Metrics for an Equitable and Just Energy System

Introduction

Communities of color, those living with low to moderate income, and those on the frontlines of climate change are only some of the groups who have disproportionately felt the burden of an inequitable energy system [1]. Recent policy initiatives [2] have begun to highlight the clear need to generate energy equity and justice by providing reliable, safe, and affordable energy where the costs and benefits of such energy services are disseminated fairly. However, the ways for measuring progress towards these goals are not yet clearly defined.

Metrics, indicators, and indexes are three mechanisms available to support these efforts. While often used interchangeably in literature, each is distinct in its functionality.
- *Metrics* are a quantitative measurement for a qualitative phenomenon that can help measure a specific equity outcome. Metrics are likely to become key for tracking equity-related efforts and ensuring goals are met.
- *Indicators* are a representation of relevant equity outcomes that can be used to establish the state of equity at a given point in time [3]; indicators are useful in collecting baseline equity measurements.
- Multiple indicators can be aggregated into a single measure, known as an *index*.

Most energy justice and equity metrics are built around measuring or assessing energy inequities such as energy poverty,[1] energy burden,[2] energy insecurity,[3] and energy vulnerability.[4] However, advancing an equitable energy future would also require equity metrics that measure the justice and equity implications of current and future energy projects. To that end, the following review is structured around three categories central to the equity metrics development process: target population identification, investment decision-making, and program impact assessment. These categories have been adapted from the equity metric dimensions developed by [4] in the literature. Each of these categories are described below and metrics within each category are presented. The metrics in each category are described, data points needed to calculate each metric are listed, and potential resources through which to acquire the necessary data are shared. This information is intended to provide an overview of the prominent metrics in each category to support ongoing efforts in energy equity metrics creation.

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[1] Energy poverty refers to the lack of access to affordable and sustainable energy service.
[2] Energy burden is defined as the percentage of gross household income spent on energy costs. https://www.energy.gov/eere/slsc/low-income-community-energy-solutions#:~:text=Energy%20burden%20is%20defined%20as,which%20is%20estimated%20at%203%25.
[3] Energy insecurity refers to the hardship households face to meet basic household energy needs.
[4] Energy vulnerability indicates the propensity of a household to suffer from a lack of adequate energy services in the home.

Target Population Identification

To advance energy equity, one must start with an understanding of population distribution within a society—who is eligible for support programs, where are energy prices higher or more burdensome, who is able to make their monthly bill payments, where have energy efficiency measures been put into place, and who has better quality of life? The target population identification metrics category provides community descriptive metrics for evaluating the distribution of benefits and burdens in society, measuring distributive[5] and recognition[6] justice.

Table 1 lists metrics that can be used to identify target populations: program equity index, program accessibility, energy cost index, energy burden index, late payment index, appliance performance, and household-human development index (HDI). These metrics require data pertaining to the cost of energy bills, frequency of late payments, demographics, and the type of assistance offered through specific programs. These data can often be collected from organizations like the Energy Information Administration (EIA), utilities, and the programs they are designed to evaluate. The National Institute of Health (NIH), Environmental Protection Agency (EPA), and appliance purchase records may also be useful sources for collecting data in this category of metrics. The spectrum of metrics in this space ranges from measuring the success of programs created to help communities access energy efficient appliances to the demographics of those who participate in programs such as the Weatherization Assistance Program (WAP) and the Low-Income Home Energy Assistance Program (LIHEAP).

Table 1 Target population identification metrics

Metric and Reference	Needed Data Points	Data Sources and Description
Program equity index [5]	Energy assistance offered	Program data; distribution of program benefits across populations
Program accessibility [6]	Eligible population data, income data	Program data; distribution of program eligibility across population groups
Energy cost index [5]	Median annual energy bill	EIA, utility records; distribution of energy cost across populations
Energy burden index [5]	Median annual energy bill and annual median income	EIA, utility records, census; distribution of energy burden across populations (i.e., 6% is considered high, 10% is considered severe)
Late payment index [5]	Late energy bill payment rate	Utility records, LIHEAP; distribution of late bill payment habits across populations
Appliance performance [7]	Appliance maintenance cost (lifespan, energy profiles)	Appliance purchase records, audit template; distribution of access to energy efficiency measures
Household-human development index [8]	Health status, education level, income	NIH, EPA, EJScreen[7]; distribution of HDI scores across population subgroups

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[5] Distributive justice involves identifying where energy injustices emerge in society.
https://www.sciencedirect.com/science/article/pii/S2214629615300669
[6] Recognition justice emphasizes the need to understand different types of vulnerability and specific needs associated with energy services among social groups.
https://www.frontiersin.org/articles/10.3389/fenrg.2019.00099/full
[7] https://www.epa.gov/ejscreen

Investment Decision-Making

Investment decision-making metrics largely use a community lens to understand the distribution of investments across populations—which communities support specific investment decisions, to what extent different communities experience health and environmental impacts, where the quality of energy service is lacking, and which communities see an increase in jobs. These metrics help in understanding effects of investments and subsequently help measure whether those investments contribute to or detract from an equitable energy system. This category evaluates procedural justice[8] by assessing the fairness of funding/grant processes, policy levers, and equity programs.

Table 2 includes metrics for investment decision-making: community acceptance rating, program funding impact, energy use impacts, energy quality, and workforce impact. Compared to the target population identification metrics, this category of metrics largely requires data around community satisfaction, the impacts of investments on health and frequency of electric outages, as well as the budget available for equity programs and the jobs generated through investment. The EIA and program-specific data are again key sources for calculating metrics in this category, and surveys from communities can also support these measurements. The metrics range from communities' acceptance of investments to the impact that investments have on local communities.

Table 2 Investment decision-making metrics

Metric and Reference	Needed Data Points	Data Sources and Description
Community acceptance rating [6, 9]	Numeric representation of community satisfaction	Surveys of community acceptance and support for investment
Program funding impact [6]	Percent budget for advancing equity	Program data; percent of investment funding supporting disadvantaged communities
Energy use impacts [9]	Health and environmental impacts due to investment	Distribution of health and environmental impacts of energy investments across populations
Energy quality [9]	Investment impact on frequency of electric outages, energy capacity	EIA; utility data
Workforce impact [6, 7]	Investment generated jobs	Department of Labor (DOL); community benefits from investment (participation from low-income groups, local business contracts)

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[8] Procedural justice evaluates decision-making processes to assess whether all stakeholders have been included in a non-discriminatory way. https://www.sciencedirect.com/science/article/pii/S2214629615300669#sec0045

Program Impact Assessment Metrics

Once equity programs have been implemented, assessing the impact they have had in achieving their goals becomes necessary—have they generated wealth for targeted communities, are communities satisfied and enrolling in programs, have they generated savings in energy or costs, and have they improved the quality of life? Compared to the target population identification and investment decision-making metrics that speak to specific tenets of justice, these metrics measure the success of the decisions and programs that were designed to generate equitable outcomes.

Table 3 lists six key metrics for assessing program impact: program acceptance rate, energy savings, energy costs savings, energy burden change, and change in HDI. They require energy use and cost data, household income data, and program data such as revenue and implementation costs in addition to the portion of a population enrolled in a program. These data can be found through resources similar to those used in target population identification metrics, including the EIA, utilities, and equity programs.

Table 3 Program impact assessment metrics

Metric and Reference	Needed Data Points	Data Sources and Description
Program acceptance rate [6]	Percent of population enrolled in program	Program data; program enrollment after receiving information (i.e., information dissemination, transparency, community trust, etc.)
Energy savings (MWh) [6]	Energy use over time	EIA, utility records; Energy use savings in disadvantaged communities after program implementation
Energy cost savings ($) [6]	Energy cost over time	Energy cost savings in disadvantaged communities after program implementation
Energy burden change [8]	Household income, energy bill	EIA, utility records, census; percent reduction in energy burden after program implementation (EE, weatherization, rate design, wage changes, etc.)
Change in HDI score [8]	Household income, quality of life	EIA, NIH; wellbeing and quality of life improvement after program implementation

Conclusion

While the above metrics represent the best available options for measuring equity within the development of energy projects and programs, metrics development for energy equity is still at the ideation phase.

Including and thinking through the equity metrics identified in this review and expanding on them as new areas are identified is important for a robust measurement capability. Based on the review of metrics above [4, 10, 11, 12], opportunities for future metrics are listed below:
- Metrics to show disparate effects of past policies
- Metrics to capture community needs
- Metrics to track and measure project impact
    - Metrics to assess quality of jobs generated
    - Metrics to capture the non-cost benefits of reducing energy burden
    - Metrics to capture health and safety issues abated

PNNL and partners are working to identify and develop additional metrics for energy system planning to support utilities, state regulatory agencies, and other interested entities.

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