



# JUST-R Metrics Framework for Integrating Energy Justice Into Early-Stage Research

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# Workshop Overview

## Goals:

- Understand the importance of energy justice
- Understand energy justice in early-stage research
- Evaluate how energy justice relates to your work



# Presentation Overview

- 1** Introduction to Energy Justice
- 2** Energy Justice in Early-Stage Research
- 3** JUST-R Overview
- 4** Q&A

# Introduction to Energy Justice

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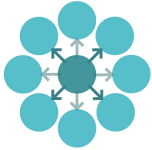





Justice Underpinning Science & Technology Research

**Energy Justice:** Principle with the goal of achieving equity in participation in, and outcome of, the energy system, while also remediating social, economic, and health burdens on those historically harmed by the energy system

**Equity:** Recognizes and addresses each individual's, or group's, circumstances and allocates resources and opportunities needed to reach an equal, fair, or just outcome

Source(s): 2020, "Equity vs. Equality: What's the Difference? | Online Public Health," GW-UMT; Baker, S., DeVar, S., and Prakash, S., 2019, "Section 1 - Defining Energy Justice: Connections to Environmental Justice, Climate Justice, and the Just Transition," Initiative for Energy Justice

# Energy Justice Concepts Overview

Type of Justice		Definition
Distributional		Equitable distribution of benefits and burdens across a population
Procedural		Equitable engagement, fairness, and transparency when allocating resources and reconciling disputes
Recognition		Respect for the rights, needs, values, understandings, and customs of a population
Restorative		Acknowledging, ameliorating, and addressing previous negative impacts that caused inequities
Intergenerational		Considering future generations, when evaluating changing effects of energy technologies over time
Cosmopolitan		Ensuring the well-being of persons, rather than communities or nations across the energy life cycle

Source(s): McCauley, D. A., Heffron, R. J., Stephan, H., and Jenkins, K., 2013, "Advancing Energy Justice: The Triumvirate of Tenets," *International Energy Law Review*, 32(3), pp. 107–110.; Jenkins, K., McCauley, D., Heffron, R., Stephan, H., and Rehner, R., 2016, "Energy Justice: A Conceptual Review," *Energy Research & Social Science*, 11, pp. 174–182.; Healy, N., Stephens, J. C., and Malin, S. A., 2019, "Embodied Energy Injustices: Unveiling and Politicizing the Transboundary Harms of Fossil Fuel Extractivism and Fossil Fuel Supply Chains," *Energy Research & Social Science*, 48, pp. 219–234.; Sovacool, B. K., Martiskainen, M., Hook, A., and Baker, L., 2019, "Decarbonization and Its Discontents: A Critical Energy Justice Perspective on Four Low-Carbon Transitions," *Climatic Change*, 155(4), pp. 581–619; Baker, S., DeVar, S., and Prakash, S., 2019, *The Energy Justice Workbook*. <https://iejusa.org/wpcontent/uploads/2019/12/The-Energy-Justice-Workbook-2019-web.pdf> ; McCauley, D., and Heffron, R., 2018, "Just Transition: Integrating Climate, Energy and Environmental Justice," *Energy Policy*, 119, pp. 1–7.; Baker, S., 2021, *Revolutionary Power: An Activist's Guide to the Energy Transition.*, Island Press. Brown, M. A., Soni, A., Lapsa, M. V., Southworth, K., and Cox, M., 2020, "High Energy Burden and Low-Income Energy Affordability: Conclusions from a Literature Review," *Prog. Energy*, 2(4), p. 042003.

# Energy Injustices



## Cost Burden

67% of low-income households spend 3X more of their income than wealthier counterparts



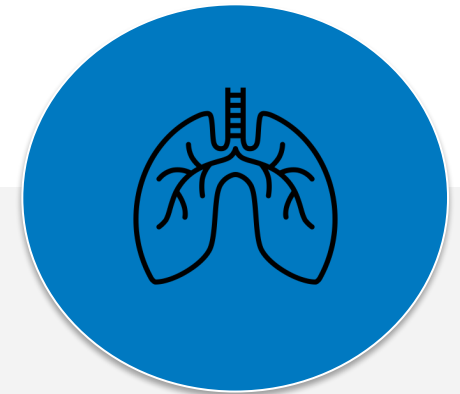
## Energy Insecurity

31% of U.S. houses struggle to sustain heating and cooling in their homes



## Clean Energy Access

Black and Latino communities have 61% and 45% less solar, respectively



## Health Concerns

Black children are nearly 8X more likely to die from asthma than White children

# Energy Injustice: Puerto Rico

## Cost Burden

- Puerto Ricans pay 8% of their income to electricity
- Compared to 2.4% average in the 50 states

## Energy Insecurity

- After hurricane Maria (2017), power was not “restored” until a year later
- Continued outages with hurricane Fiona (2022) through today
- Puerto Ricans consume 1/3 energy per capita compared to the 50 states





# Energy Injustice: Puerto Rico

## Clean Energy Access

- 97% of electricity comes from fossil fuels (2021)
- PR consumes 70 times the energy it produces

## Health Concerns

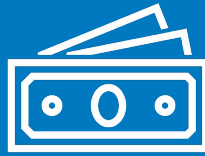
- Healthcare that requires consistent electricity (ex. dialysis)
- Criterion air pollutants that increase risk of lung illnesses and heart problems



# Barriers to a Just Clean Energy Transition



Clean energy for some



Inhibitive costs of cleaner options



Traditional lack of representation in decision-making



Potential loss of jobs, revenue, and livelihoods



Lack of access due to non-financial factors



Geography-based lack of access



Adverse impacts on health and on life-sustaining ecosystems

# Barriers to a Just Clean Energy Transition: Puerto Rico

## Inhibitive costs

- \$72 billion in debt
- Cannot apply for bankruptcy

## Lack of representation

- PROMESA (U.S. President appointed board) leads economic decisions
- No representation in Congress
- Privatized grid: LUMA

## Non-financial factors

- All goods to and from PR must go through mainland U.S.
- Population decreases

## Geographic complications

- Hurricanes and tropical storms



# Energy Justice in Early-Stage Research

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# Defining Early-Stage Research

## Deployment

- Implementation of technology in society

## Demonstration

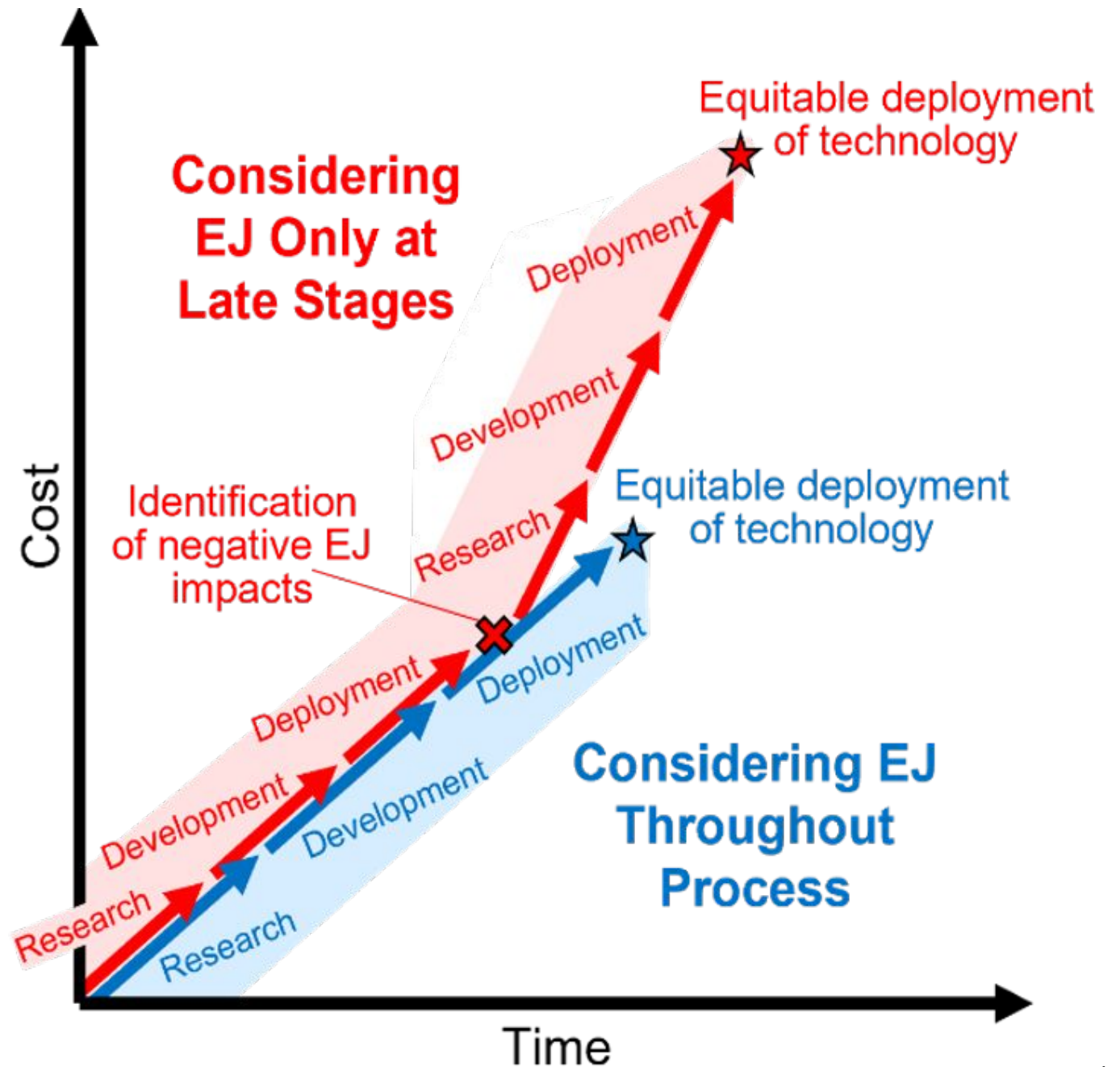
- Validating technology in a real-world setting

## Research and Development (R&D)

- Investigating existing knowledge
- Creating and refining technologies and processes



# Why Incorporate EJ in Early-Stage Research?



# Early-Stage Energy Justice: Puerto Rico

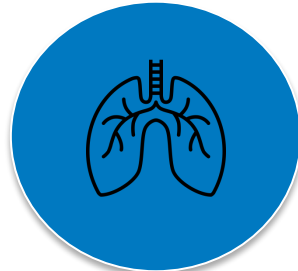
## What could have been done differently?

### Electricity Transmission

- 15% of lines are equipped for category 4 hurricanes
- 80% were destroyed in Maria



Energy Insecurity



Health Concerns

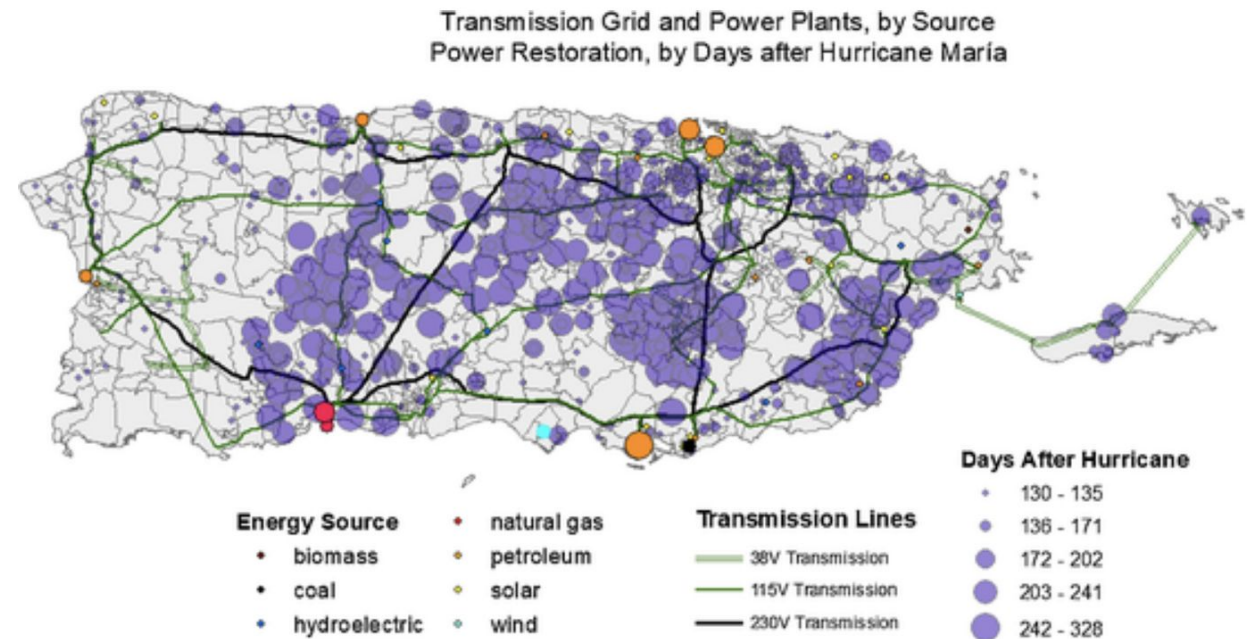


Fig 2. in M. Sotolongo et. al (2021)

# Early-Stage Energy Justice: Puerto Rico

## How could solar R&D be designed for Puerto Rico?

### Consider

- Weather resistant design and materials
- Life cycle of materials
- Island community-specific parameters





# Introduction to the JUST-R Tool

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## JUST-R: Justice Underpinning Science and Technology Research

**Goal:** Develop energy justice metrics that...

- Highlight opportunities to **incorporate justice throughout the process** of early-stage research.
- Prepare an emerging technology to **meet later-stage energy justice metrics**
- Applicable at the level of an **individual researcher or project** on a relatively **immediate timescale**.

# New metrics seek to...

Consider the whole research life cycle

Broaden the knowledge guiding our research

Expanding our solution parameter space

# New metrics seek to...

## Consider the whole research life cycle

### Hazard exposure during research life cycle



### Hidden process costs

- Hazard level of...
    - Extracting or synthesizing material inputs
    - Laboratory processes
    - Managing waste
  - Extend to which hazards would increase at industrial scale
- Estimated cost of...
    - Managing waste generated by the research
    - Energy consumed during research
  - Cost savings from operating the new technology vs. competing technologies

# New metrics seek to...

Broaden the knowledge guiding our research

## Breadth of pre-existing knowledge review

- Number of social science papers reviewed
- Diversity of authors on scientific papers reviewed
- Number of nonacademic sources reviewed



## Distribution of research results

- Proportion of results published open access
- Number of non-academic reports and oral presentations
- Diversity of audience reached
- Diversity of team members credited for and publicly presenting work

# New metrics seek to...

## Expanding our solution parameter space

### Identification of set vs. flexible parameters

- Number of alternatives explored to...
  - Waste-intensive processes
  - Energy intensive processes
  - Hazardous or unethically sourced materials
- Number of...
  - Environmental parameters tested
  - Nontechnical solutions explored to solve key problems in the research

# Thank You! Questions?

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# Feedback!

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# Supplemental Slides

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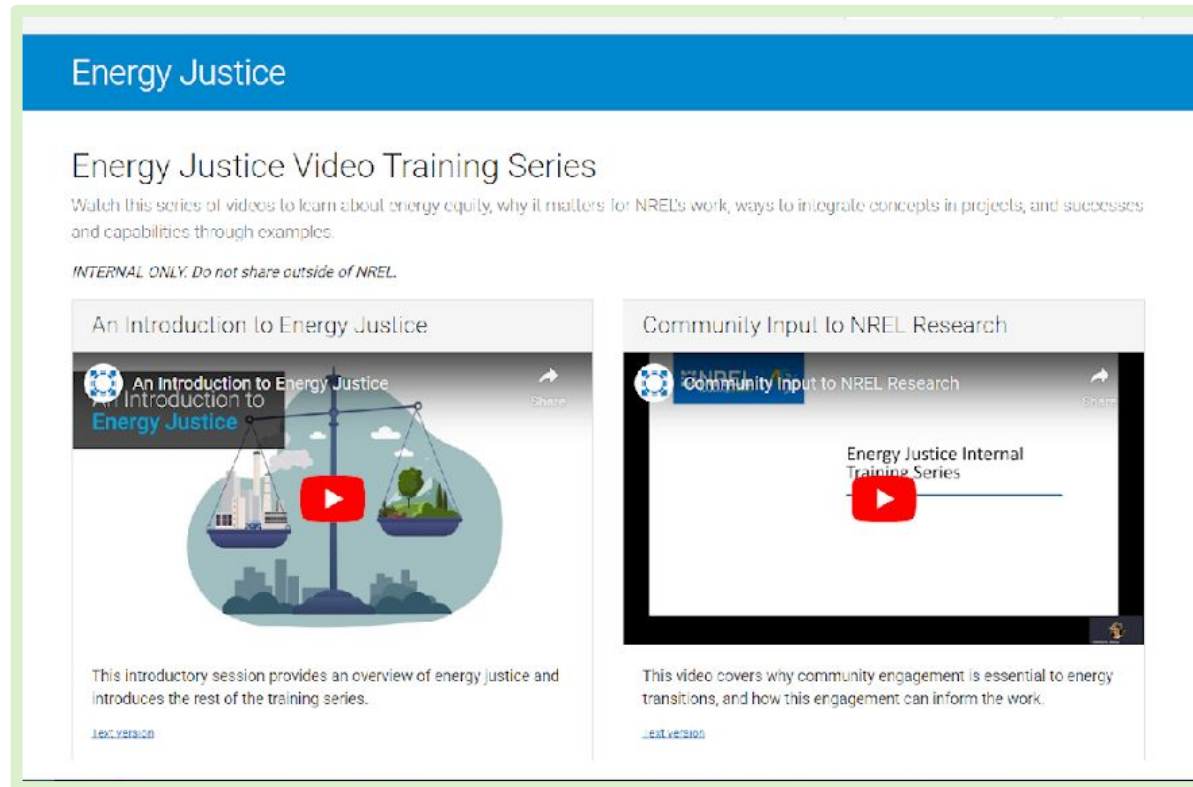
# Process of Incorporating Energy Justice

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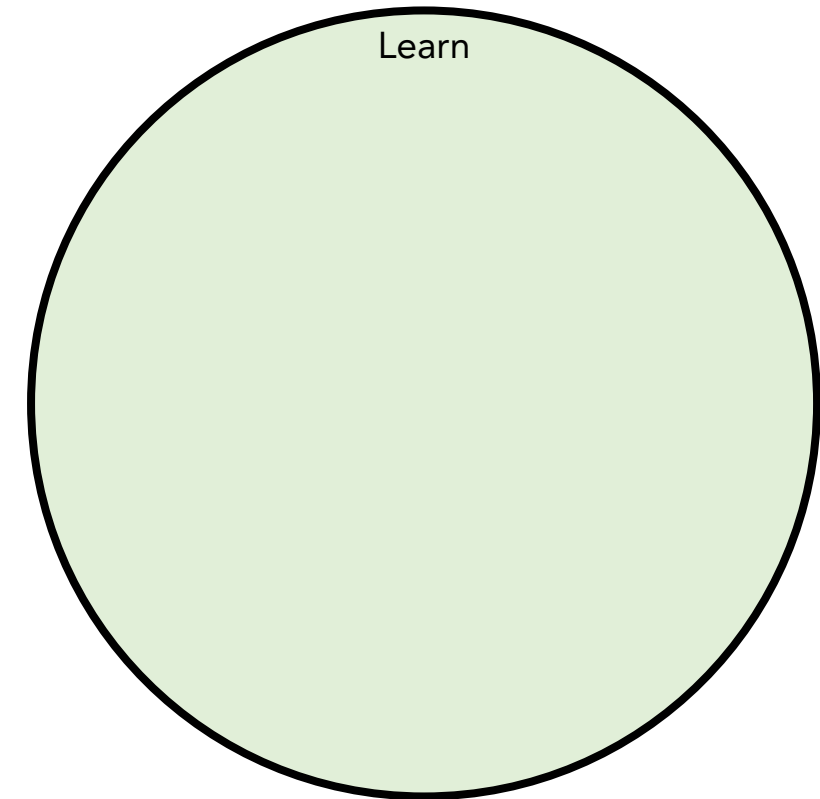
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# Incorporating Energy Justice in Your Work

1. **Learn:** Familiarize yourself with energy justice concepts through workshops and online sources: For example,

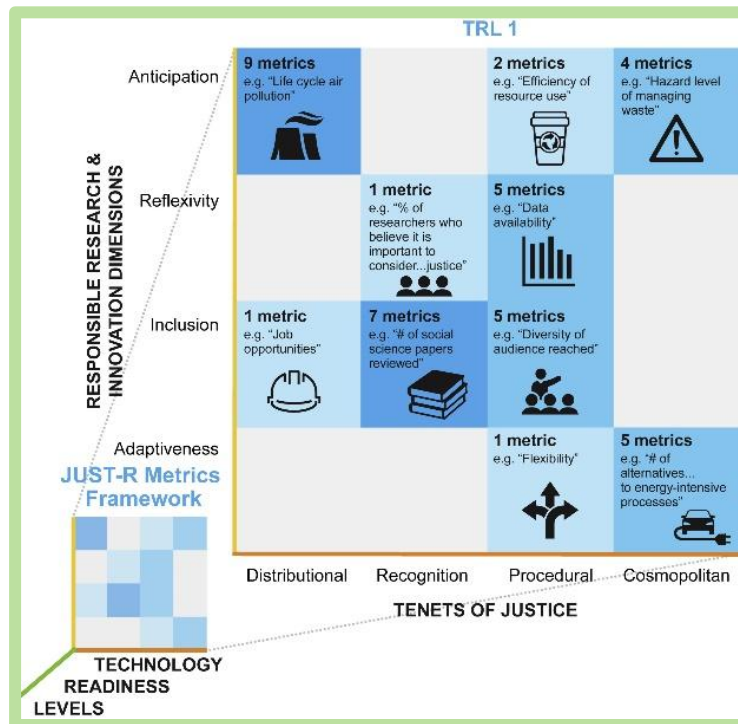
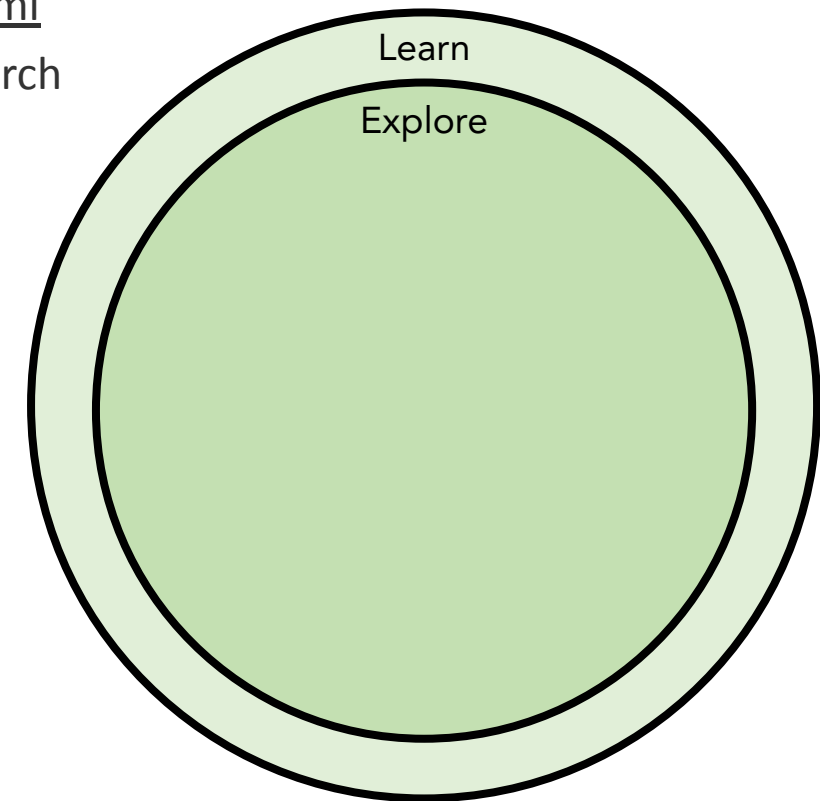


The screenshot shows a webpage titled "Energy Justice" with a sub-header "Energy Justice Video Training Series". Below the sub-header is a paragraph: "Watch this series of videos to learn about energy equity, why it matters for NREL's work, ways to integrate concepts in projects, and successes and capabilities through examples." Below this is a note: "INTERNAL ONLY. Do not share outside of NREL." There are two video thumbnails. The first is titled "An Introduction to Energy Justice" and features a scale of justice with a city on one side and a tree on the other. The second is titled "Community Input to NREL Research" and features a red play button on a white background. Both thumbnails have a "Share" button in the top right corner.



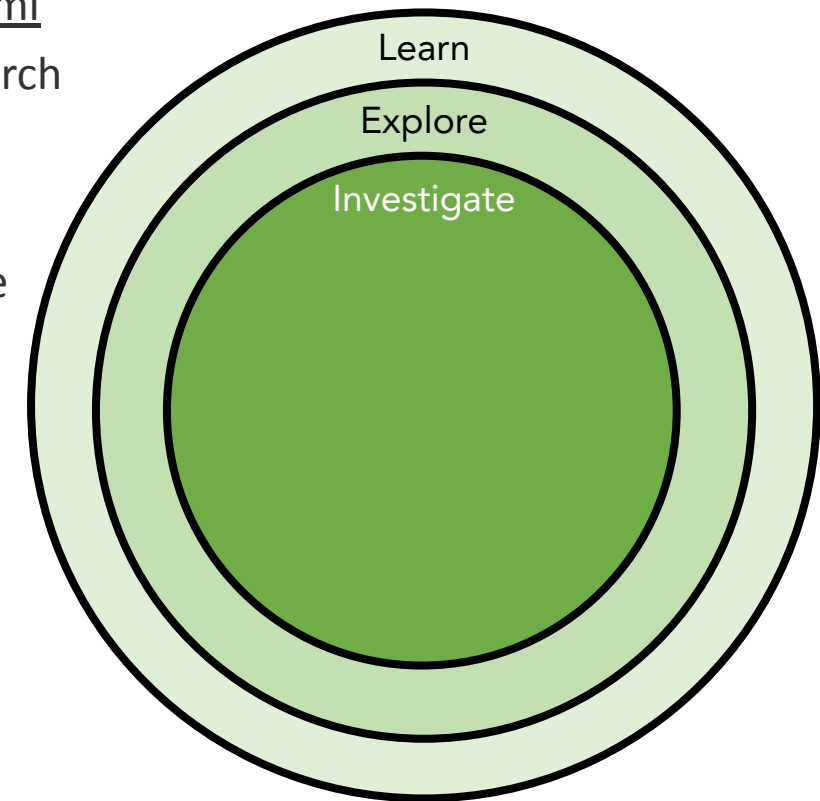
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2. **Explore:** JUST-R metrics paper provides a starting point for early-stage research discussion, with conceptual background & further resources in SI: <https://doi.org/10.1016/j.joule.2023.01.007>



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3. **Investigate:** What metrics impact energy justice in your field? For early-stage researchers, fill out blank JUST-R Metrics Tool.

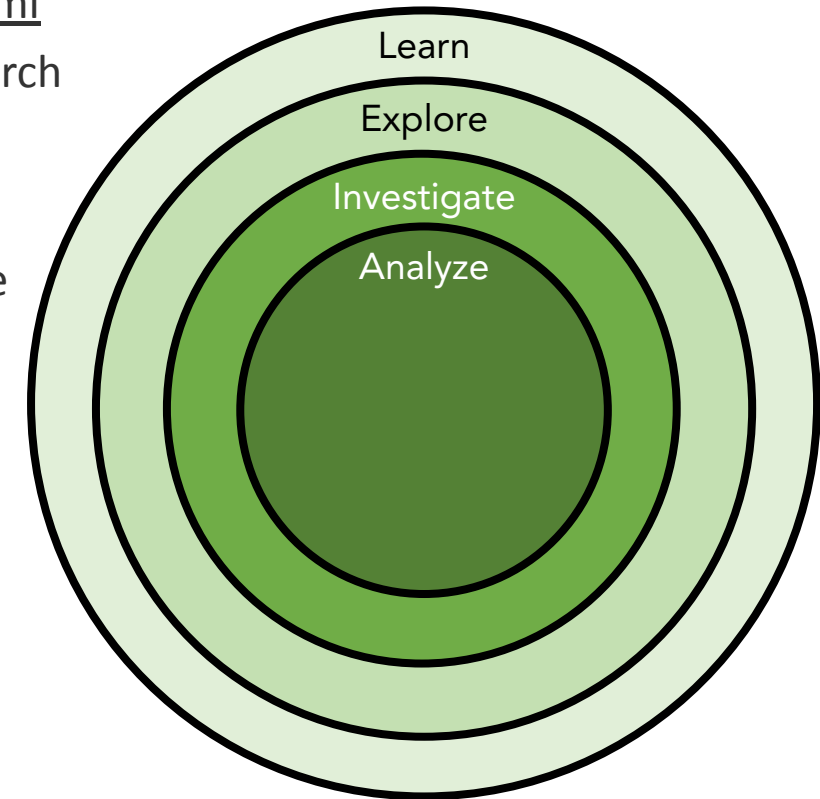


**Appendix A: Blank JUST-R Metrics Worksheet for Assessing Projects**  
See Table S5 for more details on metrics.

Metric	Assessment	What could be done differently?	Potential barriers
<b>Hidden project costs</b>			
Estimated cost of managing waste generated by the research			
Estimated cost of energy consumed during the research			
Projected cost savings from operating the new technology as competing technologies			
<b>Breadth of pre-existing knowledge review</b>			
Number of social science papers reviewed			
Diversity of authors of scientific papers reviewed			

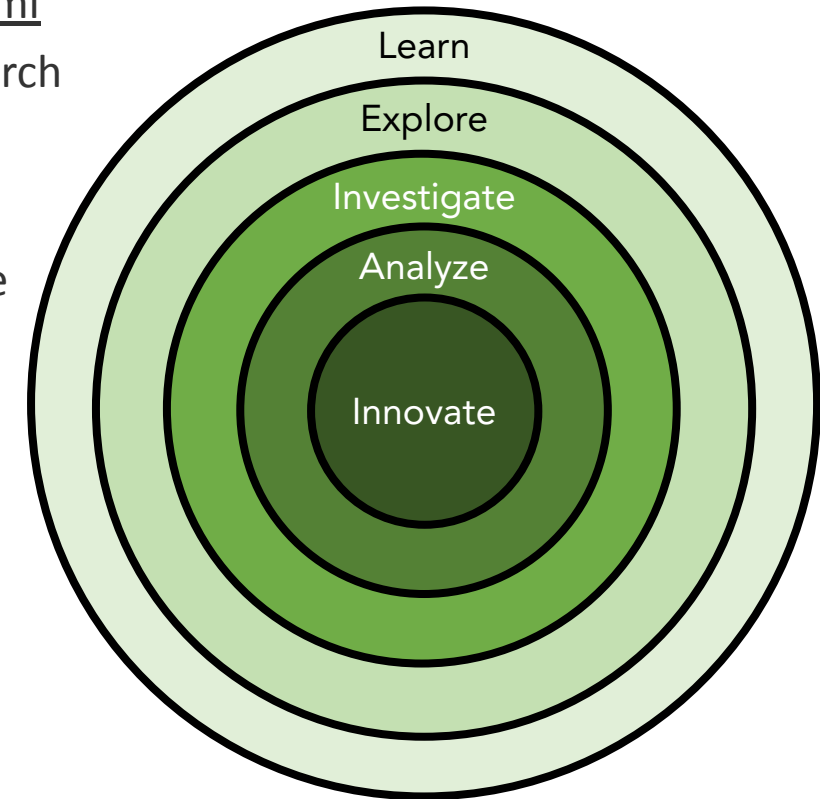
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4. **Analyze:** What are a 1-2 potential impacts you could aim to improve as a first step? What new questions can you ask to address these?



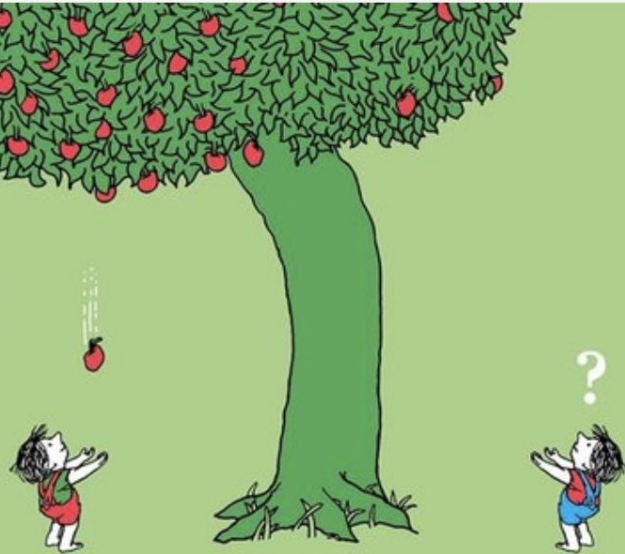
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4. **Analyze:** What are a 1-2 potential impacts you could aim to improve as a first step? What new questions can you ask to address these?
5. **Innovate:** Apply your new ideas and build the foundation for incorporating equity and justice principles into your technical area.



# Inequality

Unequal access to opportunities

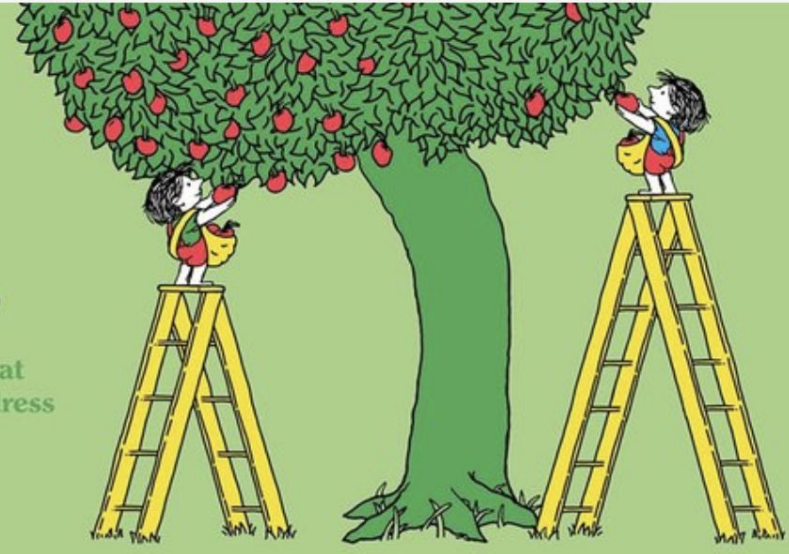


With apologies to Shel Silverstein from @lunchbreak

2019 Design In Tech Report | Addressing Imbalance

# Equity

Custom tools that identify and address inequality



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# Equality?

Evenly distributed tools and assistance

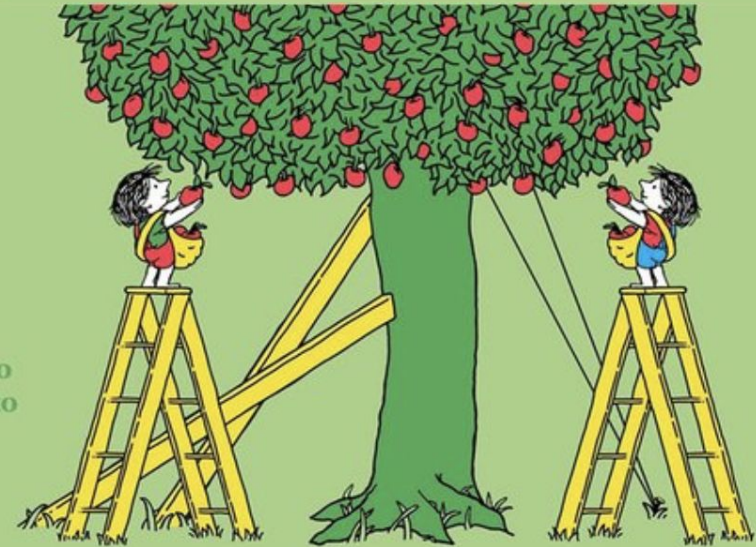


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2019 Design In Tech Report | Addressing Imbalance

# Justice

Fixing the system to offer equal access to both tools and opportunities

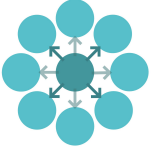






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# The Basics: Energy Justice Concepts

Type of Justice		Definition	Example
<b>Distributional</b>		Equitable distribution of benefits and burdens across a population	Ensuring a technology does not negatively impact the health of one community while lowering the electric bill of another community
<b>Procedural</b>		Equitable engagement, fairness, and transparency when allocating resources and reconciling disputes	Working with a community when deploying a new technology in that community
<b>Recognition</b>		Respect for the rights, needs, values, understandings, and customs of a population	Including and uplifting underrepresented voices on a research team
<b>Restorative</b>		Acknowledging, ameliorating, and addressing previous negative impacts that caused inequities	Building renewable energy sources on historically polluted lands in order to benefit the community
<b>Intergenerational</b>		Considering future generations, when evaluating changing effects of energy technologies over time	Ensuring natural materials that may be needed today are available for future generations to use
<b>Cosmopolitan</b>		Ensuring the well-being of persons, rather than communities or nations across the energy life cycle	Considering mining practices and the health implications on mining communities even if they will not be the end-users of a technology

Source(s): Healy, N., Stephens, J. C., and Malin, S. A., 2019, "Embodied Energy Injustices: Unveiling and Politicizing the Transboundary Harms of Fossil Fuel Extractivism and Fossil Fuel Supply Chains," *Energy Research & Social Science*, 48, pp. 219–234.; Sovacool, B. K., Martiskainen, M., Hook, A., and Baker, L., 2019, "Decarbonization and Its Discontents: A Critical Energy Justice Perspective on Four Low-Carbon Transitions," *Climatic Change*, 155(4), pp. 581–619

# Example: Cobalt in Lithium-ion Batteries

- Energy injustice: resource depletion, unethical mining
- Economic challenges: expensive, unstable supply chain

ARTICLE



<https://doi.org/10.1038/s41467-022-29022-z>

OPEN

Battery technology and recycling alone will not save the electric mobility transition from future cobalt shortages

Anqi Zeng<sup>1,2,3,8</sup>, Wu Chen<sup>2,8</sup>, Kasper Dalgas Rasmussen<sup>2</sup>, Xuehong Zhu<sup>1,3,8</sup>, Maren Lundhaug<sup>4</sup>, Daniel B. Müller<sup>4</sup>, Juan Tan<sup>5</sup>, Jakob K. Keiding<sup>5</sup>, Litao Liu<sup>6</sup>, Tao Dai<sup>7,8</sup>, Anjian Wang<sup>7</sup> & Gang Liu<sup>2,8</sup>

*Nature Communications* (2022).

*“Low-cobalt battery cathode technology development could alleviate, but not prevent, the supply crisis. The demand-supply gap would still occur around 2028-2033, even though cobalt-free LFP technology already penetrated the market in 2020 and it is predicted that the next-generation cobalt-free battery technologies will become commercialized by 2030.”*

→ Can we preempt these issues by considering energy justice earlier?

# EJ Opportunities in Early-Stage Research

Technical priorities

Technology materials and design for safety, circularity

Participatory and user-centered design for all potential users

Justice considered in siting locations and community engagement strategies

Incorporation of potential economic, environmental, and health equity impacts in decision strategies

Equity in demographic and geographic distribution of benefits and burdens of technology and its byproducts

More opportunities for incorporating justice exist at earlier stages of R&D<sup>5</sup>.

Funding and policy affect all stages



Unchecked research biases, equity-illiterate research objectives and methods

Lack of end user consideration, inaccurate user expectations and values

Inadequately designed, potentially maladaptive, technologies

Inequitable technology access and distribution

Inequitable impacts of technology use

Inequitable health outcomes

Inequities from earlier stages of R&D<sup>5</sup> are locked in.  
Impacts of equity-illiterate approaches accumulate.

# JUST-R Metrics for Early-Stage Research

## Distributional

- Life cycle greenhouse gas emissions<sup>2</sup>
- Life cycle water consumption<sup>2</sup>
- Life cycle air pollution<sup>2</sup>
- Land use<sup>2</sup>
- Job opportunities<sup>1</sup>
- Potentialities of the research to impact positively/negatively on some social groups<sup>1</sup>
- Concentrations of pollutants or toxins<sup>3</sup>
- **Hidden process costs (3)**

## Procedural

- Efficiency of resource use<sup>1</sup>
- Levels of safety<sup>1</sup>
- Transparency<sup>1</sup>
- Data availability<sup>1</sup>
- Information disclosure<sup>4</sup>
- Accountability level<sup>1</sup>
- Capability to communicate to stakeholders<sup>1</sup>
- Percentage of researchers who believe it is important to consider/address issues related to social justice in their research methodology<sup>1</sup>
- Flexibility<sup>1</sup>
- **Distribution of research results (5)**
- **Identification of set vs. flexible parameters (5)**

## Recognition

- Education<sup>1</sup>
- Institutional representation<sup>4</sup>
- Level of ability of the research problem to address an access problem of a disadvantaged social group<sup>1</sup>
- Compatibility with culture<sup>1</sup>
- **Breadth of pre-existing knowledge review (3)**

## Cosmopolitan

- **Distribution of hazard exposure during research life cycle (4)**

<sup>1</sup>Carbajo & Cabeza, "Sustainability & Social Justice Dimension Indicators for Applied Renewable Energy Research: A Responsible Approach Proposal," *Applied Energy* (2019).

<sup>2</sup>Nock & Baker, "Holistic Multi-Criteria Decision Analysis Evaluation of Sustainable Electric Generation Portfolios: New England Case Study," *Applied Energy* (2019).

<sup>3</sup>Balal & Cheu, "A Metric-Concept Map for Scoping Impact Studies of a Transportation Project on Environment & Community Health," *International Journal of Transportation Science & Technology* (2019).

<sup>4</sup>Mundaca, Busch, & Schwer, "'Successful' Low-Carbon Energy Transitions at the Community Level? An Energy Justice Perspective," *Applied Energy* (2018).

*Intergenerational justice overlaps with these categories.*

**New themes in bold (# of specific metrics).**