggest that questions of justice, equity, and the human dimensions of energy systems have generally remained absent from the field, attributing this phenomenon to the dominance of neoclassical economic analysis in energy research. Some argue that the incorporation of energy justice into research requires the integration of normative elements to account for the moral and ethical dimensions of the energy system. This is unsurprising, given that measuring energy justice necessitates definitions of fairness and equity.

The development of energy equity metrics is also complicated by relationships between stakeholders throughout the energy system. Data collection and accessibility necessary for expanding and implementing metrics may be hindered if private entities are unwilling to share data for equity research purposes. In addition, data collection can be costly, prompting questions regarding who is responsible for tracking and maintaining data. Organizations and communities with the highest level of need for energy justice data may be unable to access or afford relevant information, underscoring issues of transparency and accessibility. The complexities of energy equity necessitate greater engagement between researchers, regulators, communities, and utilities to establish appropriate methods for measurement and reporting. In addition to developing new energy equity programs and establishing robust metrics, these actors must determine the extent to which necessary data are already available and what investments are required to acquire outstanding data.

The emergent status of energy equity measurement provides room for future research to consider underlying concerns regarding methodologies and research assumptions. Those currently working to measure energy equity have the unique opportunity to consider tensions identified by energy justice scholars, namely the preference for traditional economic modeling and the absence of normative frameworks in energy analysis. These circumstances highlight the need for more cross-disciplinary collaboration to account for the multifaceted nature of energy justice and social aspects of energy systems in the development of metrics and frameworks. Those developing metrics may benefit from working with researchers in the humanities and social sciences to gain a more holistic understanding of justice concepts. Researchers may also gain insight into energy justice measurement by engaging directly with frontline communities and grassroots organizations.

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Appendix A: Full List of Metrics from Lanckton and DeVar (2021)

Energy Access and Affordability

Corresponding Utility Actions: • Fund energy assistance programs • Establish programs that reduce costs for low-income households • Establish Percentage of Income Payment Plan for low-income consumers • Limit household energy bills to the percentage of gross income • Decouple revenue to prevent underfunding of assistance programs • Simplify energy assistance for seniors • Inform customers of all energy assistance programs and payment options on calls seeking help paying a bill • Ensure that energy is affordable for frontline, Black, Indigenous, and people of color households • Provide assistance and inclusive financing for deep investments • Shift entire energy assistance system towards clean energy assistance programs that provide long-term renewable energy and efficiency benefits, and away from annual fuel subsidies • Expand local energy assistance programs to reduce disparities • Develop public education campaigns about how to enroll in programs • Target investments to help underserved communities prepare for and recover from disasters • Equitably link the grid to disaster preparedness • Make demand response programs available to households of all income levels and ensure renters have same opportunities as homeowners • Provide strong public education about demand response programs • Provide energy-reduction programs to assist low-income residents • Fund low-income energy efficiency upgrades • Establish utility and on-bill financing programs to lower barriers to financing energy efficiency projects • Fund energy efficiency assistance programs • Ensure process for applying for energy efficiency assistance is simple • Invest in underserved communities, including weatherization assistance and rebates for energy-efficient products • Improve access to energy-management systems • Establish a public benefits fund supported through utility's revenue • Fund energy efficiency and low-income weatherization services • Focus energy efficiency programs on structural change rather than placing the burden on frontline communities to change their behavior • Weatherize homes and buildings • Provide opportunities for renters to be prioritized and receive economic benefits in energy efficiency • Limit incentives to efficient electric systems, with the amount of the incentive calibrated to the efficiency of the system • Expand net metering programs to customers who participate in offsite solar generation, such as community solar, through virtual net metering • Improve access to distributed generation and distributed storage • Fund the development of new renewable energy • Create a plan for establishing and managing a network of distributed energy generation • Enable community solar projects • Provide a variety of clean energy options to achieve the 100% goal • Advance microgrids • Provide opportunities for renters to be prioritized and receive economic benefits in local renewable energy • Utilize "community benefits" framework for renewable energy development • Provide access to information technology for people without Internet • Provide assistance in accessing subsidies to obtain Internet access • Improve access to broadband in rural communities • Develop programs specifically targeted to assist low-income residents that cater to making electric vehicles more accessible and affordable • Develop programs that cater to making electric vehicles more accessible and affordable to frontline communities • Provide a variety of transportation choices beyond electric vehicle programs • Prioritize a range of clean mobility options in frontline communities • Prevent displacement with any transit-oriented development elements • Establish a Tribal Infrastructure Fund to finance energy infrastructure and projects that increase energy access in Tribal communities • Establish procedures for reparations and/or redress for Indigenous lands, territories, and resources that have been taken, confiscated, or occupied by utility operations • Ensure there is not uneven attention given to urban and rural communities • Consider varying rural contexts and provide alternatives appropriate for homes in rural communities • Staff contact centers that meet language needs of utility's customer base	Decrease in share of households (or population) without electricity or commercial energy, or heavily dependent on non-commercial energy Decrease in share of household income spent on fuel and electricity (energy burden) Decrease in household energy use for each income group and corresponding fuel mix Decrease in utility rate individual equity score Increase in access and proximity to community facilities, services, and infrastructure in neighborhoods with the highest percentage of low-income residents and people of color Increase in customer cost savings in $ saved Increase in percent of population living within a reasonable distance from a heat island mitigation feature that provides localized cooling through tree canopy cover, green roofs or green walls; white roofs or cool roofs; and/or light-colored pavement or groundcover

Procedural Justice and Democracy

Corresponding Utility Actions:	
• Hold community planning and visioning workshops • Invite all parties affected by environmental decisions to contribute to all stages of the decision-making process • Include all parties affected by environmental decisions in all stages of the decision-making process • Establish partnerships that engage key community groups • Make involvement in the decision-making process possible, the experience valuable, and act on the advisement and feedback given	Increase in local survey responses indicating that residents believe they are able to have a positive impact on their community
• Contract with community-based organizations already working on issues of racial equity to hos community events • Become familiar with the communities of color in the utility's generation and service territory, the history of oppression, and its impact on these communities, and build ongoing, mutually respectful, and beneficial relationships with these communities (i.e., no one-off meetings or processes that only serve the utility's needs) • Determine what level of engagement will be employed for each project, be upfront about the level of decision-making the community will have in each process, and use appropriately matched methods and tools	Increase in appointments to local advisory boards and commissions that reflect the gender, racial, and ethnic diversity of the community
• Provide opportunities for tribes to manage and co-manage projects • Work with local Tribal communities under Memorandums of Agreement • Engage community at all major decision points (e.g., program and service policy changes, budget and resource allocation decisions, development, and planning, etc.) • Identify possible budget allocation, policy, procedural, and practice solutions and be prepared to bring this information to the table when engaging with the community	Increase in diversity of racial, ethnic, [gender], and geographic composition of planning organization boards
• Ensure community engagement in the renewable development process by collaborating with communities where renewable energy is being sited • Collaborate with frontline, Black, and Indigenous communities, people of color, and community-based organizations • Establish processes for co-governance and collective accountability with frontline, Black, and Indigenous communities and people of color	Increase in percent of community members in a population engaged in energy policy rule-making proceedings
• Identify the group of stakeholders and affected parties – including those who have historically not been/felt included or engaged – and their roles in decision-making • Communicate with communities, stakeholders, and employees about how the action will be implemented • Learn with the community to adjust plans as their priorities shift • Communicate progress to all stakeholders • Plan to incorporate community feedback into future planning	Increase in funding for participants of rule-making proceedings, particularly marginalized and vulnerable communities
• Measure and evaluate intended outcomes of all programs, projects, and initiatives in collaboration with affected communities • Ensure that those affected by decisions have control of those decisions • Engage with affected communities and employees to guide successful implementation • Engage people of color most impacted by racial inequities to establish utility's broader vision for racial equity and theory of change to achieve it • Apply relevant rules and procedures consistently, with regard to all parties • Hold all parties accountable • Ensure that all environmental decisions are made publicly and free from external coercion • Ensure that decision-making is deliberative, that is, free from any authority of prior norms or requirements	Increase in percent of community recommendations that were meaningfully incorporated into final energy rules, policies, and/or decisions
• Appoint an advisory board to provide oversight on equity • Establish and maintain an office or interdepartmental working committee to ensure access, equity, and inclusion in programs and service delivery • Establish an Equity & Environment Initiative to lead the effort to shift the utility's approach so those most affected by the combined impacts of hazardous pollutants, climate change, racial and socioeconomic conditions will lead on designing solutions and directly benefit from utility's investments • Set up an Environmental Justice (or Climate Justice) Board or Accountability Board comprised of frontline communities that can set processes and structures in place for the accounting of investments and disinvestments inn energy programs that impact environmental justice and frontline communities • Consult tribes prior to developing projects • Consult with leadership from Tribal nations • Consult with communities to determine if there are sufficient monitoring and accountability systems in place • Provide staff with equity, inclusion, and/or cultural disparity training • Train staff in how to provide meaningful consultation to tribes • Use existing community-produced reports as research material • Learn about affected communities', employees' and/or stakeholders priorities and concerns • Conduct outreach that is linguistically- and culturally-appropriate on the utility's plan to reach the 100% renewable requirement • Provide all parties with access to sufficient skills and material resources to enable them to participate on an equal footing • Compensate community participants, advocates, and experts for their consultation	Increase in percent of utility actions and projects engaged in with prior consent and consultation with Indigenous communities

Procedural Justice and Democracy (continued)

Corresponding Utility Actions:	
• Provide childcare and language translation services • Hold meetings after regular working hours • Hold meetings in a space that is ADA accessible • Use a community impact assessment early on and throughout all major decision points • Incorporate equity impact assessments into the development and evaluation of program and services	Increase in local survey responses indicating that residents believe they are able to have a positive impact on their community
• Integrate racial equity into routine decision-making processes through the use of a Racial Equity Tool and the development and implementation of measurable actions • Evaluate whether utility actions appropriately respond to community priorities and concerns • Implement a Results Based Accountability framework • Create a utility wide Racial Equity Action Plan • Utilize the Mobility Equity Framework for all projects that impact the transportation system	Increase in appointments to local advisory boards and commissions that reflect the gender, racial, and ethnic diversity of the community
• Consider externalities such as environmental and system benefits in the valuation of renewable energy projects Consider the full cost of environmental impacts and pollution in planning, as well as benefits such as economic values, improved health outcomes, reduced indoor air pollution, housing security, and energy affordability • For every project proposal, conduct an analysis of the best use of public land and the local impacts of proposed projects • Identify how utility actions will affect/serve people and places using demographic information • Determine which known disparities and determinants of equity will be affected by your proposed course of action and intended outcomes	Increase in diversity of racial, ethnic, [gender], and geographic composition of planning organization boards
• Identify potential unintended equity-related outcomes of this action • Project how alternatives will affect community and employee priorities and concerns • Evaluate each alternative for who will be disproportionately burdened or benefited, considering whether, now and in the future, alternative actions differ in improving or worsening current equity conditions • Include upstream alternatives that target root causes to eliminate disproportionate impact	Increase in percent of community members in a population engaged in energy policy rule-making proceedings
• Prioritize alternatives by equitable outcomes and reconcile with functional and fiscal policy drivers • Ensure that data and information regarding ongoing community changes are accurate and accessible and transparent to all • Provide quality demographic data on pilots and programs by identifying the benefits and burdens associated with our energy system • Track data and provide public reports that outline which communities benefit from energy efficiency and renewable energy programs	Increase in funding for participants of rule-making proceedings, particularly marginalized and vulnerable communities
• Track and report on the progress of the Racial Equity Action Plan • Disaggregate all data collected by race • Quantify performance measures to achieve clarity in progress towards equity goals • Identify, analyze, and report inequities and disparate impacts of the utility's programs and services • Develop mechanisms for collecting data and evaluating progress to measure whether racial equity is being advanced • Collect and report robust data on emissions • Protect customers' data privacy	Increase in percent of community recommendations that were meaningfully incorporated into final energy rules, policies, and/or decisions
• Publish a recognition of the Indigenous land on which the utility operates and the Indigenous Peoples within its service and generation areas • Recognize past and current harms to Indigenous communities related to the control and domination of energy as well as Tribal Sovereignty and rights • Respect sacred sites on Indigenous lands and mark them as off-limits for energy projects • Provide a written recognition that people of color, immigrants and refugees, people with low incomes and individuals with limited English proficiency tend to be overburdened by health impacts from pollution and environmental issues • Review policy and practices through a justice lens • Center social equity and community power as primary values in all transportation planning and decision-making • Seek to align utility mission with environmental and social goals • Clearly identify desired goals of frontline, Black, and Indigenous communities and people of color to be achieved by all programs	Increase in percent of utility actions and projects engaged in with prior consent and consultation with Indigenous communities

Economic Participation and Community Ownership

Corresponding Utility Actions:	
• Collect and track data, especially to determine if frontline, Black, and Indigenous communities, people of color, women of color, and LGBTQ workers are able to maintain employment • Provide and report detailed data and tracking of employment, including salaries, wages, promotions, and new hires, disaggregated by race, gender, income, and all other relevant determinants • Track who is hired, whether a worker comes from a frontline, Black , or Indigenous community or community of color, particular zip code or census tract, and other key information related to local hire • Set gender targets in recruitment, hiring, and retention • Conduct evaluations to determine what factors impact worker retention • Hire people who live near their place of work • Ensure equitable access to a broad range of careers in the renewable energy sector that are high wage with comprehensive benefits • Advance women, women of color, and LGBTQ individuals to leadership • Provide frontline communities access to high quality, high wage jobs in the renewable energy sector • Ensure that African Americans are brought into the clean energy sector • Prioritize the recruitment, retention, and advancement of women • Institute hiring thresholds to encourage the recruitment of women • Invest in a Race and Social Justice Program Manager position • Implement programs that create pathways for higher-paying positions • Ensure equitable wages and benefits across genders • Provide good family-sustaining benefits including healthcare, dental, retirements, and other elements of a comprehensive benefits plan • Ensure worker safety and protections, rights to meal breaks and rest periods, and universal labor rights including the right to organize in the workplace and the right to collective bargaining for better wages and working conditions • Recruit in communities of color • Increase connections to entry-level opportunities • Implement classroom-based education, workforce development, trade skills-building programs, and supplier diversity practices • Promote job creation and the development of green jobs • Implement training and workforce development programs • Fund education and workforce development programs with a priority on those facing historic or systemic barriers to equitable outcomes • Pay trainees in apprenticeship programs high wages and include benefits • Establish clear certification processes for trainings relevant to long-term careers in the green sector • Ensure that job trainings lead to actual jobs • Promote potential job opportunities that can be created in the retirement of old fossil fuel infrastructure • Ensure that professional development opportunities extend to women • Increase accessibility to training and apprenticeship programs for women, women of color, and LGBTQ communities • Develop a Green Jobs Initiative to increase utility workforce diversity to reflect the communities that the utility serves • Create high road careers that are linked to the infrastructure development of local distributed generation • Establish robust apprenticeship and pre-apprenticeship programs • Create mid-level opportunities that accelerate leadership • Cover the cost of expenses for jobs skills training programs • Create an annual Race and Social Justice Initiative work plan • Develop annual events centering social justice, racial justice, and equity • Provide training to all staff on institutionalized racism and how to apply this learning to work at the utility • Provide intern orientations that include racial and social justice activities • Provide employees with information on implicit gender biases • Ensure access to support services for women and families in the workforce including childcare, paid family leave, funding for work required equipment and protective clothing, and on-site breastfeeding space • Implement protections for employees in the workplace • Update human resources policies to respond to the needs of women • Require contractors to provide a living wage for employees • Require contractors to provide health insurance for employees • Implement supplier diversity programs • Encourage prime contractors and major suppliers to provide opportunities for diverse supplier subcontractors and businesses • Provide the consultant and construction community with information about upcoming opportunities within the utility • Ensure supplier diversity in contracting • Prioritize people of color-owned and women-owned business enterprises	Decrease in Gini coefficient Decrease in income inequality "95/20" ratio Decrease in percentage of residents living below the poverty line Decrease in percentage of women, men, children, and additional subgroups of residents living below the poverty line Increase in local energy generation in GWh generated per year Increase in percent of energy resources/ assets owned or controlled by women and equity business enterprises Increase in percent of energy resources/ assets owned or controlled by the local community

Economic Participation and Community Ownership (continued)

Corresponding Utility Actions: • Establish a Women and Minority Business Enterprise Program • Establish requirements for a certain percentage of the dollar amount spent toward WMBEs • Report on WMBE expenditures • Notify WMBEs of utility business opportunities • Set-aside funds for WMBEs • Demand support for women-led enterprises • Offer well-designed community shared solar programs • Enable low-income access to community shared renewable programs • Make solar PV-market participation available to low-income customers through arrangements like community solar • Alleviate the up-front cost barrier to community shared solar programs through "pay as you go" options • Ensure that community shared solar programs operated by the utility maximize the benefits of going solar, including increasing community control and expanding the opportunity to use community energy projects to accomplish social goals such as quality employment for disadvantaged populations • Cooperate with non-utility owned community shared solar programs and collectives • Identify ways to extend financing to customers with higher credit risk, including on-bill repayment programs • Size renewable energy projects to ensure siting in frontline, Black, and Indigenous communities and communities of color • Utilize the "solarize" approach to allow groups of homeowners or businesses to work together to collectively negotiate rates, competitively select an installer, and increase demand through a creative limited-time offer to join the campaign • Invest in research and development of microgrids in frontline, Black, and Indigenous communities and communities of color • Advance and incentivize community ownership and procurement among frontline, Black, and Indigenous communities and communities of color • Adopt a community-wide plan to reduce poverty	Decrease in Gini coefficient Decrease in income inequality "95/20" ratio Decrease in percentage of residents living below the poverty line Decrease in percentage of women, men, children, and additional subgroups of residents living below the poverty line Increase in local energy generation in GWh generated per year Increase in percent of energy resources/ assets owned or controlled by women and equity business enterprises Increase in percent of energy resources/ assets owned or controlled by the local community

Health and Environmental Impacts

Corresponding Utility Actions: • Construct new facilities and infrastructure in locations that reduce existing disparities • Incorporate environmental justice criteria and priorities into zoning, land use planning, permitting policies, and development of new projects • Create community benefit agreements for environmental justice site remediation projects and/or proposed development projects with environmental justice concerns • Invest in comprehensive electric vehicle programs and infrastructure, and fund the electrification of public transportation • Incorporate environmental equity principles into projects and programs • Include the impacts and costs related to road creation, recycling of old vehicles parts such as tires, and how and where various modes of transportation will be created and dumped in transportation goals • Do No Harm: Ensure that wherever renewable energy is sited and energy efficiency upgrades are made, these projects do not create further harm in frontline, Black, and Indigenous communities and communities of color • Reduce reliance on bridge fuels such as gas plants • Identify the community's priority environmental justice conditions • Conduct a comprehensive environmental justice assessment • Define and set strong public health goals • Reduce the risks and exposure to priority environmental justice conditions for priority neighborhoods • Monitor and enforce environmental standards for facilities that impact prioritized environmental justice sites and overburden neighborhoods • Implement projects to reduce exposure to contaminants and risks associated with environmental justice conditions • Demonstrate a measurable reduction in vulnerability and/or increase in resiliency to community wide risks and at-risk population groups • Ensure that public health benefits continue in the transition to renewable energy • Compensate communities that are most impacted by pollution from fossil fuels for healthcare necessary to treat cancer, asthma, and other diseases resulting from fossil fuels	Decrease in accident fatalities per energy produced by fuel chain Decrease in metric tons (MT) of criteria pollutants Decrease in GHG emissions in metric tons of CO_2 ($MTCO_2$), GHG intensity ($MTCO_2$/ MWh)

EPRI RESOURCES

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Technology Innovation

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Founded in 1972, EPRI is the world's preeminent independent, non-profit energy research and development organization, with offices around the world. EPRI's trusted experts collaborate with more than 450 companies in 45 countries, driving innovation to ensure the public has clean, safe, reliable, affordable, and equitable access to electricity across the globe. Together, we are shaping the future of energy.

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