Energy Justice: Key Concepts and Metrics Relevant to EERE Transportation Projects

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National Renewable Energy Laboratory

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Introduction

For decades, transportation planning and policy has focused on optimizing the performance and efficiency of the transport system (Martens 2016). This focus on the technical aspects of improvement fails to account for the real-world human impact. This has had deep consequences on justice, as some populations have enjoyed the fruits of the improving system, while others have been excluded from the benefits, experienced negative externalities, faced health risks, or received reduced mobility and accessibility.

The strong commitment of the Biden administration to energy justice provides important new opportunities for the U.S. Department of Energy (DOE) and Vehicle Technologies Office (VTO) to further principles of transport equity and justice. Yet this increased emphasis also provides challenges as technology managers seek to incorporate potentially unfamiliar concepts from the social sciences into their research projects. This document provides VTO with a "primer" of key concepts and metrics relevant to energy equity and justice. This is a living document, subject to change, and is not intended to be comprehensive. It provides a starting point for further engagement and discussion.

Definitions of Concepts

It is important at the outset to differentiate *equity* and *justice.* For centuries, concepts and theories of equity and justice have sparked compelling philosophical, conceptual, and ethical discussions (Cowell 2009). Although often used interchangeably, equity and justice represent different concepts (Ikeme 2003; Reckien et al. 2018).

Equity refers to being fair and impartial; it engages with an organization or system, particularly systems of grievance. "Equity" is often conflated with the term "equality" (meaning sameness). In fact, true equity implies that an individual or group may need to experience or receive something different (not equal) to facilitate fairness and access. For example, a person with a wheelchair may need differential access to transportation services relative to someone else (Ikeme 2003; Agyeman et al. 2016).

Justice, on the other hand, involves removing barriers that prevent equity. Justice entails constructing a system that offers individuals and groups equal access to assets, options, and opportunities to pursue their life goals (Sen 2011; Nussbaum 2011).

It is also helpful to differentiate environmental, energy, and climate justice, with justice also being defined in many ways (Baker, DeVar, and Prakash 2019; Carley and Konisky 2020; Sovacool et al. 2019). Definitions for these concepts are shown in Figure 1. These concepts are often inextricably linked and can be difficult to delineate, yet they provide useful frameworks for focusing efforts. Within this framing, DOE has a primary role in addressing and advancing energy justice tenets and principles (see Figure 2).

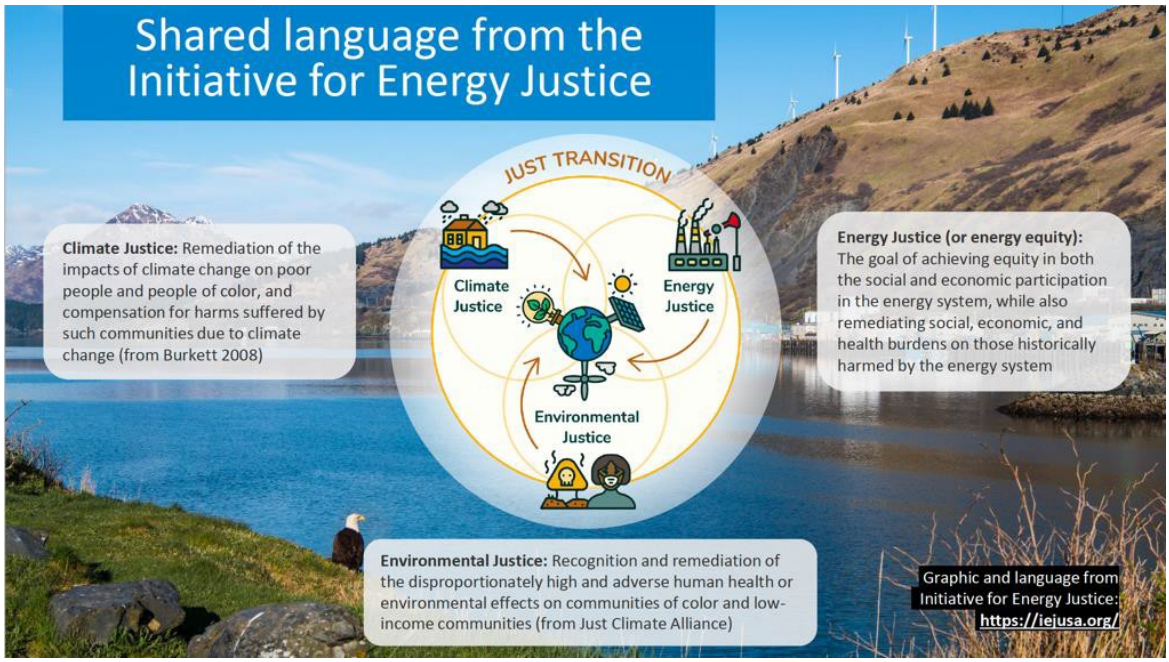

Figure 1. Example definitions of climate, environmental, and energy justice (Ikeme 2003)

Building on scholarship recently cited by Baker, DeVar, and Prakash (2019), we briefly discuss five tenets of energy justice aimed to foster equity in DOE projects. The first, *distributional justice*, seeks to ensure the fair distribution of benefits or negative impacts from transportation—including shifts to electric vehicles (EVs), clean fuels, and other technological innovations—across the range of different users. The second, *procedural justice*, aims to achieve equity by including women, elderly, the working class, rural, and other underrepresented racial or ethnic groups in framing the mobility and energy needs and innovations to address those needs. *Recognition justice*, the third tenet, involves innovations and solutions that promote equity by addressing historic and ongoing inequalities—e.g., those that target historically underrepresented groups who have been more at risk from the health impacts of transport corridors and have been excluded from some areas through redlining, defined as "the systematic denial of various services or goods by federal government agencies, local governments, or the private sector either directly or through the selective raising of prices" (Denver Metro Chamber Leadership Foundation 2020).

Most recently, experts and decision makers have expanded the scope of energy justice to include a fourth tenet, *cosmopolitan justice*. This integrates the energy life cycle assessment with what is argued to be a "social life cycle" assessment framework, to target the impact on historically excluded or underrepresented groups of all life cycle stages of transportation and energy systems. Elements to target within a cosmopolitan tenet include, for instance, inequalities in (1) raw material extraction, (2) production of vehicles, (3) operation and supply (e.g., of electricity), (4) consumption and use, and (5) waste management (e.g., of old vehicles and their parts) (Heffron and McCauley 2018; Maier, Mueller, and Yan 2017).

As represented in Figure 2, *restorative justice*, the fifth tenet, integrates the concepts of distributional, procedural, recognition, and cosmopolitan justice. It is a process whereby all parties with a stake in a particular environmental offense come together on a voluntary basis to collectively resolve how to deal with the aftermath of the offense and its implications for the future. Restorative justice does offer an innovative response to environmental harm in line with values such as collaboration, trust, nature

conservation, and restoration of social relationships (Heffron and McCauley 2018; Robinson and Carlson 2021).

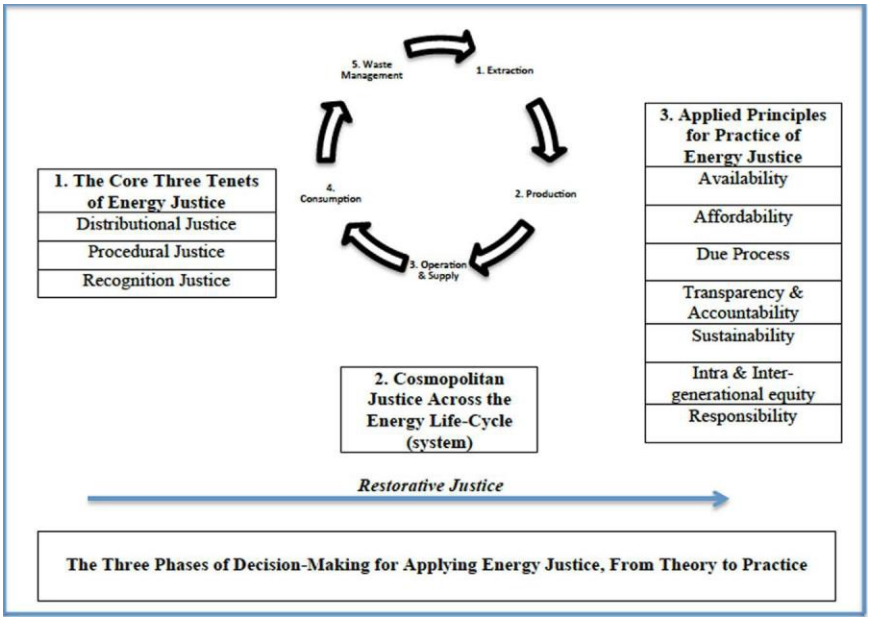

Figure 2. The energy justice conceptual framework (Heffron and McCauley 2018)

It is important to differentiate transport versus mobility justice (Gössling 2016). *Transport justice* addresses fairness in the distribution of benefits, burdens, risks, and access. It contends that governments have the fundamental duty to provide virtually every person with adequate transportation and mitigate the social disparities that have been historically created (Martens 2016). Transport justice considerations commonly focus on accessibility,[1] or the ease with which different social groups can reach destinations and services; personal risks from traffic accidents, noise, and vehicle emissions; time (differential treatment, such as via traffic priorities); and climate change impacts. The term *mobility justice* is usually used in relation to larger-scale (time and spatial) considerations, such as tourism and migration. It is also concerned with people's ability (i.e., assets, options) to feel safe on the streets and to pursue their everyday lives "experiencing the full joy of **movement** regardless of their physical ability" or socioeconomic or cultural status (Gössling 2016). The boundary between these terms can be fluid at times. Sheller (2018) recently attempted to integrate these concepts by proposing that issues at the spatial scale of individuals fall under the purview of transport justice, whereas those relevant to the nation-state and planet (e.g., migration, international tourism, climate change, global elite mobilities) fall within the realm of mobility justice. Current research is refining and integrating these concepts.

[1] In transport planning, accessibility refers to a measure of the ease of reaching (and interacting with) destinations or activities distributed in space (e.g., around a city or country). Accessibility is generally associated with a place (or places) of origin. A place with "high accessibility" is one from which many destinations can be reached, or destinations can be reached with relative ease. "Low accessibility" implies that relatively few destinations can be reached for a given amount of time/effort/cost, or that reaching destinations is more difficult or costly from that place. Karel Martens (2016) maintains that there is a basic minimal threshold of accessibility that all citizens should have, and that public funding should go to supporting this sufficiency threshold. Martens also upholds Amartya Sen (2011) and Martha Nussbaum's (2011) arguments for capabilities rather than outcomes by saying that accessibility should not be based on the ability to predict actual travel behavior, but rather should cover the range of possibilities and options individuals can draw on.

Figure 3. An approach to move equity and justice from theory to practice. Any of the five tenets are included in the center, whereas the principles are depicted in the outer circle.

Embedding Equity in DOE Projects

Building on the prior section, including equity and justice considerations in DOE's Office of Energy Efficiency and Renewable Energy (EERE) transportation projects can be accomplished through consideration of the process depicted in Figure 3. This is an iterative process that should ideally be used at every step of the cosmopolitan justice cycle from Figure 2. The cycle needs to be revisited after every round of programming to determine if the approach still aligns with the goals, and if it is targeting the correct factors. The approach includes four stages:

1. **Identify** the factors that have and continue to contribute to inequality and the existence of underrepresented communities. Use a series of tools to guide and measure disadvantaged community status[2]—e.g., indices and other tools described in Table 3.
2. **Enhance** the institutional and cultural factors that can foster the capabilities of communities. Use strategies and policies, such as funds and compensation, to alleviate damage or subsidize technology adoption and civil society organizations (NGOs) communities can draw on.

[2] States prominent in setting examples of practice have developed definitions and tools used by public utility commissions to objectively guide and measure disadvantaged community status. In the past, disadvantaged community status has been applied in relation to water access, public health, and economics, though is increasingly being applied to mobility. Below are a couple examples of state-level tools:

- New York: https://www.nyserda.ny.gov/ny/disadvantaged-communities
- California: https://www.cpuc.ca.gov/discom/

3. **Co-develop** adaptive and inclusive governance and policy systems. For example, collaborating with communities to design programs that increase their opportunities to access jobs, schools, and good quality energy services.
4. **Evaluate** using metrics to monitor performance and determine whether the goals of the program are being addressed (see Table 1).

Table 1. An Approach To Include Equity and Energy Justice Considerations in Decision-Making

(Litman 2021; Fan et al. 2019; Karpouzoglou, Dewulf, and Clark 2016)

Identify factors that can contribute to inequality and exclusion of underrepresented groups
• Affordability (e.g., of transport and housing) and income • Race/ethnicity (including American Indians and Alaska Natives) • Gender • Age (including children and seniors) • Driver's license/vehicle access • (Dis)Ability • Language • Level of isolation • Caregiver responsibilities • Obligations (school, employment)
Identify factors that can contribute to marginalization of some places
• Access to roads, transit, or shared mobility • Opportunity to board • Connections to jobs, schools, hospitals, groceries • Health risks from exposure to air pollution, particularly along transportation corridors
Consider factors that can enhance capabilities such as community, participation, and agency
• Local social safety nets (e.g., religious or community organizations) • Local institutional safety nets (e.g., governmental EV ride-and-drives in underserved communities) • Local leaders that can function as cultural brokers • Other community-led engagement and decision-making processes that can help ensure community agency (community self-determination) and inclusive public participation
In collaboration with communities, design and support programs that
• Increase access to opportunities (income, affordable transport and housing, food, education, health care, day care, social activity) • Increase time savings, comfort, and safety • Decrease travel costs for different individuals and groups • Support public and nonmotorized transport • Support walk, bike infrastructure (e.g., shared streets, protected bike lanes, signalized pedestrian crosswalks) • Consider health and environment of frontline communities • Consider different time scales of outcomes and impacts
Include adaptive and inclusive governance practices within the project plans
• Start with assessment of needs across all users • Adapt tools, knowledge, research, technologies, and data to address these needs • Evaluate performance through partnerships with representatives of stakeholders and communities

Co-design multidisciplinary solutions
• Collaborate and coordinate across programs, agencies, organizations, institutions, and stakeholder groups to improve equity considerations • Leverage existing programs and policies • Create multidisciplinary and cross-sector solutions
Include qualitative and quantitative metrics to

• Evaluate how transportation projects that support DOE and the Biden administration affect
  ○ Access to job, health, education, and recreation opportunities
  ○ Improvements in health, environment, and climate change
• Set project and program goals and measure impact based on what is important to underrepresented groups (e.g., children care), not just what is easily quantifiable.

Metrics

This section is intended as a representative sample of metrics, indices, and frameworks meant to begin discussion and collaboration. NREL looks forward to an iterative process with EERE to address specific goals and priorities.

Principles of equity and justice guide the development of measures to determine how wealth is distributed within a city, state, or country such as income, expenditure, and consumption (Filmer and Pritchett 2001). However, these indicators do not fully capture the assets and options (capabilities) of individuals or groups. For example, many have unreported income or at least a portion of their livelihoods supported by barter (Sen 2011; Nussbaum 2011). Therefore, to identify factors that can contribute to inequality and exclusion of underrepresented communities, social scientists increasingly advocate the use of asset or capability indicators such as education, gender, race, family, social, or institutional safety nets (e.g., communities, NGOs, churches), as well as metrics of accessibility or affordability (see examples in Table 1 and Table 3) (Sen 2011; Romero-Lankao, Gnatz, and Sperling 2016; Romero-Lankao and Gnatz 2019).

Principles of equity and justice also guide the development of metrics measuring the differential impacts of transport and energy policies and plans, asking, for instance:

- Whose mobility needs and realities are embodied in policy decisions?
- How do policies target historic and current inequalities?
- How do policies shape:
  - Societal levels of environmental externalities and what groups are more or less exposed to them?
  - The lives of different groups in terms of their ability to access life-enhancing opportunities such as employment, health care, education, and recreation?

Finally, principles of equity and justice in a cosmopolitan approach can be used to develop metrics measuring the differential impacts of transport policies and plans at all levels of a product or service life cycle, from extraction of materials to disposal of wastes (see Figure 3).

Table 2. Examples of Metrics Guided by Energy Justice Principles

Energy Justice Tenet	Applied Principle	Sub-Priority	Metric
Distributional Equity	Affordability	Provide Public, Workforce, Affordable, and Market Rate Housing to Create a Mixed-Income Community	Vocational school graduation rates/completion of job training or other workforce development program
			Proportion of housing units classified as affordable
			Housing cost-to-income ratio
			Housing and Transportation Affordability Index score
			Total number of households in each income threshold
Procedural Equity	Accountability	Community Agency	Participation in decision-making committees
			Recruiting, outreach, and retention efforts
			Direct community relationships created
			Good faith community projects offered
Recognition Equity	Intra- and Intergenerational Equity	Transitional Workforce Development	Number of programs and enrollment levels to cultivate business innovation
			Number of training programs matched to district job opportunities
			Green job training programs, vocational schools, and training facilities in the community
			Number of residents who have completed a job training program or workforce development program and were placed in jobs within 3 months of completion in the past year

Overview of Methods To Measure Equity

Specific indicators and metrics are fundamental tools to define equity priorities, inform policies, and enhance capabilities of underrepresented groups. Social inequality indices, for instance, can serve as heuristic tools to examine an individual or household membership within specific status groups and structural features, such as education, income and other assets, options, and perceptions associated with (lack of) capabilities (Romero-Lankao, Gnatz, and Sperling 2016; Sanchez and Brenman 2008). A few caveats need to be kept in mind, however, given the dynamic nature of inequality. The use of indices to classify individuals or households may or may not hold over time; inequality is multidimensional, and robust methods are needed to assign weights in the aggregation of indicators (Giordani and Giorgi 2010).

Unfortunately, the most common approach used in index construction is to assign equal weight to each indicator. Although this method has the virtue of simplicity, it often creates overgeneralization. A common practice to overcome these limitations has been the use of principle components analysis to aggregate ownership, asset, and capability variables into a single dimension (Filmer and Pritchett 2001; Vyas and Kumaranayake 2006; Qin et al. 2015). However, this method runs the danger of reductionism because the aggregation cannot capture the multidimensionality of social inequality, nor the portfolio of assets and options individuals or households draw on to pursue their livelihoods and respond to adversities.

With these points in mind, this section provides a focused overview of tools that may be relevant to addressing equity in EERE transportation projects (e.g., those that may help prioritize underrepresented groups or areas of intervention). The review of indices, tools, and resources for this effort was representative but not exhaustive, focusing on existing measurements used to address the issues of equity, opportunity, and transportation planning. This review builds on prior research (Romero-Lankao, Gnatz, and Sperling 2016; Vyas and Kumaranayake 2006; Qin et al. 2015) and on a project evolved from the spring 2019 University of Colorado, Denver, College of Architecture and Planning course "Making Sustainability Count," led by Dr. Elizabeth Walsh.

Table 3. Examples of Tools and Indices

Index or Tool	Intended Goal of the Index	Alignment with Energy Justice Principles	Source
Regional Equity Atlas	• Inform how well an individual, household, or community can access assets and opportunities • Identify where targeted investments or policy changes will have the greatest impact	• Availability	(Regional Equity Atlas 2020)
Opportunity Index	• Identify conditions that can increase access to residential and community opportunity • Measure opportunity beyond economics, to include education, health, and community	• Availability • Affordability	(Opportunity Index 2021)
Enterprise Green Community Criteria	• Measure quality of affordable housing stock based on price, efficiency, access, and environment at community level	• Availability • Affordability • Due Process • Transparency and Accountability • Sustainability • Intra- and Intergenerational Responsibility	(Enterprise Green Communities 2015)
Leadership in Energy and Environmental Design Neighborhood Development	• Establish a framework for planning, measuring, and managing social, economic, and environmental conditions for an individual, household, or community • Encourage thoughtful neighborhood planning	• Availability • Affordability • Transparency and Accountability • Sustainability	(U.S. Green Building Council 2018)
EcoDistricts	• Respond to urgent social and environmental changes in neighborhoods • Align community, developers, policymakers, and investors under a common umbrella of goals • Create trust and community ownership	• Availability • Affordability • Due Process • Transparency and Accountability • Sustainability • Intra- and Intergenerational Responsibility	(EcoDistricts 2021)

Index or Tool	Intended Goal of the Index	Alignment with Energy Justice Principles	Source
Housing and Transit Affordability Index	• Measure affordability of housing and transportation at the neighborhood level	• Affordability	(Center for Neighborhood Technology 2021)
EPA Human Well-Being Index	• Measure social, economic, and environmental well-being at the county level	• Availability • Affordability • Due Process • Transparency and Accountability • Sustainability • Intra- and Intergenerational Responsibility	(Summers et al. 2017)
Social Inequality and Vulnerability Index	• Use census or survey data to create indicators of education, race, minority status, health, transport infrastructure/services, etc. • Normalize indicators using scaling techniques • Create indices	• Indices of socioeconomic status groups based on human capabilities, social capabilities, and institutional and infrastructural capabilities	(Giordani and Giorgi 2010; Vyas and Kumaranayake 2006; Romero-Lankao, Qin, and Borbor-Cordova 2013)
Socioeconomic Status (SES) Groups	• Use census or survey data to create indicators of education, race, minority status, health, transport infrastructure/services, etc. • Use Analytic Hierarchic Process, a multicriteria decision analysis tool, to weight these indicators • Conduct compromise programing and “fuzzy logic” to assign households to SES groups	• Classification into SES groups based on human capabilities, social capabilities, and institutional and infrastructural capabilities	(Karpouzoglou, Dewulf, and Clark 2016; Romero-Lankao, Gnatz, and Sperling 2016)

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