

Realizing Justice40: Addressing Structural Funding Barriers for Equitable Community Engagement in Energy RD&D

[Bettina K. Arkhurst](#)¹, [Wyatt Green Williams](#)^{2,3}

¹Georgia Institute of Technology, Mechanical Engineering Department, Atlanta, GA, USA

²Georgia Institute of Technology, Civil and Environmental Engineering Department, Atlanta, GA, USA

³Georgia Institute of Technology, Scheller School of Business, Atlanta, GA, USA

<https://doi.org/10.38126/JSPG230201>

Corresponding author: bettina@gatech.edu

Keywords: energy justice; systemic equity; Justice40; funding; energy research; community engagement

Executive Summary: The Justice40 Initiative, established by the Biden Administration through Executive Order 14008, aims to ensure 40% of the benefits associated with relevant governmental investments in areas such as climate and energy go to disadvantaged communities. However, persistent structural limitations pose challenges for energy researchers and engineers seeking to integrate justice into research, development, and demonstration (RD&D) activities, ultimately inhibiting full realization of Justice40. Using the Systemic Equity framework, this policy position paper highlights inadequacies in the U.S. Department of Energy's (DOE) funding model and proposes changes to RD&D funding opportunity announcements (FOAs) to support the in-depth community engagement necessary for more equitable technology creation and demonstration. The recommended changes to FOAs are provided to encourage DOE Program Offices to rethink the RD&D funding process, the values that are fortified (intentionally or unintentionally) in that process, and systematically recenter RD&D processes on the goal Justice40 set out to achieve—a more just, equitable, and sustainable future.

I. Pursuing an equitable clean energy transition in the United States

i. Landmark decarbonization investments

The United States government has set historic decarbonization goals to reach 100% carbon pollution-free electricity by 2035 and a net-zero emissions economy by 2050 (U.S. Dept. of State and United States Executive Office of the President 2021). Importantly, these ambitious goals do not merely seek to curb greenhouse gas emissions and deploy more efficient technologies, they also aim to secure a more equitable and sustainable energy future for all Americans. In fact, many argue that these ambitious decarbonization goals cannot be reached without an “all-of-society” approach (U.S. Dept. of Energy Office of Policy 2023). Such an approach requires a unique focus on equity, justice, and communities that have historically been

marginalized, underserved, and disadvantaged by climate change, the existing energy system, and energy transition efforts (Transportation Research Board et al. 2023; S. H. Baker 2019).

ii. The Justice40 Initiative

In January 2021, the White House released Executive Order 14008, *Tackling the Climate Crisis at Home and Abroad*, which introduced the Justice40 (J40) Initiative (Joseph R. Biden 2021). Justice40 and other landmark efforts, such as the \$6 billion in funding for environmental justice initiatives in the Inflation Reduction Act (Congress 2022), highlight an emphasis on environmental justice and energy equity in the U.S.'s transition to a clean energy economy. J40 is a whole-of-government initiative that aims to ensure at least 40% of overall benefits from relevant federal investments in areas such as climate action, environmental remediation, clean

infrastructure, critical water and wastewater infrastructure, and workforce development flow to “disadvantaged communities” (DACs) (Joseph R. Biden 2021; The White House 2021; Office of Economic Impact and Diversity 2022). These communities disproportionately bear the adverse impacts of climate change and the energy system. A combination of variables can be used to determine DAC status, including low income, high unemployment, racial and ethnic segregation, high housing cost burden, large environmental stressor burden, and access to healthcare (Office of Economic Impact and Diversity 2022; Shalanda D. Young, Brenda Mallory, and Gina McCarthy 2021). Given the controversy over the use of the term “disadvantaged communities” (Shalanda D. Young, Brenda Mallory, and Gina McCarthy 2021), throughout the remainder of this paper, these communities will be referred to as “frontline communities” (Shalanda Baker, Subin DeVar, and Shiva Prakash 2019).

The U.S. Department of Energy (DOE), which oversees the country’s energy and nuclear policies, is the primary funder of energy research activities, from basic energy sciences to large-scale system deployment. When justifying budgets for the 2024 fiscal year, fifteen Department of Energy Program Offices explicitly mentioned equity-focused initiatives or incorporated diversity, equity, inclusion, and accessibility (DEIA) in budgeted activities (Office of the Chief Financial Officer 2023). Equity-focused initiatives often center communities with fewer socioeconomic resources, incorporate environmental justice and equity, or focus on workforce development in frontline communities (Office of the Chief Financial Officer 2023). In research, development, and demonstration (RD&D) initiatives, specifically, incorporating justice often takes the form of enhancing “co-benefits” (benefits that may be realized in addition to project objectives) of technology creation, demonstration, and deployment. This paper is not an exhaustive survey of all federal RD&D or DOE funding models, but it specifically focuses on DOE Program Offices and the external energy RD&D funding opportunities they release.

The total budget of DOE Program Offices that mention equity-centered initiatives is shown in Figure 1. Equity-centered initiatives were found by analyzing the budget justifications of each Program

Office to identify those that centered frontline communities, environmental justice, or equity. It is important to note that the DOE Loan Deployment Office had a negative budget in fiscal year 2021. Although other offices, such as the Indian Energy Policy and Programs Office, had a positive budget and equity-focused initiatives mentioned in their budget request, the Loan Deployment Office had a larger negative budget, which is why the Program Offices that mentioned equity-aligned initiatives had a negative total budget that fiscal year (Office of Chief Financial Officer 2021).

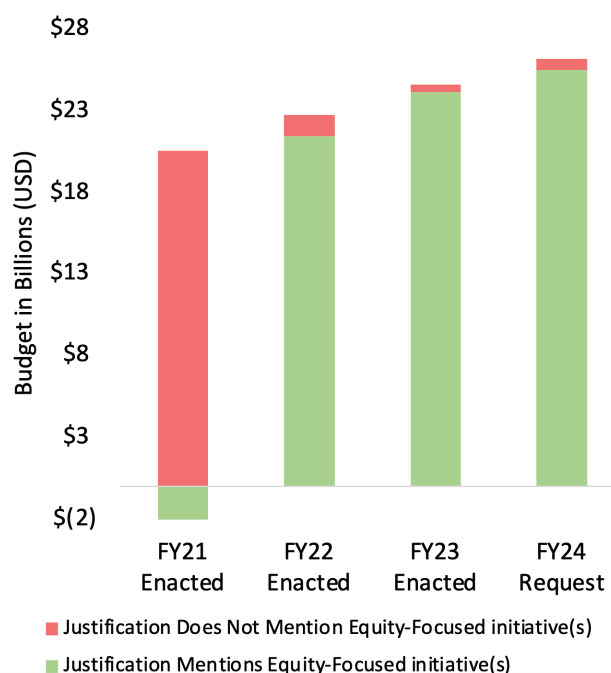


Figure 1. Total budget of Department of Energy Program Offices in billions of USD, categorized by mentions of equity-focused initiatives in budget justifications (Office of the Chief Financial Officer 2023).

iii. Public engagement and civic participation enable an equitable energy transition

Public engagement and civic participation are cornerstones of a more equitable energy system. These actions are not only expected to enable broader adoption of sustainable technologies but also allow for the creation of more contextually relevant and effective climate interventions and energy solutions (Transportation Research Board et al. 2023). Embedding equity, community engagement, and community stewardship across all energy transition efforts provides an opportunity to ensure that the historic investments and benefits associated with the clean energy transition are

equitably distributed across the entire population, particularly to frontline communities. Given that energy research and innovation form the backbone of decarbonization efforts, there is increasing interest in understanding how energy RD&D can grapple with the justice implications of technologies along with growing calls for policymakers and members of the RD&D workforce to do so (Transportation Research Board et al. 2023; Wailoo, Dzau, and Yamamoto 2023; E. Baker, Goldstein, and Azevedo 2021; Ravikumar et al. 2023). Unfortunately, the existing research system perpetuates formidable structural barriers that inhibit the full realization of J40 and the just energy system it seeks to support.

II. Structural barriers limit the Justice40 Initiative

i. Structural injustice in RD&D

The J40 Initiative has the potential to recenter energy RD&D activities on pursuing an equitable and just energy future. However, pre-existing *structural injustices* in RD&D can reduce J40's impact. Structural injustice "exists when social processes put large groups of persons under systematic threat of domination or deprivation of the means to develop and exercise their capacities, at the same time that these processes enable others to dominate or to have a wide range of opportunities for developing and exercising capacities available to them" (Young 2010). Essentially, structural injustice occurs not from a distinct individual or subset of perpetrators but from a collection of actions, decisions, and outcomes that set up and perpetuate large-scale existing systems of inequity and oppression (Young 2010; Arista et al. 2021). Structural injustice can be reified by individual or collective actions, and it traditionally obfuscates any direct links to the systemic and potentially unintentional harm produced, oftentimes leaving individuals feeling powerless to address these issues (S. H. Baker 2019; McKeown 2021).

Examples of structural injustice that face clean energy RD&D activities include:

- Biases in energy modeling and planning that exclude or obscure negative impacts on frontline communities (Baker, Goldstein, and Azevedo 2021; Mehrabi et al. 2021);
- Historical injustice, such as a historical disinvestment in infrastructure, that makes cutting-edge technologies inaccessible to frontline community members (Woodson, Hoffmann, and Boutilier 2021);
- Lack of value placed on the expertise, experience, priorities, or concerns of frontline community members (Hofstra et al. 2020; Kozlowski et al. 2022; Graves et al. 2022); and
- Lack of frontline community representation in RD&D workforce (Graves et al. 2022).

Figure 2 aligns these examples in RD&D, along with others found in the literature, with the themes of devaluation, disinvestment, and exploitation of frontline communities. Here, we define *devaluation* as deprioritizing and exhibiting a disinterest in the assets, knowledge, history, ways of life, innovations, well-being, and livelihoods of frontline communities. We define *disinvestment* as an undue lack of resources and opportunities presented and provided to members of frontline communities that result in the perpetuation of harm and injustice. Finally, we define *exploitation* as using frontline communities for personal or professional economic, social, or political gain with a disregard for community goals, values, or welfare. Implementing interventions that allow for *systems justice* can enable members of the energy RD&D workforce to address structural injustice. Systems justice calls for a collective response to existing problems of injustice. It provides a "bird's-eye view of justice" in which each agent in a system is empowered to create, envision, and work towards a more just system given their unique position in the social system (Arista et al. 2021).

Devaluation		Disinvestment		Exploitation	
Deprioritizing and exhibiting a disinterest in the assets, knowledge, history, ways of life, innovations, well-being, and livelihoods of frontline communities		An undue lack of resources and opportunities presented and provided to members of frontline communities that results in existing issues and harms perpetuating		Using frontline communities for personal or professional economic, social, or political gain with a disregard for community goals, values, or welfare	
Examples	Biases, exclusion and dehumanization	Examples	Crumbling or out-of-date infrastructure	Examples	Tokenism, low wages, and a lack of career progression
	Narrow problem definition and solution spaces		A lack of access to community development through mainstream RD&D activities		Uncompensated mental, physical, and emotional labor
	Embedded systems of injustice				Frontline communities ultimately adopting risk
	Unintended consequences of RD&D				

Figure 2. Definitions and examples of structural justice issues of devaluation, disinvestment, and exploitation in research, development, and demonstration (RD&D) that affect frontline communities and inhibit full realization of Justice40 in energy RD&D.

ii. The need for systems justice in DOE-Funded RD&D

At the core of funded RD&D activities are the values and priorities of funders. Thus, funding agencies ultimately determine and prioritize RD&D work and the system it engenders. Community Benefit Plans (CBPs) are the prime method DOE Program Offices employ in an attempt to embed and operationalize J40, and equitable community engagement, in DOE-funded RD&D activities (“About Community Benefits Plans” 2023). From our analyses, however, we observe that CBPs tend to be appended to existing funding opportunity announcements (FOAs) instead of being embedded more deeply into RD&D work, effectively diluting their impact. Here, we focus particularly on DOE FOAs because of the inherent role they play in guiding energy RD&D activities in the United States and the justice implications of those RD&D activities. These implications include new capabilities, technologies, analyses, or programming. The existing structures of DOE FOAs for technology research, development, and demonstration are inadequate for pursuing the equitable community-based participatory research and community engagement necessary to build the just energy system that the Justice40 Initiative aims to realize.

III. Justice40 in existing DOE FOAs and programs

To understand the current role of equity in DOE funding models, we apply the Systemic Equity framework (Bozeman III, Nobler, and Nock 2022) to assess the incorporation of J40 goals into DOE FOAs and programs. We then provide recommendations for enhancing equity incorporation and community participation in DOE-funded RD&D work. The Systemic Equity framework (Figure 3), describes and synthesizes distributive (distribution of tangible resources in an unbiased and fair manner), procedural (procedures and decision-making processes to facilitate fair and unbiased resource allocation), and recognitional (addressing psychological, emotional, and cultural needs of the systematically marginalized) dimensions of equity and their intersections from a systems perspective (Bozeman III, Nobler, and Nock 2022). Twelve FOAs and their CBPs across eight DOE Program Offices, released from September 2021 to September 2023, were reviewed for this paper. All analyzed FOAs were released after the creation of the Justice40 directives and include the majority of DOE Program Offices. A summary of the FOAs used for this study can be found in Appendix A.

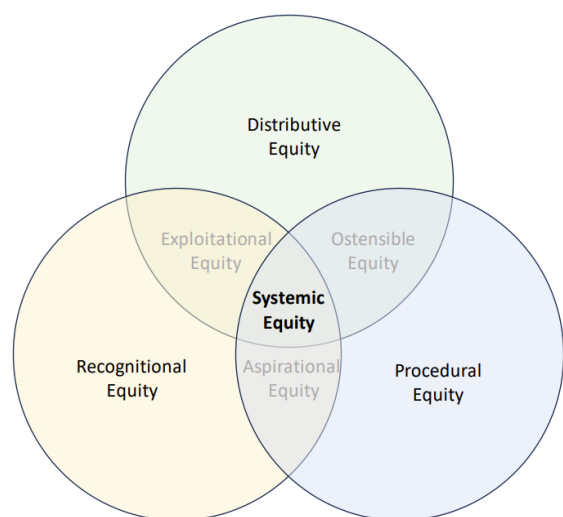


Figure 3. Systemic Equity Framework showing depictions of partial realization of equity concepts (Bozeman III, Nobler, and Nock 2022).

Although many funding opportunities attempt to incorporate J40 goals, there is variation in the areas of focus and methods used to embed J40 priorities into FOAs. Within the twelve FOAs analyzed for this paper, we found four different approaches for incorporating J40 into FOAs, including through:

1. A CBP that included sections on DEIA, workforce development, and energy equity;
2. A CBP that included sections on community engagement and labor engagement, which was subtitled investing in job quality and workforce continuity;
3. A DEIA Plan; and
4. Focusing the entirety of the grant goals and intended benefits on underserved communities without using a separate plan.

The structure, content, and sought responses of approaches 1, 2, and 3 differed but were related as they all aimed to promote diversity and create a resilient and strong workforce within the proposed activities of the FOA. However, the typical structure of an FOA that includes a CBP or DEIA plan silos equity-aligned activities from the technical work that the FOA seeks to fund. When analyzed using the Systemic Equity framework, while the FOA may allocate the appropriate distributive resources to community goals, the separation from the technical portion of the proposed activities represents a barrier to procedural equity and prevents the realization of full systematic equity (Bozeman III,

Nobler, and Nock 2022). Furthermore, although the CBPs had examples of potential activities regarding workforce development, energy equity, and DEIA, all of these examples lacked the specificity found in the FOA's technical criteria. These CBPs could have benefitted from including specific metrics of success, similar to those found in the portions related to the technical criteria.

Although CBPs recommend the use of SMART (specific, measurable, achievable, relevant, and timebound) goals, none sufficiently exemplified, encouraged, or funded prolonged, deep collaboration between communities or community-based organizations and the groups responding to the FOA. Despite the inclusion of adequate distributional equity through project funding, the existing CBP structure does not necessitate mapping of project activities to community goals or needs, thereby insufficiently incorporating procedural and recognitional equity (Bozeman III, Nobler, and Nock 2022). Three of the twelve FOAs analyzed did not include CBPs or DEIA plans; however, they integrated equity into the technical activities of the grant by mandating the inclusion of community groups in the project and ensuring that all of the benefits of the proposed activities go to underserved communities. An example of one such FOA is the Clean Energy Deployment on Tribal Lands FOA announced by the Office of Indian Energy Policy and Programs. Here, FOAs that more thoroughly incorporated J40 were used when developing recommendations for amendments to FOAs to better enable community engagement and stewardship in RD&D activities.

Beyond RD&D FOAs, there are various approaches used to embed equity and justice within funding opportunities. Programs such as the DOE Solar Energy Innovation Network, DOE Clean Energy to Communities Program, and the DOE Communities Local Energy Action Program provide extended multi-year direct funding, technical expertise, cohort-based learning, and partnership with community groups to ensure that a minimum of 40% of the benefits go to frontline communities ("Solar Energy Innovation Network" 2020; "Clean Energy to Communities Program" 2022; "Communities LEAP" 2022). These initiatives show evidence of recognitional, procedural, and distributional justice by design through a more holistic approach to

investing in communities, accountability, and actively pursuing community participation and empowerment, which are also implementation methods recommended by the Luskin Center for Innovation (Callahan et al. 2021). However, these initiatives are not centered on RD&D activities. They primarily focus on deployment, leaving many more purely technological solutions and opportunities for earlier, more rigorous engagement with frontline communities unexplored.

IV. Recommendations: Bolstering justice dimensions of DOE RD&D funding opportunities

The J40 Initiative's commitment to integrating equity and fostering community engagement presents a unique opportunity to pursue more just energy RD&D. For example, CBPs that encourage RD&D FOA applicants to partner with community stakeholders create pathways for enhanced procedural equity in technical RD&D activities. Further, programs such as the DOE Solar Energy Innovation Network and the DOE Clean Energy to Communities Program amplify this opportunity by enabling greater community agency ("Solar Energy Innovation Network" 2020; "Clean Energy to Communities Program" 2022; "Communities LEAP" 2022). Here, we build upon the strengths of these programs and offer recommendations to address the structural injustices that inhibit thorough incorporation of equity and community engagement in DOE RD&D activities. These recommendations include:

- **Recommendation 1. Incorporate J40 goals throughout RD&D FOAs:** Rework DOE RD&D FOAs to include more holistic and specific guidance on equitable technology creation and demonstration throughout FOAs rather than merely using siloed CBPs.
- **Recommendation 2. Enable more in-depth community engagement:** Provide funding for deeper, longer-term community engagement and open opportunities for enhanced community co-development and stewardship in RD&D projects.
- **Recommendation 3. Provide funding flexibility for community priority alignment:** Embed reasonable flexibility into the funding structure to respond to community concerns and priorities, especially those that arise as RD&D projects progress.

Figure 4 aligns issues of structural injustice in RD&D with the major aspects of these recommendations and indicates some of the potential benefits of fully realizing J40 goals. These recommendations are specifically made to be implemented in technical RD&D FOAs but align with recommendations made by several others across energy and science policy literature and discourse (Transportation Research Board et al. 2023; S. H. Baker 2019; E. Baker, Goldstein, and Azevedo 2021; Ravikumar et al. 2023; Graves et al. 2022; Colleen Callahan et al. 2021; Shi and Moser 2021).

i. Incorporate J40 Goals throughout RD&D FOAs

Given the separation of CBPs, and thus J40 goals, from the main objectives of typical DOE RD&D-focused FOAs, we recommend a more thorough integration of J40 goals in RD&D FOAs through the addition of more holistic and specific guidance for FOA applicants. Rather than only acknowledging potential justice implications in a siloed section of the FOA, such as a "Community Benefits Plan" section or "Diversity, Equity, Inclusion, and Accessibility Plan" section, we recommend revamping FOAs to embed J40 goals across all activities presented in the FOA. Typically, technical criteria and desired outcomes are explicitly mentioned in FOAs; we recommend this level of specificity for equity-focused goals, as well. To apply a high level of rigor to equity and community-centered goals, teams releasing FOAs should include individuals experienced in the equitable development and co-design of technology. Additionally, FOA creation teams may benefit from applying socio-technical frameworks such as the Systemic Equity framework (Bozeman III, Nobler, and Nock 2022), Responsible Research and Innovation (Owen, Macnaghten, and Stilgoe 2012; Jenkins et al. 2020), Design Justice (Costanza-Chock 2020), Value-Sensitive Design (Davis and Nathan 2021), Asset-Based Community Development (Mathie and Cunningham 2003), or the Justice Underpinning Science and Technology Research metrics framework (Dutta et al. 2023) during FOA creation. Incorporation of these socio-technical frameworks can provide a more holistic envisioning of RD&D FOAs that better align with the complex systems-level issues at play (Table 1).



Figure 4. Visualization demonstrating that tackling the structural issues of devaluation, disinvestment, and exploitation in RD&D through the recommended changes in DOE FOAs can enable the full realization of Justice40 goals.

Frameworks and Methodologies	Descriptions
Systemic Equity Framework (Bozeman III, Nobler, and Nock 2022)	A framework for integrating equity in energy and environmental work
Responsible Research and Innovation (Owen, Macnaghten, and Stilgoe 2012; Jenkins et al. 2020)	Framework that fosters collaborations between societal actors and innovators to create ethical, socially desirable innovations
Design Justice (Costanza-Chock 2020)	A justice-focused design framework characterized by community stewardship and empowerment along with reflective and collaborative design processes
Value-Sensitive Design (Davis and Nathan 2021)	Design methodology for incorporating values into the design process
Asset-Based Community Development (Mathie and Cunningham 2003)	A place-based framework that focuses on building upon community assets for development
Justice Underpinning Science and Technology Research Metrics Framework (Dutta et al. 2023)	A metrics framework to enable consideration of energy justice in early-stage research

Table 1. Examples of sociotechnical frameworks that can be applied during the FOA creation process.

ii. Enable more in-depth community engagement
Frontline community members may distrust actors in government agencies, private industry, utility companies, and research institutions. In many cases, this distrust was earned through a long history of harm and exploitation that was directly or indirectly

enabled, facilitated, or perpetuated by these same institutions (S. H. Baker 2019; Graves et al. 2022). To ensure the J40 goals can be better embedded and realized in RD&D activities, this distrust and the underlying history that led to it must be understood and addressed. Trust must be built or rebuilt, and

good working relations with community members, community leaders, and community-based organizations are imperative for more just RD&D activities. FOAs should fund space and time to enable and support relationships with communities and provide opportunities to address pre-existing harm communities have experienced (Siddiqi et al. 2023). Without scope flexibility to enable trust-building and meaningful engagement with communities, projects, particularly those at the demonstration and deployment stages, are likely to face pushback (Temper et al. 2020; Mundaca, Busch, and Schwer 2018; Sovacool et al. 2022; Ottinger, Hargrave, and Hopson 2014) and fall short of their potential.

Additionally, communities have a lot of untapped innovation, experiential knowledge, and history that can be leveraged for more context-specific solutions. Despite this, innovation from marginalized groups is often undervalued and thus underutilized, especially in technical spaces (Hofstra et al. 2020; Kozlowski et al. 2022; Holly and Comedy 2022). Due to this historic deprioritization of innovations created by and for frontline communities, funding opportunities tend not to align with community priorities (Graves et al. 2022). This factor is a particularly important one to change to fully realize the potential of Justice40 in DOE-funded RD&D work. Enabling communities to bring their concerns and values to the table and connect with technical experts to solve these problems can be particularly transformative. Instead of prescribing problems to solve on behalf of frontline communities, which can unintentionally incentivize FOA respondents to tokenize communities, DOE FOAs should enable communities to initiate research. The DOE can also facilitate connections between the communities initiating research and researchers to carry out the work. These actions can better ensure that researchers are not forcefully implementing solutions community members do not support. FOAs analyzed within this paper did not seek adequate community outreach in program building, although several of the FOAs analyzed requested that applicants partner with Minority Business Enterprises, Minority Owned Business, Women Owned Business, Veteran Owned Business, and workforce training organizations. On the other hand, programs such as DOE Solar Energy Innovation Network, the DOE Clean Energy to Communities Program, and the DOE Communities Local Energy Action Program facilitate community

stakeholder collaboration to aid the delivery of proposed benefits to community goals. These programs can be used as examples for future FOA development (“Solar Energy Innovation Network” 2020; “Clean Energy to Communities Program” 2022; “Communities LEAP” 2022).

iii. Provide funding flexibility for community priority alignment

Enabling projects to address additional needs and optimize co-benefits will also require a more flexible funding model that can dynamically respond to relevant identified community needs in the project’s timeframe. We recommend enhanced flexibility in funding models by including a set amount of discretionary funding in award allocations to address additional community needs that arise, enabling a broader scope of activities and more effective realization of the co-benefits of RD&D participation. Discretionary funding would broaden the scope of activities researchers and community partners could investigate to ensure RD&D activities can be more responsive to and informed by community needs. This type of flexible funding dedicated to community development can be used to enhance opportunities for communities, such as enterprise creation and workforce development. Additionally, creating infrastructure to enable community members to own and financially benefit from intellectual property from community-based RD&D opens additional pathways for communities to tangibly benefit from RD&D efforts.

More funding flexibility can also enable collaborators to better accommodate the complex challenges associated with legacy harms to frontline communities stemming from funding agencies’ prior inaction or disinterest in addressing these issues (Bullard et al. 2008). Discretionary funding can be used to address additional community needs that were not originally in the purview of researchers or funding agencies. Along with potentially being useful for addressing historical community needs, funding flexibility also enables RD&D collaborators to identify and attempt to mitigate potential future harms. Optimizing such co-benefits in the energy transition continues to be a topic of great significance in energy transition literature (Transportation Research Board et al. 2023; S. H. Baker 2019; E. Baker, Goldstein, and Azevedo 2021).

iv. Policy evaluation

To understand the effectiveness of the recommended changes to RD&D FOA structure, or “interventions,” implementers should seek to carry out short- and long-term assessments of intervention impacts. These recommendations can be incorporated into a subset of RD&D FOAs. FOAs in the same or similar technical areas can be used as controls for comparison. In the short-term assessment of amended FOAs, indicators to quantify and qualify effectiveness can include: the number of equity-centered RD&D FOA responses received in contrast to controls, survey results from frontline communities about project success, measured impacts from project outcomes, and so on. Long-term assessment will require planning at the beginning of intervention implementation to gather periodic data around indicators such as:

- Physical and mental health statistics
- Economic development indicators
- Public safety
- Population make-up and migration (particularly as an indicator for gentrification)
- Other pertinent ecological, economic, social, political, and technological indicators

These indicators can be tracked over time and, along with the controls, provide an understanding of intervention impacts in the long term.

v. Recommendation limitations

These recommendations face four potential obstacles: (i) scope expansion, (ii) cost, (iii) time, (iv) tension due to increased community agency in RD&D.

Scope expansion

Using FOAs as a tool to tackle historical structural injustice in technology creation and demonstration will inevitably expand the scope of technology RD&D activities.

- Addressing this limitation requires both interdisciplinary research and FOA-creation teams capable of more holistic problem definition, ideation, civic participation, reconciliation and remediation, and solution identification and implementation. Teams creating FOAs can scope funding calls using

examples from other agencies, such as the National Science Foundation (NSF), that are pursuing similar initiatives to incorporate equity and civic participation into RD&D. For example, NSF’s “Responsible Design, Development, and Deployment of Technologies” Initiative seeks to bolster responsible, community-centered RD&D and could provide a helpful blueprint for the DOE.

Cost

The project scope expansion and deeper, longer-term community engagement recommended in this paper also necessitate an increase in funding to enable these activities. Implementing these recommendations will likely introduce additional project costs and require more flexible budget timelines, and an expansion in allowable costs to address broader community needs.

- To address this limitation, the DOE may consider increasing funding provided for these activities through partnering with other interested entities such as philanthropic organizations or decreasing the number of projects funded. Additionally, they will need to provide clear guidance on allowable costs for projects or an accessible tool or mechanism for project teams to use to identify funding boundaries and unallowable costs.

Time

Implementing recommendations will also likely increase the time needed to carry out these more holistic, equity-centered RD&D activities. Longer timelines will likely require additional funding for projects since the same budget over a longer time may reduce work quality. Ultimately, budgets and timelines will depend on the scale and scope of the RD&D project at hand.

- This limitation can be addressed by providing longer, more flexible timelines for project implementation and evaluation with the necessary dedicated technical support and budget.

Tension from Enhanced Community Agency

Increasing frontline community agency in RD&D activities will likely require traditional players (private industry, utility companies, and academia) in the RD&D space to relinquish some control. This new source of tension may require additional funding for conflict resolution resources and mediators.

- Addressing this limitation will require a multi-pronged approach. First, funders can ensure accountability and use go/no-go checkpoint meetings throughout the project to ensure community partners have a seat at the table. Additionally, it would be helpful to encourage project teams to apply mediation frameworks for navigating conflicts. Finally, identifying effective avenues for navigating these potential tensions can be a policy evaluation goal or a funded project in itself.

As with most systemic change, pushback is possible. Therefore, it will be of utmost importance to emphasize that the purpose of these recommendations is to better enable the Department of Energy to accomplish its oft-stated goals of pursuing a just energy transition that better serves a broader range of citizens. Given the novelty of these efforts, further research on successful scoping, timeline creation, project implementation

and mediation, and follow-up could address uncertainty associated with all of the aforementioned limitations.

V. Conclusion

If justice and equity are not embedded across all aspects of our transition to a clean energy system, at best, we run the risk of leaving valuable opportunities for frontline communities unrealized but, at worst, our transformed energy system may entrench and reinforce injustice and harm to frontline communities. We now have a once-in-a-lifetime opportunity to imagine and build an energy system for all, but to do so requires major attention to the structural injustices already embedded in the work we do and systems we perpetuate. As new initiatives like the Affordable Home Energy Shot (“Affordable Home Energy Shot” 2023.) that aim to center equity and justice throughout RD&D activities are implemented, attention to elements such as FOA structure will make the difference between theoretical fulfillment and practical realization of these goals. The recommended changes to DOE FOAs are an opportunity to rethink the initial stages of the RD&D process, the values reinforced (intentionally and unintentionally) in that process, and to recenter RD&D processes on the goal Justice40 set out to attain – a more just, equitable, and sustainable future.

References

- “About Community Benefits Plans.” 2023. Energy.Gov. Accessed October 27, 2023. <https://www.energy.gov/infrastructure/about-community-benefits-plans>
- “Affordable Home Energy Shot.” 2023. Energy.Gov. Accessed October 29, 2023. <https://www.energy.gov/eere/affordable-home-energy-shot>
- Arista, Noelani, Sasha Costanza-Chock, Vafa Ghazavi, Suzanne Kite, Cathryn Klusmeier, Jason Edward Lewis, Archer Pechawis, et al. 2021. “7 Systems Justice, AI, and the Moral Imagination.” In *Against Reduction: Designing a Human Future with Machines*, 117–40. MIT Press. <https://ieeexplore.ieee.org/document/9591986?denied=>
- Baker, Erin, Anna P. Goldstein, and Inês ML Azevedo. 2021. “A Perspective on Equity Implications of Net Zero Energy Systems.” *Energy and Climate Change* 2 (December): 100047. <https://doi.org/10.1016/j.egycc.2021.100047>.
- Baker, Shalanda H. 2019. “Anti-Resilience: A Roadmap for Transformational Justice within the Energy System.” *Harv. CR-CLL Rev.* 54: 1.
- Bozeman III, Joe F., Erin Nobler, and Destenie Nock. 2022. “A Path toward Systemic Equity in Life Cycle Assessment and Decision-Making: Standardizing Sociodemographic Data Practices.” *Environmental Engineering Science* 39 (9): 759–69.
- Bullard, Robert D., Paul Mohai, Robin Saha, and Beverly Wright. 2008. “Toxic Wastes and Race at Twenty: Why Race Still Matters After All Of These Years.” *Environmental Law* 38 (2): 371–411.
- “Clean Energy to Communities Program.” n.d. Energy.Gov. Accessed October 27, 2023. <https://www.energy.gov/eere/clean-energy-communities-program>.

- Colleen Callahan, Daniel Coffee, J.R. DeShazo, and Silvia R. González. 2021. "Making Justice40 a Reality for Frontline Communities." Los Angeles: UCLA Luskin Center for Innovation. <https://innovation.luskin.ucla.edu/wp-content/uploads/2021/10/luskin-justice40-final-web-1.pdf>.
- "Communities LEAP." n.d. Energy.Gov. Accessed October 27, 2023. <https://www.energy.gov/communitiesLEAP/communities-leap>.
- Congress, U. S. 2022. "HR 5376-Inflation Reduction Act of 2022." *HR 5376-Inflation Reduction Act of 2022*.
- Costanza-Chock, Sasha. 2020. *Design Justice: Community-Led Practices to Build the Worlds We Need*. The MIT Press. <https://library.oapen.org/handle/20.500.12657/43542>.
- Davis, Janet, and Lisa P. Nathan. 2021. "Value Sensitive Design: Applications, Adaptations, and Critiques." In *Handbook of Ethics, Values, and Technological Design: Sources, Theory, Values and Application Domains*, edited by Jeroen van den Hoven, Pieter E. Vermaas, and Ibo van de Poel, 1–26. Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-6994-6_3-1.
- Dutta, Nikita S., Elizabeth Gill, Bettina K. Arkhurst, Mary Hallisey, Katherine Fu, and Kate Anderson. 2023. "JUST-R Metrics for Considering Energy Justice in Early-Stage Energy Research." *Joule*, February. <https://doi.org/10.1016/j.joule.2023.01.007>.
- Graves, Joseph L., Maureen Kearney, Gilda Barabino, and Shirley Malcom. 2022. "Inequality in Science and the Case for a New Agenda." *Proceedings of the National Academy of Sciences* 119 (10): e2117831119. <https://doi.org/10.1073/pnas.2117831119>.
- Hofstra, Bas, Vivek V. Kulkarni, Sebastian Munoz-Najar Galvez, Bryan He, Dan Jurafsky, and Daniel A. McFarland. 2020. "The Diversity–Innovation Paradox in Science." *Proceedings of the National Academy of Sciences* 117 (17): 9284–91.
- Holly, James, and Yolanda Comedy. 2022. "Whitey on the Moon: Racism's Maintenance of Inequity in Invention and Innovation." *National Academy of Inventors, Technology & Innovation*, , December. <https://www.ingentaconnect.com/content/nai/ti/pre-prints/content-22.3jh#>.
- Jenkins, Kirsten EH, Shannon Spruit, Christine Milchram, Johanna Höffken, and Behnam Taebi. 2020. "Synthesizing Value Sensitive Design, Responsible Research and Innovation, and Energy Justice: A Conceptual Review." *Energy Research & Social Science* 69: 101727.
- Joseph R. Biden. 2021. "Exec. Order No. 14008: Tackling the Climate Crisis at Home and Abroad." Federal Register. January 27, 2021. <https://www.federalregister.gov/documents/2021/02/01/2021-02177/tackling-the-climate-crisis-at-home-and-abroad>.
- Kozlowski, Diego, Vincent Larivière, Cassidy R. Sugimoto, and Thema Monroe-White. 2022. "Intersectional Inequalities in Science." *Proceedings of the National Academy of Sciences* 119 (2): e2113067119. <https://doi.org/10.1073/pnas.2113067119>.
- Mathie, Alison, and Gord Cunningham. 2003. "From Clients to Citizens: Asset-Based Community Development as a Strategy for Community-Driven Development." *Development in Practice* 13 (5): 474–86.
- McKeown, Maeve. 2021. "Structural Injustice." *Philosophy Compass* 16 (7): e12757. <https://doi.org/10.1111/phc3.12757>.
- Mehrabi, Ninareh, Fred Morstatter, Nripsuta Saxena, Kristina Lerman, and Aram Galstyan. 2021. "A Survey on Bias and Fairness in Machine Learning." *ACM Computing Surveys* 54 (6): 115:1-115:35. <https://doi.org/10.1145/3457607>.
- Mundaca, Luis, Henner Busch, and Sophie Schwer. 2018. "'Successful' Low-Carbon Energy Transitions at the Community Level? An Energy Justice Perspective." *Applied Energy* 218 (May): 292–303. <https://doi.org/10.1016/j.apenergy.2018.02.146>.
- Office of Chief Financial Officer. 2021. "Department of Energy FY 2022 Congressional Budget Request." Volume 3 Part 2. <https://www.energy.gov/sites/default/files/2021-06/doe-fy2022-budget-volume-3.2-v3.pdf>.
- Office of Economic Impact and Diversity. 2022. "Justice40 Initiative." Energy.Gov. Accessed October 20, 2023. <https://www.energy.gov/diversity/justice40-initiative>.
- Office of the Chief Financial Officer. 2023. "FY 2024 Budget Justification." Energy.Gov. March 13, 2023. <https://www.energy.gov/cfo/articles/fy-2024-budget-justification>.
- Ottinger, Gwen, Timothy J. Hargrave, and Eric Hopson. 2014. "Procedural Justice in Wind Facility Siting: Recommendations for State-Led Siting Processes." *Energy Policy* 65 (February): 662–69. <https://doi.org/10.1016/j.enpol.2013.09.066>.
- Owen, Richard, Phil Macnaghten, and Jack Stilgoe. 2012. "Responsible Research and Innovation: From Science in Society to Science for Society, with Society." *Science and Public Policy* 39 (6): 751–60. <https://doi.org/10.1093/scipol/scs093>.

- Ravikumar, A. P., E. Baker, A. Bates, D. Nock, D. Venkataraman, T. Johnson, M. Ash, et al. 2023. "Enabling an Equitable Energy Transition through Inclusive Research." *Nature Energy* 8 (1): 1–4. <https://doi.org/10.1038/s41560-022-01145-z>.
- Shalanda Baker, Subin DeVar, and Shiva Prakash. 2019. "The Energy Justice Workbook." Initiative for Energy Justice. <https://iejusa.org/wp-content/uploads/2019/12/The-Energy-Justice-Workbook-2019-web.pdf>.
- Shalanda D. Young, Brenda Mallory, and Gina McCarthy. Memorandum. 2021. "M-21-28 Memorandum for the Heads of Departments and Agencies: Interim Implementation Guidance for the Justice40 Initiative," July 20, 2021. <https://www.whitehouse.gov/wp-content/uploads/2021/07/M-21-28.pdf>.
- Shi, Linda, and Susanne Moser. 2021. "Transformative Climate Adaptation in the United States: Trends and Prospects." *Science* 372 (6549): eabc8054. <https://doi.org/10.1126/science.abc8054>.
- Siddiqi, Sameer M., Cate Mingoya-LaFortune, Ramya Chari, Benjamin L. Preston, Grace Gahlon, Carlos Calvo Hernandez, Alexandra Huttinger, Scott R. Stephenson, and Jaime Madrigano. 2023. "The Road to Justice40: Organizer and Policymaker Perspectives on the Historical Roots of and Solutions for Environmental Justice Inequities in U.S. Cities." *Environmental Justice* 16 (5): 340–50. <https://doi.org/10.1089/env.2022.0038>.
- "Solar Energy Innovation Network." 2020. Energy.Gov. Accessed October 27, 2023. <https://www.energy.gov/eere/solar/solar-energy-innovation-network>.
- Sovacool, Benjamin K., David J. Hess, Roberto Cantoni, Dasom Lee, Marie Claire Brisbois, Hans Jakob Walnum, Ragnhild Freng Dale, et al. 2022. "Conflicted Transitions: Exploring the Actors, Tactics, and Outcomes of Social Opposition against Energy Infrastructure." *Global Environmental Change* 73 (March): 102473. <https://doi.org/10.1016/j.gloenvcha.2022.102473>.
- Temper, Leah, Sofia Avila, Daniela Del Bene, Jennifer Gobby, Nicolas Kosoy, Philippe Le Billon, Joan Martinez-Alier, et al. 2020. "Movements Shaping Climate Futures: A Systematic Mapping of Protests against Fossil Fuel and Low-Carbon Energy Projects." *Environmental Research Letters* 15 (12): 123004. <https://doi.org/10.1088/1748-9326/abc197>.
- The White House. 2021. "FACT SHEET: President Biden Takes Executive Actions to Tackle the Climate Crisis at Home and Abroad, Create Jobs, and Restore Scientific Integrity Across Federal Government." The White House. January 27, 2021. <https://www.whitehouse.gov/briefing-room/statements-releases/2021/01/27/fact-sheet-president-biden-takes-executive-actions-to-tackle-the-climate-crisis-at-home-and-abroad-create-jobs-and-restore-scientific-integrity-across-federal-government/>.
- Transportation Research Board, National Academy of Engineering, National Academy of Medicine, and Engineering National Academies of Sciences and Medicine. 2023. *Accelerating Decarbonization in the United States: Technology, Policy, and Societal Dimensions*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/25931>.
- U.S. Dept. of Energy Office of Policy. 2023. "On The Path to 100% Clean Electricity." <https://www.energy.gov/policy/articles/path-100-clean-electricity>.
- U.S. Dept. of State and United States Executive Office of the President. 2021. "The Long-Term Strategy of the United States: Pathways to Net-Zero Greenhouse Gas Emissions by 2050." Washington, DC. <https://www.whitehouse.gov/wp-content/uploads/2021/10/US-Long-Term-Strategy.pdf>.
- Wailoo, Keith A., Victor J. Dzau, and Keith R. Yamamoto. 2023. "Embed Equity throughout Innovation." *Science* 381 (6662): 1029–1029. <https://doi.org/10.1126/science.adk6365>.
- Woodson, Thomas S., Elina Hoffmann, and Sophia Boutilier. 2021. "Evaluating the NSF Broader Impacts with the Inclusion-Immediacy Criterion: A Retrospective Analysis of Nanotechnology Grants." *Technovation* 101 (March): 102210. <https://doi.org/10.1016/j.technovation.2020.102210>.
- Young, Iris Marion. 2010. *Responsibility for Justice*. Oxford University Press.

Bettina K. Arkhurst is a Ph.D. candidate in the George W. Woodruff School of Mechanical Engineering at the Georgia Institute of Technology. As a member of the Engineering Design Research Laboratory, Bettina researches how concepts of energy justice can be applied to energy technology design to better consider

marginalized and vulnerable populations. She strives to create frameworks and tools for mechanical engineers to apply as they design the next generation of clean and energy-efficient technologies for all communities.

Wyatt Green Williams is a Master of Environmental Engineering student and MBA candidate at the Georgia Institute of Technology, where he is a researcher in the Social Equity and Environmental Engineering Laboratory (SEEL). His research interests include environmental justice, circularity, building energy efficiency, construction material selection, and artificial intelligence for climate solutions. After graduation, Wyatt aims to enter industry and lead decarbonization and sustainability efforts within the private sector.

Acknowledgements

The authors would like to thank Dr. Joe F. Bozeman III for his helpful guidance and feedback. The authors would like to acknowledge the Georgia Tech Center for Sustainable Communities Research and Education (SCoRE) for their financial support during the writing of this paper and enabling B.K.A to attend the 2023 Southeast Environmental Justice Summit, which motivated this paper. The authors would particularly like to acknowledge Drs. Jennifer Hirsch and Ruth Yow of the Georgia Tech SCoRE Center for their support. The authors also gratefully acknowledge Harambee House, the host of the 2023 Southeast Environmental Justice Summit, along with Harambee House founder, Dr. Mildred McClain, Ayika Solutions CEO, Dr. Erica Holloman-Hill, and Executive Director of the Greater Frenchtown Revitalization Council, Queen Mother Miaisha Mitchell for their wisdom, passion, and powerful words during the Southeast Environmental Justice Summit that inspired the creation of this paper. B.K.A also acknowledges her Ph.D. advisor, Dr. Katherine Fu, for her continuous support and guidance.