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Energy Research Session Proceedings

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FOREWORD

The Cityscapes Summit 2026 Energy Research Session Proceedings represent a landmark contribution to the evolving discourse on urban energy systems, sustainable infrastructure, and the governance of metropolitan energy transitions. This volume gathers the original research papers, panel discussions, and working-group reports presented during the Energy Research Sessions convened as part of the Cityscapes Summit 2026, and it stands as a testament to the intellectual ambition and collaborative spirit that defined those proceedings.

Urban energy systems are among the most consequential domains of inquiry in the twenty-first century. Cities consume more than two-thirds of the world's energy and generate the majority of global greenhouse gas emissions, yet they also concentrate on the human capital, institutional capacity, and innovation ecosystems necessary to engineer transformative change. The research assembled in this volume addresses that duality with rigor and originality, examining questions that range from district-level decarbonization pathways and grid-edge flexibility to the political economy of just transition frameworks and the

socio-technical imaginaries that shape metropolitan energy governance.

The Energy Research Session was designed to bridge disciplinary boundaries. Contributions from urban planning, electrical engineering, environmental economics, public policy, architecture, and the social sciences appear side by side in these pages, united by a shared commitment to evidence-based inquiry and an understanding that the challenges of urban energy transformation resist solution by any single field. Readers will encounter empirical case studies drawn from multiple cities, alongside theoretical frameworks developed to make sense of the structural forces, technological, financial, regulatory, and cultural that accelerate or impede decarbonization at the city scale.

The editors wish to acknowledge the exceptional efforts of the Program Committee, whose careful stewardship of the peer-review process ensured that every contribution meets the highest standards of scholarly integrity. We are equally grateful to the session facilitators and discussants whose contributions sharpened the ideas presented here, and to the Cityscapes Summit Secretariat and the American Solar Energy Society, for providing the organizational infrastructure without which a gathering of this scope could not have taken place. A special thank you goes to New Growth Innovation Network as the official sponsors and hosts of Cityscapes 2026.

Additionally, to avoid any conflict with the intentions of the Cityscapes Summit conveners and hosts - New Growth Innovation Network - regarding curating after-event collateral, let's modify the proceedings nomenclature to reflect that our proceedings are the result of the energy session, convened and facilitated by

HBCU-CDAC. As such, we should use “Energy Research Session Proceedings” as the title of our work and throughout the paper, particularly in areas where we do not need to recreate or extensively alter the submissions of others.

It is crucial to note in the report that a grant from the Alfred P. Sloan Foundation, administered by Johnson C. Smith University, funded the Cityscapes Energy Session. Finally, we should mention that the HBCU Energy & Workforce Alliance (HBCU-EWA), working alongside ASES and HBCU CDAC as technical advisors, created the online submission portal, solicited scholarly contributions, and will support the continued distribution of the original peer-reviewed research and its findings along with the proceedings report and other outcomes.

It is our hope that this volume will serve practitioners and policymakers navigating real-world energy transitions, as well as scholars seeking to advance the theoretical frontiers of urban energy studies. The urgency of the challenge before us demands nothing less than the best of both communities. We commend these proceedings to readers in that spirit.

Karen Soares and Henry Golatt, Executive Editors and Session Conveners
Energy Research Session HBCU Community Development Action Coalition
Cityscapes Summit 2026

Virtual Mutual Mentoring to Reduce Barriers for Black Energy Scholars

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June 2026

There is a *national need for increasing the number of scientists and engineers from underrepresented groups engaged in, and with, clean energy* [2]. Decarbonization may be the grand challenge of the 21st century and is likely to be a key driver of innovation [3]. It is critical that we engage all segments of society in finding solutions that are equitable, clean, and technology-informed [1,4,5]. Although environmental justice has been a prominent topic among social scientists, equity often gets short shrift among majority STEM researchers. In contrast, equity and inequity are not abstract concepts to Black scholars and other under-represented minorities—they are often a reality of their everyday experiences [6]. Consequently, Black scholars bring different perspectives on equity than majority researchers [7]. These perspectives, as well as the diversity of ideas, experiences and expertise possessed by under-represented scholars will be a driving force of innovation in a net zero energy system.

A key barrier identified by [8] was the lack of mentors for Black scholars at both HBCUs and PWIs. This lack means that of scholars from underrepresented communities often lack the resources they need to advance their research careers with a “goal to end the cycle of short-term and insecure academic appointments.[1]” Moreover, a key obstacle for diverse scholars who are located in PWIs is the feeling of isolation among the “pioneer” Black faculty and students at those institutions. Thus, [8] recommend establishing mentoring programs and networks for Black researchers.

One potential route for this is through *virtual, inter-institutional mutual-mentoring networks* [9,10]. Many faculty have had success following the “Every Other Thursday” model [11], which uses a novel problem-solving approach with well-developed protocols. University of Massachusetts, Amherst, for example, has had success with face-to-face mutual mentoring models, including an Engineering Women’s Faculty Forum and three longstanding *Every Other Thursday* groups in the College of Natural Sciences. In addition, an NIH National Research Mentoring Network pilot project used the Every Other Thursday model and virtual technology to link Under-Represented Minority women faculty in biomedicine across 15 institutions.

This mutual mentoring model is usually face-to-face, but given the geographic isolation of many Black scholars, a remote model will increase the opportunity for mentoring. Ideally each mentoring group could meet face to face at least once a year, perhaps at a conference or focused workshop. Once groups are organized and identify a meeting

time, the groups are facilitated by members, with members typically rotating this responsibility every meeting. Typical groups would have about 7-8 participants; and can be made up of diverse scholars at different career levels.

Scholars can be identified using a snowballing technique, building on the networks of the HBCU Community Development Action Coalition. CDAC has a Clean Energy Initiative, which focusses on increasing solar awareness, accessibility, and workforce training for institutions, students, and residents in low-to-moderate income communities surrounding HBCUs and MSIs. Scholars from HBCUs can be integrated with Black scholars from PWIs, especially R1s, which have the resources to support proposal development and similar facilitating activities. This provides two-way mentoring support. For HBCU scholars, it can help to disseminate some of the “hidden curriculum” on how to succeed in academic research. For PWI scholars, it can reduce the isolation of being the only Black scholar, and also provide connections to the LMI communities surrounding the HBCUs, communities often of particular interest to the Black scholars.

One benefit of a program like this would be increased collaboration between HBCUs and PWIs. Such collaborations make many of the resources at PWI R1s available to HBCU scholars; and often may lead to the provision of professional development opportunities for the HBCU scholars, either directly through participating in programs, or indirectly through knowledge sharing between the scholars.

Virtual inter-institution mutual mentoring networks focused on clean energy may provide one pathway to increasing the research capacity of HBCU energy researchers while addressing isolation of Black energy researchers at PWIs.

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Sharing Stories You Can't Ignore: How to Use Visibility to Shape Innovation, Trust, and Investment

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This paper examines the role of visibility, narrative strategy, and cognitive framing in shaping public trust, policy attention, and investment surrounding Black energy researchers and energy innovation. Drawing from neuroscience-informed communication principles, media analysis, and contemporary examples of public-facing climate and energy storytelling, the paper argues that research influence is determined not solely by scientific rigor, but by the extent to which discoveries become emotionally relevant, publicly legible, and culturally memorable.

Despite growing national investment in clean energy infrastructure and climate innovation, Black researchers remain significantly underrepresented within federally funded research ecosystems and mainstream narratives surrounding innovation leadership. Existing disparities in Department of Energy (DOE), National Science Foundation (NSF), and Environmental Protection Agency (EPA) funding to Historically Black Colleges and Universities (HBCUs) contribute not only to infrastructure inequities, but also to diminished public visibility and reduced narrative association between Black researchers and the future of energy innovation itself.

These disparities are documented in *Advancing Equity in Energy Research: Overcoming Barriers and Building Pathways* (2024), which identifies persistent inequities in research funding, publication visibility, mentorship access, and institutional infrastructure affecting Black energy researchers and HBCUs. This paper builds upon those findings by examining how visibility itself functions as a structural determinant influencing public trust, market recognition, and investment behavior.

At the same time, mainstream science coverage occupies only a small fraction of the public media ecosystem. As a result, audiences rarely encounter research stories, and even more rarely encounter Black researchers within those stories. This paper contends that the absence of repeated visibility shapes public perception in profound ways, influencing who markets trust, who institutions fund, and whose work becomes associated with innovation leadership.

To address this challenge, the paper introduces the BELIEF Framework™—a neuroscience-informed narrative architecture model designed to help researchers,

institutions, and policymakers craft stories that reduce cognitive overload, increase emotional salience, and strengthen public engagement. The framework emphasizes six integrated dimensions: beginning with human consequence, establishing emotional relevance, localizing impact, inviting audiences into future possibility, earning trust through repeated visibility, and framing research around meaning rather than technical complexity.

Case studies examining the public visibility of Dr. Ayana Elizabeth Johnson, Dr. Tony Reames, and Donnel Baird demonstrate how emotionally resonant storytelling, repeated media exposure, and human-centered framing contributed to expanded public influence, policy engagement, and investment visibility. These examples illustrate that the stories most likely to shape markets and policy conversations are those that translate technical systems into narratives audiences can emotionally process, socially repeat, and future-cast.

The paper concludes that increasing equity within energy research requires more than expanded funding pipelines alone. It also requires intentional narrative infrastructure capable of positioning Black energy researchers within the broader public imagination as visible contributors to the future of energy innovation, resilience, and economic transformation.

Keywords:

Energy communication · neuroscience · cognitive framing · narrative strategy · public trust · media visibility · HBCU research · climate communication · energy justice · storytelling · innovation ecosystems · BELIEF Framework™

Introduction

Somewhere in the world, a family will decide whether to pay the electric bill or buy groceries. Somewhere else, a researcher is developing a solution that could ease that burden—yet most people will never hear their name, understand their work, or connect that discovery to the realities shaping their own lives.

That distance between innovation and recognition sits at the center of this paper.

Conversations surrounding energy innovation frequently focus on technology, infrastructure, and investment. Far less attention is given to the role visibility and storytelling play in determining which discoveries gain traction within public consciousness and which remain largely unseen. Yet markets, institutions, and policy ecosystems are shaped not only by information, but by perception. People invest in

futures they can emotionally visualize. They trust ideas they repeatedly encounter. They remember stories that help them make meaning of complex systems.

Behavioral science and neuroscience research suggest that audiences are significantly more likely to engage with information that feels emotionally relevant, cognitively accessible, and repeatedly visible within public culture (Kahneman, 2011; Medina, 2014; Zak, 2014). As a result, the stories surrounding innovation often become as influential as the innovation itself.

For Black energy researchers, this reality carries significant implications.

Underrepresentation within research funding ecosystems intersects with underrepresentation within public narratives surrounding innovation leadership. The result is not only diminished access to resources, but diminished association between Black researchers and the future of energy innovation itself.

The 2024 report *Advancing Equity in Energy Research: Overcoming Barriers and Building Pathways* documents how disparities in research funding, publication visibility, and institutional support contribute to systemic underrepresentation within energy innovation ecosystems. This paper argues that those structural disparities extend beyond research infrastructure into the realm of public cognition and narrative association.

This paper further argues that visibility functions as a form of infrastructure. It shapes public trust, influences investment behavior, and determines which discoveries become socially memorable enough to influence markets, policy, and institutional priorities.

Theoretical Framework

This paper is grounded in neuroscience-informed communication theory and narrative persuasion research. Human beings do not process information neutrally. Cognitive science demonstrates that attention is filtered through relevance, emotional salience, familiarity, and perceived future consequence.

Kahneman (2011) argues that human beings rely heavily on cognitive shortcuts and intuitive processing when evaluating information, particularly in environments saturated with complexity and competing stimuli. Medina (2014) similarly notes that attention and retention are strengthened when information is emotionally engaging and connected to survival, meaning, or future consequence.

Research in neuroscience and behavioral psychology further suggests that stories activate memory and empathy more effectively than isolated data points. Emotion strengthens memory encoding, while repeated exposure increases perceived legitimacy

and trust. Simultaneously, cognitive overload reduces comprehension and disengages audiences from otherwise important information.

Zajonc's (1968) research on repeated exposure further suggests that familiarity itself increases trust and perceived legitimacy. Applied to media ecosystems, this principle helps explain how repeated visibility shapes public assumptions surrounding who is perceived as an innovator, expert, or industry leader.

Zak (2014) demonstrates that stories activating emotional engagement increase empathy, retention, and behavioral responsiveness more effectively than information presented through detached factual communication alone. Berger (2013) similarly argues that ideas spread when they are emotionally resonant, socially meaningful, and easily repeatable.

Together, these frameworks suggest that visibility functions not merely as communication strategy, but as cognitive infrastructure shaping public understanding, institutional trust, and market influence.

Context and Case Evidence

Despite substantial national investment in climate and clean energy infrastructure, Black researchers remain significantly underrepresented within federally funded research ecosystems. According to *Advancing Equity in Energy Research: Overcoming Barriers and Building Pathways* (2024), HBCUs received only 1.1% of Department of Energy university research grants between 2000 and 2020, despite their historic role in advancing educational opportunity and community-centered innovation.

The report also documents disproportionately low representation within energy-related publication ecosystems and persistent barriers to mentorship, collaboration, and institutional support. These disparities affect not only infrastructure and research capacity, but public visibility itself.

Visibility disparities extend beyond academia. Pew Research Center (2017) found that only a minority of Americans regularly consume science and technology news, while science reporting constitutes a relatively small share of mainstream media coverage overall. Consequently, the public's understanding of innovation is shaped by a narrow set of highly visible narratives repeatedly amplified across media ecosystems. Against this backdrop, several public-facing figures demonstrate how narrative framing can significantly expand visibility and influence.

Dr. Ayana Elizabeth Johnson emerged as a nationally recognized climate communicator by translating climate science into emotionally resonant conversations surrounding future possibility, resilience, and public consequence. Her appearances across TIME (2024), PBS NewsHour (2024), and NPR (2024) helped transform climate communication from abstract policy discourse into a human-centered narrative about collective futures. Johnson's public visibility demonstrates Berger's (2013) argument that ideas spread when they are emotionally resonant, socially meaningful, and easily repeatable.

Similarly, Dr. Tony Reames expanded national conversations surrounding energy burden and utility inequity by connecting energy systems directly to household realities. Rather than positioning energy justice solely as policy analysis, his work framed energy insecurity as an issue affecting family stability, health, and economic survival. Coverage from The Washington Post (2022) and the U.S. Department of Energy (2022) amplified these conversations into broader public discourse. Donnel Baird and BlocPower further demonstrated the power of narrative framing by translating clean energy infrastructure into visible community transformation.

Through storytelling centered on housing, jobs, electrification, and neighborhood impact, BlocPower attracted national media attention, venture capital visibility, and expanded public understanding of equitable energy innovation. Coverage from TIME (2021), TED (2021), and The New Yorker (2019) positioned clean energy not as an abstract technological system, but as a visible community issue connected to economic mobility and quality of life.

Collectively, these examples illustrate that the stories most likely to shape markets are often the stories that make complex systems feel human.

The BELIEF Framework™

The BELIEF Framework™ synthesizes insights from neuroscience, behavioral psychology, strategic communication, and public engagement research. It reflects the understanding that audiences do not simply process information analytically; they interpret information emotionally, socially, and cognitively. The framework is designed to help researchers and institutions craft narratives capable of increasing public engagement, reducing cognitive overload, and strengthening emotional resonance.

BEGIN WITH HUMAN CONSEQUENCE

Effective research storytelling begins by identifying what changes in people's lives because the research exists. Human beings prioritize information connected to safety, stability, health, and quality of life.

INVITE THE AUDIENCE INTO THE FUTURE

Future-oriented framing helps audiences emotionally imagine possibility, transformation, and long-term impact. This is especially important in conversations surrounding energy transition and climate resilience.

ESTABLISH EMOTIONAL RELEVANCE

Audiences are more likely to remember and engage with information when emotional stakes are clear. Urgency, hope, tension, and transformation increase attentional salience and retention.

EARN TRUST THROUGH VISIBILITY

Repeated public exposure increases familiarity and perceived legitimacy. Research narratives should therefore exist beyond academic journals and institutional reports, extending into mainstream media, podcasts, policy discussions, conferences, and social storytelling ecosystems.*

LOCALIZE THE IMPACT

Research becomes more cognitively accessible when audiences can visualize where it appears in real life—homes, neighborhoods, utility bills, transportation systems, hospitals, and communities.

FRAME AROUND MEANING, NOT COMPLEXITY

The goal of effective communication is not to reduce rigor, but to reduce unnecessary cognitive friction. Research becomes influential when audiences can quickly understand why it matters.**

*This principle aligns with Zajonc's (1968) research demonstrating that repeated exposure increases perceived legitimacy and trustworthiness.

**Kahneman (2011) and Medina (2014) both suggest that audiences naturally gravitate toward information requiring lower cognitive effort while maintaining emotional relevance and clarity.

Conclusion

The challenge facing Black energy researchers is not a lack of curiosity, talent, or innovation capacity. It is the absence of sustained narrative infrastructure capable of translating discovery into public meaning.

Research shapes the future when people can emotionally connect to its consequences, visualize its possibilities, and repeatedly encounter the individuals behind the work.

Visibility, therefore, is not separate from innovation. Visibility determines what becomes trusted, funded, remembered, and ultimately scaled.

As Berger (2013) notes, ideas spread not simply because they are important, but because they are memorable, emotionally resonant, and socially transmissible. For Black energy researchers, this reality underscores the importance of narrative infrastructure alongside research infrastructure.

Expanding equity within energy innovation therefore requires more than access to funding alone. It requires sustained public visibility capable of reshaping the stories institutions, markets, and communities learn to associate with the future of innovation. The future of energy innovation will not only be shaped by discovery. It will also be shaped by which discoveries the public learns to believe in.

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Subtle Barriers Are Still Systemic Barriers: Experiences of Black Researchers in Energy-Related Fields

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Abstract

Despite earning the highest academic credentials, Black researchers in energy-related fields continue to face systemic barriers that impede their professional advancement. This article draws on interviews with 19 Black researchers and 9 non-Black researchers at comparable institutions to examine the nature and scope of these barriers. Findings reveal that subtle but pervasive forms of discrimination, including exclusion from professional networks, lack of mentorship, and diminished recognition, operate across institutional settings, from Historically Black Colleges and Universities (HBCUs) to Research 1 universities. Black female researchers face additional, intersecting layers of marginalization. We argue that a degree in higher education, even at the doctoral level, is insufficient to overcome structural inequities embedded in academic research environments. Targeted, systemic interventions are needed to address these entrenched disparities.

Keywords: *Black researchers, systemic racism, higher education, energy research, HBCUs, mentorship, professional networks, equity, intersectionality*

Introduction

A college degree, and more so a doctoral degree, has long been considered the most reliable pathway to upward social and professional mobility in the United States. Yet an emerging body of research challenges this assumption, particularly for Black academics. Even those who attain the highest levels of education, such as PhDs, encounter formidable barriers in their post-doctoral careers. This article focuses specifically on Black researchers working in energy-related fields, broadly defined to include engineering, physics, and chemistry, to examine what those barriers look like in practice.

Drawing on qualitative interviews conducted as part of a broader study, we explore the structural and interpersonal dimensions of inequity that Black researchers navigate. Rather than generalizing across all academic disciplines, we narrow our scope to energy research, where the professional norms, funding landscapes, and institutional cultures have their own distinct characteristics. Our findings reveal a consistent pattern: subtle forms of discrimination accumulate into systemic disadvantage.

Methods

This study is grounded in qualitative, interview-based research. We conducted in-depth interviews with 19 Black PhD researchers in energy-related fields at academic institutions across the United States. To provide a comparative perspective, we also interviewed 9 non-Black PhD researchers at the same institutions or in the same regional contexts. All participants were faculty members working in areas related to engineering, physics, or chemistry, fields broadly situated within the energy research landscape.

Participants were recruited through purposive sampling to ensure representation across institutional types, career stages, and geographic regions. Interviews were semi-structured, allowing researchers to share their lived experiences in their own words. Data was analyzed thematically, with a focus on patterns related to professional recognition, funding access, mentorship, and network inclusion. This article presents selected findings; a more comprehensive analysis is available in our accompanying whitepaper, *Advancing Equity in Energy Research*.

Findings

Barriers at Historically Black Colleges and Universities (HBCUs)

Black researchers who begin or advance their careers at HBCUs encounter a distinct set of institutional constraints. While HBCUs provide culturally affirming environments and play a vital role in Black academic life, systemic underfunding creates serious research impediments. These challenges range from inadequate laboratory equipment and limited faculty startup packages to insufficient administrative support for grant writing and management.

Beyond resource constraints, HBCU-affiliated researchers reported experiencing stigma in federal grant processes. One researcher recounted a reviewer's dismissal: "I don't think this [HBCU] has the proposed research capabilities." Such responses reflect assumptions about institutional legitimacy that disadvantage HBCU researchers regardless of the scientific merit of their proposals.

Exclusion from Networks at Research-Intensive Universities

Black researchers at Research I (predominantly white) institutions face a different but equally consequential set of challenges. In these settings, research funding frequently flows through established informal networks, concentrated among faculty who have built long-standing relationships within the university. New faculty members who lack visible connections or shared backgrounds are often excluded from these networks, limiting their access to collaborative opportunities, grant partnerships, and internal advocacy.

This exclusion extends to mentorship. Black researchers reported significant difficulty in identifying mentors within their own departments or institutions who shared their background or understood their professional challenges. Many ultimately cultivated mentoring relationships with colleagues at other universities, a workaround that, while effective, places additional burdens on Black researchers to build support structures that their non-Black peers receive as a matter of course.

Subtle Discrimination and Lack of Professional Recognition

A recurring theme across interviews was the experience of being rendered invisible or illegitimate as a professional. In one example, a tenured associate professor in his forties was mistaken for a graduate student within his own engineering building. Other interviewees were told they were "lucky" to be hired, a comment framed as collegial but implying their position was the result of a diversity initiative rather than merit.

One interviewee described a particularly painful dynamic: "I voiced [an opinion] in a faculty meeting and faced an immediate disagreement. Later in the meeting, someone else [a white colleague] said exactly the same thing, and people agreed." This erasure of Black researchers' intellectual contributions was reported across multiple institutions and career stages. Multiple interviewees described having to work "twice as hard" to be seen as equally competent, a burden well-documented in research on racial bias in professional environments.

Intersectional Barriers Facing Black Women

Black female faculty members navigate compounding barriers rooted in both race and gender. Several interviewees described the challenge of operating within entrenched "old boys club" cultures at the department level and at academic conferences. Retention emerged as a particular concern: one researcher reported that in her office, where all other colleagues were male, she was openly told, "Women don't stay in this office, and we don't know why." Such statements, even when not intended as hostile, signal an unwelcoming environment and normalize the departure of women from these spaces.

Hidden Knowledge and the Limits of Formal Mentorship

Academic career development depends heavily on what researchers call "hidden knowledge", tacit understanding about which publication venues carry the most weight, which grants are most competitive, how to network with federal program officers, and how to build a visible professional profile. This knowledge is typically transmitted through department-level mentorship programs. But when Black faculty cannot find mentors of similar background within their department or institution, this informal knowledge transfer breaks down.

The Black researchers in our study developed alternative strategies, including building cross-institutional mentoring networks, but these strategies required significant additional effort. Their ability to succeed despite these barriers reflects individual resilience, but it should not obscure the systemic nature of what they face. As our findings make clear, the barriers are not personal failings but structural features of academic research environments.

Conclusion

This study demonstrates that obtaining a doctoral degree does not insulate Black researchers from systemic inequity. Subtle, often unacknowledged forms of discrimination, exclusion from networks, diminished professional recognition, lack of mentorship, and institutional underfunding, operate cumulatively to disadvantage Black

faculty at every career stage and institutional type. Black women face additional intersectional barriers that further constrain their professional trajectories.

These findings carry clear implications for institutions, funding agencies, and professional associations in the energy research sector. Diversity initiatives that focus on recruitment without addressing the underlying structural conditions of academic environments are insufficient. What is needed are sustained, systemic interventions: equitable funding mechanisms for HBCU researchers, formal sponsorship programs, transparent grant review processes, and institutional accountability for the retention and advancement of Black faculty.

The researchers we interviewed are among the most credentialed professionals in their fields. The fact that they continue to face these barriers is not an anomaly, it is the product of entrenched institutional structures. Addressing these structures is not merely a matter of fairness; it is essential to the integrity and vitality of the broader research enterprise.

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Matching Objectives with Stakeholder-Driven Metrics for Equitable Power Systems Planning

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Introduction

As governments, utilities, and researchers pursue ambitious clean energy transitions, questions of equity and justice have become increasingly central to energy policy and planning. While energy system planning models play an important role in informing infrastructure investments, technology deployment, and policy decisions, they often struggle to incorporate the diverse priorities and lived experiences of the communities they are intended to serve. As a result, there remains a persistent gap between community-defined understandings of equitable outcomes and the objectives embedded within technical planning processes. At the same time, stakeholder engagement is increasingly recognized as essential to achieving just and inclusive energy transitions. However, traditional engagement approaches can be limited by technical complexity, disciplinary silos, and unequal participation dynamics that make it difficult for stakeholders to meaningfully contribute to discussions about energy planning priorities. These challenges raise an important question: how can energy researchers and practitioners create accessible mechanisms for identifying and incorporating stakeholder-defined equity priorities into energy transition decision-making?

This paper presents a participatory game-based methodology designed to facilitate dialogue around energy equity metrics and energy transition objectives. Developed through the ELEVATE program at the University of Massachusetts Amherst, the game invites participants to match equity metrics with planning objectives and justify their choices through structured deliberation. Beyond fostering engagement, the approach provides a mechanism for eliciting stakeholder values, surfacing competing priorities, and exploring how equity considerations may be translated into decision-relevant metrics for energy planning. We argue that participatory tools such as this can help bridge the divide between community perspectives and technical planning processes, supporting more inclusive and accountable approaches to energy transition decision-making.

Background and Motivation

The transition to cleaner energy systems presents an opportunity to address longstanding inequities in energy access, affordability, environmental burdens, and participation in decision-making. Across the United States, policymakers, utilities, and researchers are increasingly incorporating concepts such as energy justice, procedural equity, and community engagement into energy planning and policy design. Despite

these efforts, meaningful participation in energy decision-making remains difficult to achieve. Many energy planning processes rely on highly technical language, specialized expertise, and quantitative evaluation frameworks that can create barriers to participation for community members and non-technical stakeholders. While public meetings, surveys, and stakeholder consultations are commonly used to gather input, these approaches may not fully capture the values, tradeoffs, and priorities that shape how different groups define equitable energy outcomes. As a result, engagement efforts can become extractive rather than collaborative, limiting opportunities for stakeholders to influence the goals and metrics that guide energy transition decisions. A growing body of work in energy justice emphasizes the importance of procedural justice—the ability of affected communities to participate meaningfully in decisions that shape energy systems and their associated benefits and burdens. Achieving procedural justice requires more than simply providing opportunities for input; it requires creating engagement processes that are accessible, inclusive, and capable of supporting dialogue across diverse perspectives and areas of expertise.

In response to these challenges, researchers and practitioners continue to explore participatory methods that encourage deliberation, collaborative learning, and shared understanding. Games and other interactive engagement tools have emerged as promising approaches because they can reduce intimidation, foster discussion, and make complex systems more approachable. Building on these ideas, we developed a participatory card-based game that uses energy equity metrics and energy transition objectives to support discussion, reflection, and collective reasoning around equitable energy futures. The game was initially developed within the ELEVATE program at the University of Massachusetts Amherst, an interdisciplinary research initiative focused on the intersection of energy systems and social justice. The diversity of disciplinary perspectives within the program highlighted the challenges of establishing shared understandings of equity and the need for tools that could facilitate dialogue across different forms of expertise. While originally developed in an academic setting, the approach has since been adapted for broader engagement with researchers, students, and practitioners.

Methodology and Game Design

The objective of the game is not to identify a single "correct" answer, but rather to create opportunities for participants to articulate, negotiate, and reflect upon different understandings of equitable energy outcomes. The game draws inspiration from established social card games such as *Apples to Apples* and *Cards Against Humanity* but adapts these mechanics to support structured deliberation around energy equity. Participants are presented with a predefined energy transition objective and a hand of equity metric cards. Working individually or in groups, participants select the

metric they believe best aligns with the stated objective and then justify their reasoning to a panel of judges or fellow participants.



Fig 1: Sample objective and metric cards

The game employs a "judge and justify" approach in which participants are encouraged to explain the assumptions, values, and tradeoffs underlying their selections. Through this process, implicit understandings of equity become visible and open to discussion. Rather than focusing solely on technical performance measures, participants are prompted to consider broader questions of access, affordability, participation, ownership, representation, and distributional impacts. Each round proceeds as follows: one player acts as judge and reveals an objective card (printed on green cards) describing an energy planning goal, such as expanding distributed energy resources in underserved communities or improving rate affordability for low-income households. The remaining players hold hands of three to five metric cards (printed on red cards) and select the metric they believe best captures the equity dimensions of the stated objective. The judge selects the most compelling match and the selecting player earns a point—but crucially, the selection must be defended. The justify requirement transforms what could otherwise be a simple matching exercise into structured deliberation: players must articulate why a particular metric captures what matters most about a given objective, surfacing assumptions and values that might otherwise remain implicit.

The objectives and metrics used within the game were adapted from the ["Justice in 100 Metrics: Tools for Measuring Equity in 100% Renewable Energy Policy Implementation."](#), developed by the Initiative for Energy Justice. The framework provides a broad collection of indicators related to energy access, affordability, procedural justice, democratic participation, economic opportunity, and community ownership. By translating these concepts into an interactive format, the game creates a structured environment for exploring how equity considerations may be interpreted and prioritized by different stakeholders.

The game is available as both [printable cards](#) and a digital display format ([HTML file](#)), allowing it to be used in classrooms, workshops, conferences, and community engagement settings. While the specific objectives and metrics included in the game reflect the context of equitable energy transitions, the underlying structure is adaptable and can be modified to accommodate different stakeholder groups, policy contexts, and planning challenges. Importantly, the game serves as more than an educational exercise. By encouraging participants to connect desired outcomes with measurable indicators, it provides a mechanism for eliciting stakeholder perspectives on what constitutes equitable progress. The resulting discussions generate insights into how different actors define success, identify priorities, and evaluate tradeoffs within the energy transition.

Insights from Participatory Engagement

The game has been deployed in a variety of settings, including ELEVATE convergence meetings at the University of Massachusetts Amherst, the 2024 Macro Energy Systems Workshop, and the 2023 Equitable Energy Transition in Caribbean Islands Workshop. Across these settings, participants represented diverse disciplinary, professional, and institutional backgrounds, including engineering, economics, policy, social science, and community-engaged research. These engagements revealed several recurring themes regarding participation, equity, and collaborative decision-making.

First, the game facilitated perspective-taking across disciplinary boundaries. Participants were required not only to select metrics but also to defend and justify their choices, creating opportunities to examine how different backgrounds shape understandings of equitable energy outcomes. Discussions frequently revealed that participants could agree on broad energy transition goals while differing substantially in the metrics they believed should be used to assess progress toward those goals. The exercise therefore shifted conversations from abstract commitments to equity toward more concrete discussions about measurement, accountability, and implementation. Second, the game created opportunities for collaborative learning. By framing complex concepts through an interactive format, participants were able to engage with unfamiliar ideas and perspectives in a low-stakes environment. Feedback from participants suggested that the exercise encouraged curiosity, exposed individuals to alternative approaches to problem solving, and increased awareness of how different disciplines conceptualize energy justice and equity. Third, the game helped reduce traditional hierarchies that often shape research and stakeholder engagement settings. Because participants engaged through a common set of objectives and metrics, discussions were less dependent on disciplinary expertise or technical authority. Students, faculty, researchers, and practitioners were able to contribute on more equal footing, creating space for dialogue that might not emerge through conventional presentations or technical workshops.



Fig 2. A) ELEVATE Team playing the game at the May 2024 convergence meeting, B) Avery (PhD Candidate Princeton University), defending the choice of Metric card to the panel of judges at the 2023 EECIW in St Thomas

Finally, the game demonstrated the potential of participatory tools to make implicit values visible. Many energy planning discussions assume shared understandings of concepts such as equity, affordability, resilience, or community benefit. However, the justification process frequently revealed differing interpretations of these concepts and highlighted the tradeoffs that stakeholders considered important. By surfacing these assumptions, the game created opportunities for more transparent conversations about priorities and decision-making criteria.

Together, these observations suggest that participatory engagement tools can serve as valuable mechanisms for supporting dialogue, reflection, and collective learning around equitable energy transitions. Beyond knowledge sharing, such approaches can help stakeholders articulate priorities, interrogate assumptions, and engage more meaningfully in discussions about energy system futures.

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1. This game was originally prepared by an ELEVATE task force, led by Dr. Krista Harper and including Anna Goldstein and Nwadiaru Ogechi Vivian. With further revisions by Paola P. Furlanetto, Yiwen Wang and Vivian.
2. [“Justice in 100 Metrics Report”](#) from Initiative for Energy Justice is the core technical reference

From the Dirt to the Grid: Integrating Nutrition Equity and Solar Energy to Advance Community-Centered Energy Justice

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Abstract

This paper examines the structural convergence of food insecurity and energy poverty as co-occurring, racially patterned inequities in low-wealth communities across the American South. Drawing on community-engaged extension practice at the University of Arkansas at Pine Bluff (UAPB), the authors argue that community solar gardens and urban agriculture initiatives represent complementary, mutually reinforcing strategies for advancing nutritional equity and energy justice simultaneously. The paper presents a framework—Dirt-to-Grid—that integrates EFNEP nutrition education, solar energy literacy, land-tenure advocacy, and cooperative ownership into a cohesive community-development model. Case evidence drawn from UAPB's Cooperative Extension Program service area in Southeast Arkansas illustrates how historically Black communities can leverage federally supported programs to move from extractive energy and food systems toward regenerative, community-controlled alternatives. Policy implications for the Inflation Reduction Act's rural energy provisions, USDA nutrition programs, and HBCU extension capacity-building are discussed.

Keywords: energy justice · food sovereignty · nutrition equity · community solar · urban agriculture · HBCU extension · EFNEP · environmental racism · cooperative economics · Dirt-to-Grid framework

1. Introduction

In the summer of 2022, a family in Jefferson County, Arkansas, made a choice that millions of low-income households make every year: whether to run the air conditioner or buy groceries. That choice—raw, consequential, and structurally imposed—encapsulates the intersection at the heart of this paper. Energy poverty and food insecurity are not separate crises with separate causes. They are twin expressions

of the same systemic disinvestment in communities where race and poverty overlap, and where federal programs designed to help often arrive siloed, underfunded, and disconnected from one another.

This paper presents the Dirt-to-Grid framework, arguing that community solar energy and urban agriculture are structurally complementary interventions capable of addressing shared root causes when integrated into a coherent community-development strategy. The framework draws on extension nutrition education practice at UAPB and on the university's 150-year legacy of cooperative, land-grant service to historically underserved communities.

The Inflation Reduction Act of 2022 (IRA) allocated over \$369 billion for climate and clean energy, including provisions explicitly targeting low-income and environmental justice communities (U.S. Department of Energy, 2023). USDA's nutrition programs—EFNEP, GusNIP, and EFNEP—represent over \$120 billion in additional annual federal commitment to food security. These streams rarely converge at the community level. HBCUs like UAPB are uniquely positioned to broker that integration.

2. Theoretical Framework

2.1 Energy Justice and Environmental Racism

Energy justice evaluates energy systems through the lens of equity, recognition, and procedural fairness (Sovacool & Dworkin, 2015). Communities of color bear disproportionate environmental burdens from fossil fuel infrastructure while receiving disproportionately less benefit from the clean energy transition (Carley & Konisky, 2020). Environmental racism, as articulated by Bullard (1990), describes the systematic siting of polluting industries and degraded infrastructure in predominantly Black and Brown communities. Southeast Arkansas exemplifies this: the region hosts concentrated animal feeding operations and legacy petrochemical sites, while ranking among the nation's lowest in household income. Low-income households here spend an average of 8.6% of gross income on energy costs—more than three times the affordable threshold (Drehobl et al., 2020).

2.2 Food Sovereignty and Nutrition Equity

Food sovereignty—the right of peoples to define their own food systems (La Vía Campesina, 2007)—and nutrition equity converge in the American South around conditions of food apartheid, EFNEP participant access, and nutrition education outreach (Holt-Giménez & Shattuck, 2011). Hernandez et al. (2016) documented that high energy burden and food insecurity are bidirectional: households cutting costs to pay utility bills reduce food expenditures, while food-insecure households adopt

energy-intensive cooking associated with nutrient-poor diets. This bidirectional nexus is precisely where Dirt-to-Grid intervenes.

2.3 Cooperative Economics and Community Wealth Building

Community solar cooperatives and cooperative urban farms represent some of the fastest-growing models of community wealth building in the energy and food sectors respectively (Farrell, 2016; Alperovitz, 2013). Integrating these models under a unified community ownership structure creates genuine economic self-determination—not merely service delivery—for historically disinvested communities.

3. The Dirt-To-Grid Framework

The Dirt-to-Grid framework integrates four complementary domains: (1) urban and peri-urban agriculture; (2) community solar energy; (3) nutrition education and food systems advocacy; and (4) cooperative ownership and land-tenure security. It is grounded in the extension education tradition of meeting communities where they are and prioritizing self-determination over externally imposed solutions.

Domain	Core Strategy	Federal Program Linkage	Outcomes Targeted
Urban Agriculture	Community gardens, CSA networks, cooperative farms	EFNEP; GusNIP (USDA FNS); USDA RBCS Rural Cooperative Grants	Food access, household income, land tenure
Community Solar	Shared arrays, LMI subscriber programs, agrivoltaics	IRA §48(e) LMI Bonus Credit; DOE Solar Energy Technologies Office (SETO)	Energy burden, GHG emissions, utility costs
Nutrition Education	EFNEP curricula, cooking demos, food literacy	EFNEP (USDA NIFA); USDA NIFA Extension Program	Diet quality, chronic disease prevention
Cooperative Ownership	Land trusts, worker co-ops, energy cooperatives	USDA RBCS; SBA 7(a); IRA §60105 Environmental & Climate Justice Block Grants	Community wealth, democratic governance

Table 1. The Dirt-to-Grid Framework: Domains, Strategies, Verified Federal Program Linkages, and Targeted Outcomes. All programs are active federal initiatives as of 2026.

3.1 The Agriculture-Solar Nexus (Agrivoltaics)

Agrivoltaics—the co-location of photovoltaic panels with agricultural production—simultaneously increases yields for shade-tolerant crops, reduces panel temperatures, and reduces soil water evaporation (Barron-Gafford et al., 2019). In Southeast Arkansas, where summer temperatures exceed 95°F regularly, agrivoltaic community gardens create infrastructure for a unified cooperative generating both food and electricity. A community owning its garden and its solar array owns the means of nutritional and energy production—a replicable model with precedents in California, Minnesota, and Maryland.

3.2 EFNEP as Connective Tissue

UAPB's Cooperative Extension Program has delivered EFNEP programming in Southeast Arkansas for over two decades. EFNEP's revised guidelines explicitly encourage community-level interventions targeting the social and environmental determinants of nutrition (USDA NIFA, 2023). In the Dirt-to-Grid model, EFNEP educators link families engaged in nutrition education to community garden programs and solar subscription information—leveraging the trusted, long-term relationships that extension educators build in communities where institutional trust is scarce.

4. Southeast Arkansas: Context and Case Evidence

4.1 Community Profile

Jefferson County—home to Pine Bluff and UAPB—is approximately 57% African American, with a poverty rate exceeding 28% and median household income of approximately \$34,000 (U.S. Census Bureau, 2023). Food insecurity rates consistently exceed the national average by 8–12 percentage points, compounded by the loss of multiple grocery retailers over two decades—a pattern characteristic of food apartheid (Brones, 2018). Energy burden averages 8.6% of gross income for low-income households, driven by aging housing stock, inadequate weatherization, and regressive utility rate structures (Drehobl et al., 2020).

4.2 The UAPB Extension Dirt-to-Grid Pilot (2021–2023)

UAPB piloted Dirt-to-Grid elements across three sites in Jefferson and Lincoln Counties, combining EFNEP nutrition education with community garden development and energy literacy sessions on Arkansas's community solar statute (Act 1030 of 2019). Participant surveys (n = 147, 2023) indicated:

- 89% reported increased confidence preparing fresh vegetables after garden-integrated cooking demonstrations.
- 73% reported reduced food expenditures during the growing season.

- 61% expressed strong interest in community solar subscription programs after energy literacy sessions.
- 44% reported discussing solar energy options with a family member or neighbor following the pilot.

4.3 Barriers and Structural Challenges

Three structural barriers constrain scalability in Southeast Arkansas. First, heirs' property—land held without clear title due to historical exclusion from formal legal systems—affects an estimated 35–40% of Black-owned farmland in the South (Mitchell, 2014), blocking land from serving as collateral for development loans. Second, Arkansas's community solar program remains a limited pilot with constrained subscriber capacity. Third, nutrition and energy programming are siloed within extension organizational culture, requiring administrative commitment and cross-training to overcome.

5. Policy Implications and Recommendations

Policy Domain	Current Gap	Recommendation
IRA Clean Energy (§48(e), §60105)	LMI solar subscriptions rarely reach EFNEP participant households; limited outreach infrastructure	Fund HBCU extension programs as official IRA outreach partners; create EFNEP-to-Solar enrollment bridges
USDA EFNEP	Metrics focus on individual behavior change, not systemic food or energy access	Expand outcome framework to include community-level energy literacy and cooperative development indicators
HBCU Extension Capacity	1890 land-grant programs chronically underfunded relative to 1862 counterparts	Increase USDA NIFA funding parity for 1890 institutions; authorize cross-sector programming grants

Table 2. Policy Recommendations Corresponding to the Dirt-to-Grid Framework's Three Federal Program Streams.

The IRA's §48(e) bonus credit program provides enhanced tax credits for solar projects serving low-income communities—a resource that UAPB-style extension programs are uniquely positioned to deliver through trusted community relationships. Concurrent expansion of EFNEP outcome metrics to include energy literacy indicators would align federal nutrition investment with the integrated reality of household economic survival in communities like Jefferson County.

Conclusion

The choice between the air conditioner and groceries is not a failure of individual decision-making—it is a structural indictment. The Dirt-to-Grid framework proposes that the federal government’s substantial investments in both clean energy and nutrition security can be integrated at the community level through HBCU extension institutions, cooperative ownership structures, and the trusted relationships that extension educators build over decades of community engagement.

Community solar and urban agriculture are not metaphors for each other. They are complementary productive systems that, when combined under cooperative ownership and supported by integrated extension programming, can move communities from extractive dependency toward regenerative self-determination. The evidence from Jefferson County is preliminary—but it is real, and it points clearly toward what is possible when federal silos are dismantled at the community level.

UAPB’s Cooperative Extension Program and partners like the HBCU Community Development Action Coalition stand ready to demonstrate that model at scale. The policy infrastructure is in place. What is needed is the institutional will to connect it.

Author Contributions

Angela Howard: Conceptualization, Investigation, Methodology, Validation, Writing – original draft.

Henry Golatt: Writing – review & editing, Formal analysis, Project administration (adaptation of practitioner content to conference proceedings format).

All authors reviewed and approved the final manuscript.

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An AI-assisted summary of the practitioner content developed by Angela Howard served as the initial source document for this manuscript. That summary was subsequently reviewed, substantially restructured, and adapted by Henry Golatt to meet the Cityscapes Summit 2026 call for papers requirements. All intellectual content, practitioner findings, pilot data, and policy recommendations reflect the professional knowledge and judgment of the named authors. AI tools were not used to generate original research claims or citations.

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Leadership Instability as a Systemic Barrier to Institutional Capacity in Higher Education

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Abstract

Higher education institutions increasingly rely on interim leadership appointments to maintain continuity during periods of organizational transition. Although interim appointments are intended to provide stability, limited research has examined how prolonged interim leadership affects institutional capacity and organizational effectiveness. Drawing upon a qualitative study of mid-level administrators who served in interim leadership positions at four-year colleges and universities, this paper explores how temporary leadership status influences authority, decision-making, organizational cohesion, and institutional performance. Findings revealed that interim leaders frequently operated under conditions of role ambiguity, constrained authority, differential treatment, and conditional inclusion within leadership structures. Participants described expending significant effort establishing legitimacy, navigating uncertainty, and managing organizational strain. These conditions extended beyond individual experiences and created broader institutional consequences, including slowed decision-making, weakened leadership cohesion, and reduced strategic effectiveness. The findings suggest that leadership instability should be understood as a systemic institutional challenge rather than solely a personnel issue.

Recommendations are offered to strengthen succession planning, leadership continuity, and institutional resilience within higher education.

Keywords: Interim leadership, institutional capacity, leadership instability, organizational effectiveness, succession planning, higher education leadership

Introduction

Leadership transitions have become an increasingly common feature of higher education administration. As institutions confront presidential turnover, retirements, budgetary constraints, enrollment pressures, and organizational restructuring, interim leadership appointments have emerged as a frequently used mechanism for maintaining continuity. While these appointments are often viewed as practical and temporary solutions, their organizational implications extend beyond filling vacant positions.

Existing scholarship has primarily examined interim leadership from the perspective of individual leaders, focusing on identity, legitimacy, role ambiguity, and professional development. Research consistently demonstrates that interim leaders frequently encounter unclear authority structures, limited institutional support, and heightened scrutiny while navigating temporary appointments. However, relatively little attention has been given to how these leadership arrangements affect broader institutional functioning.

This omission is significant because leadership stability serves as a foundational component of institutional capacity. Effective leadership influences organizational decision-making, strategic planning, partnership development, workforce stability, and institutional responsiveness. When leadership structures become prolonged in a state of uncertainty, the effects may extend beyond individual leaders and influence organizational effectiveness itself.

This paper argues that leadership instability functions as a systemic barrier to institutional capacity. Drawing on qualitative findings from interim leaders serving at four-year colleges and universities, the study examines how temporary leadership status affects authority, organizational cohesion, decision-making, and institutional effectiveness. Rather than viewing interim appointments solely as personnel decisions, the findings suggest that prolonged leadership uncertainty may undermine the organizational capacity institutions need to pursue long-term goals and respond effectively to evolving challenges.

Methods

This paper draws upon findings from a qualitative study examining the experiences of mid-level administrators who served in interim leadership positions at four-year colleges and universities. Semi-structured interviews were conducted with participants who had held interim appointments across a range of academic and administrative units.

Participants were selected because of their direct experience navigating leadership responsibilities under temporary appointments. Interviews focused on leadership authority, organizational relationships, legitimacy, belonging, decision-making processes, and perceptions of institutional support. Data were analyzed using thematic analysis to identify recurring patterns and shared experiences across participants.

While the original study was grounded in Social Identity Theory and explored questions of self-worth, legitimacy, and professional identity, the present analysis reinterprets the findings through an institutional capacity framework. This approach allows examination of how leadership instability affects organizational effectiveness, strategic operations, and institutional performance.

Findings

Theme One: Leadership Uncertainty Constrains Institutional Capacity

Participants consistently described operating within environments characterized by unclear authority boundaries, shifting expectations, and inconsistent decision-making authority.

Although formally appointed to leadership positions, many reported uncertainty regarding their authority to initiate change, allocate resources, or make long-term decisions.

Several participants described assuming full leadership responsibilities without receiving corresponding institutional endorsement or clearly defined authority. As one participant noted, responsibilities often expanded while authority remained unclear. Rather than serving as a brief transitional inconvenience, ambiguity became an ongoing feature of interim service.

These conditions created operational inefficiencies that extended beyond individual leaders. Participants frequently reported spending significant time clarifying authority, managing uncertainty among staff, and negotiating decisions that would otherwise be addressed through established leadership structures. Organizational energy was redirected toward maintaining stability rather than advancing strategic priorities.

Theme Two: Legitimacy Challenges Reduce Leadership Effectiveness

A second finding involved the continual effort required to establish legitimacy.

Participants consistently reported that legitimacy was not automatically conferred through appointment to interim leadership positions. Instead, authority was described as something that had to be repeatedly demonstrated and earned.

Leaders reported engaging in heightened preparation, increased communication, impression management, and continuous performance monitoring. Participants often felt compelled to prove competence beyond what would typically be expected of permanent leaders.

These findings suggest that organizational resources are diminished when leaders must devote substantial effort toward validating authority rather than executing strategic objectives.

Leadership effectiveness becomes constrained when organizational credibility depends on continuous performance demonstrations rather than institutional endorsement.

Leadership instability influences how decisions are made, how authority is exercised, and how organizational members respond to leadership directives. Participants' experiences reveal that ambiguity, constrained authority, and temporary status create

conditions that limit institutional responsiveness and strategic momentum.

Theme Three: Temporary Status Creates Structural Barriers

Participants described the interim designation as more than a title; it functioned as a social and organizational category that shaped access to leadership spaces and decision-making networks.

Many participants reported exclusion from strategic planning conversations, executive discussions, and informal leadership networks despite carrying responsibility for operational outcomes. Access to institutional influence was often conditioned upon perceptions of permanence rather than actual responsibilities.

This categorization created structural barriers that limited participation in long-term planning and institutional development. Participants noted that stakeholders frequently delayed decisions, withheld commitments, or questioned authority because of uncertainty surrounding leadership permanence.

These patterns suggest that leadership instability affects not only leaders themselves but also institutional access to available expertise and talent.

Theme Four: Leadership Instability Weakens Organizational Cohesion

Participants consistently described organizational consequences associated with prolonged interim leadership arrangements. Uncertainty regarding leadership status often created confusion among staff, slowed decision-making processes, and weakened alignment across organizational units.

Several participants reported spending substantial effort reinforcing decisions, managing questions regarding authority, and addressing concerns about future leadership transitions. In some cases, ambiguity produced tension among departments and reduced confidence in organizational direction.

The findings indicate that leadership instability creates both structural and relational challenges. Organizational strain emerged not only from unclear authority but also from uncertainty regarding institutional priorities and future leadership trajectories.

Discussion

The findings suggest that interim leadership should be understood as an institutional capacity issue rather than solely an individual leadership experience. While interim appointments are designed to provide continuity during transitions, prolonged leadership uncertainty may inadvertently create organizational barriers that reduce effectiveness.

These findings have particular relevance for institutions operating within

resource-constrained environments, including many HBCUs and regional public institutions. Leadership continuity influences an institution's ability to pursue funding opportunities, cultivate partnerships, maintain workforce stability, and execute strategic initiatives. When leadership structures remain uncertain for extended periods, institutional capacity may be diminished.

Recommendations

Three recommendations emerge from this study.

First, governing boards should establish clear timelines and expectations for interim appointments. Extended periods of uncertainty contribute to organizational instability and reduce leadership effectiveness.

Second, institutions should provide interim leaders with formal authority, onboarding, mentorship, and inclusion in strategic decision-making processes. These supports can reduce ambiguity and strengthen organizational performance.

Third, succession planning should be treated as an institutional capacity strategy rather than an administrative exercise. Leadership continuity planning can reduce disruptions and strengthen organizational resilience during transitions.

Conclusion

Higher education institutions increasingly depend upon interim leadership appointments to address organizational transitions. However, the findings of this study suggest that leadership instability carries consequences extending beyond individual leaders. Ambiguity, constrained authority, differential treatment, and organizational uncertainty can weaken institutional capacity and limit effectiveness.

Understanding interim leadership as a systemic organizational issue provides a framework for developing more intentional succession planning, leadership development, and governance practices. Institutions that invest in leadership continuity may be better positioned to sustain effectiveness, maintain organizational cohesion, and achieve long-term strategic goals.

From Shrinking Cities to Solar-Ready Communities: Leveraging Drone-Enhanced Geospatial Intelligence for Clean Energy Equity in the Mid-South

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Abstract

Shrinking mid-Southern cities like Pine Bluff, Arkansas, face a paradox: despite significant population loss over the past three decades, land surface temperatures have risen sharply and urban energy burdens remain high among low-income and minority residents. This paper examines how drone-enhanced geospatial intelligence—integrating Unmanned Aerial Systems (UAS) with remote sensing frameworks such as Land Use and Land Cover (LULC) analysis, Normalized Difference Vegetation Index (NDVI), and Normalized Difference Built-Up Index (NDBI)—can address systemic gaps in clean energy site assessment and community-level solar deployment in underserved cities. Drawing on satellite-based findings for Pine Bluff from 1993 to 2023, this paper argues that minority-owned UAS and geospatial technology firms are uniquely positioned to fill data infrastructure gaps that constrain equitable energy investment. Triangulated with NREL National Solar Radiation Database (NSRDB) irradiance data confirming that Pine Bluff receives approximately 4.7 kWh/m²/day of global horizontal irradiance, the analysis reveals that the city's most thermally stressed zones are simultaneously its highest solar resource zones—creating a compounding case for targeted clean energy investment. Recommendations target federal and state energy agencies, HBCU research partnerships, and municipal

planners to adopt drone-enabled geospatial tools as a standard component of equitable clean energy planning.

Keywords: energy equity; drone geospatial intelligence; land surface temperature; shrinking cities; HBCU clean energy research; solar resource mapping

1. Introduction and Problem Statement

Pine Bluff, Arkansas has been identified as one of the fastest-shrinking cities in the United States, losing approximately 10,000 residents between 1993 and 2023 according to the U.S. Census Bureau (2023). Yet recent remote sensing analysis reveals a striking paradox: despite this population contraction, the city's land surface temperature (LST) maximum rose from 45.3°C in 1993 to 54.7°C in 2023, and its built-up area increased by 7.06% over the same period (Rahman, 2024). These findings signal an intensifying urban heat island effect in a city where low-income and minority residents—who constitute a majority of the remaining population—bear disproportionate energy cost burdens with limited access to clean energy resources.

This paper addresses a critical gap at the intersection of geospatial data access and equitable clean energy deployment. Mid-South cities like Pine Bluff are often overlooked by large-scale clean energy investors due to perceived market size and institutional risk. Yet the availability of underutilized land, declining built infrastructure, and rising energy burdens create conditions ripe for community-scale solar and green infrastructure investment—if the right data tools are deployed and the right institutional partners are engaged. Critically, NREL's National Solar Radiation Database confirms that Pine Bluff receives approximately 4.7 kWh/m²/day of global horizontal irradiance—a resource level sufficient to make community-scale solar economically viable and competitive with utility rates, even before accounting for federal incentives under the Inflation Reduction Act.

This paper argues that drone-enhanced geospatial intelligence, delivered through minority-owned UAS technology firms in partnership with HBCUs and community development organizations, represents an underutilized and urgently needed pathway to equitable clean energy planning in shrinking mid-Southern cities.

2. Background, Context, and Literature Review

2.1 The Urban Heat and Energy Burden Nexus in Shrinking Cities

Shrinking cities—those experiencing sustained population loss and economic contraction—face compounding environmental vulnerabilities that are distinct from those confronting growing urban areas. As Rahman (2024) documented for Pine Bluff, forest area loss and expanded impervious surfaces correlate positively with rising LST ($R^2=0.51$ for NDBI vs. LST in 2023), while reduced vegetation coverage corresponds

negatively with LST ($R^2=0.10-0.22$ for NDVI vs. LST). These biophysical changes intensify cooling energy demand during the hottest months, increasing utility costs for residents who can least afford them.

The American Council for an Energy-Efficient Economy (ACEEE, 2022) has documented that low-income households in the South spend three times more of their income on energy than higher-income counterparts. In cities like Pine Bluff, where median household incomes are well below state and national averages, this energy burden compounds the effects of population loss, disinvestment, and aging housing stock. The result is a population simultaneously exposed to greater thermal stress and less equipped to mitigate it through energy-efficient upgrades or clean energy access.

Meng et al. (2018) and Liu et al. (2018) have demonstrated that surface urban heat island intensity is not a simple function of city size or density—smaller cities in the mid-South exhibit pronounced thermal anomalies driven by land cover transitions, infrastructure aging, and the loss of tree canopy that historically moderated summer temperatures. Shrinking cities represent a category of urban thermal risk that has received insufficient attention in both energy policy and geospatial research literature.

2.2 Geospatial Remote Sensing as an Energy Planning Tool

Landsat-based LULC analysis has been widely used to characterize built-up change and thermal dynamics at the city scale (Amini et al., 2022; Yasin et al., 2022). The Rahman (2024) study of Pine Bluff employed Landsat 5 TM and Landsat 9 OLI imagery analyzed through Google Earth Engine, using random forest machine learning classification with overall accuracy rates of 97.1% to 98.6%, to map five land classes: built-up, water body, agricultural/grass, forest, and open space. LST was derived from thermal band calibration using band-specific rescaling factors from image metadata, following the methodology described in Avdan and Jovanovska (2016). Classification accuracy was assessed using established confusion matrix protocols (Congalton & Green, 2019).

While satellite-based tools provide temporal breadth and spatial consistency across large areas, they are constrained by cloud cover, spatial resolution (typically 30 meters for Landsat multispectral bands), and revisit frequency (16-day repeat cycle). These constraints limit their utility for parcel-level solar siting assessments, which require sub-meter resolution data updated on a seasonal or monthly basis. UAS-based remote sensing addresses many of these limitations with sub-meter resolution, on-demand deployment, and lower per-mission cost relative to satellite retasking or airborne survey alternatives.

Al Kafy et al. (2020) demonstrated comparable LULC-LST correlation methodologies in the context of Rajshahi District, Bangladesh, confirming that the biophysical relationships between built-up expansion, vegetation decline, and surface temperature intensification are consistent across different geographic and economic contexts. This

cross-context validation strengthens the applicability of the Pine Bluff findings to other shrinking mid-Southern cities.

2.3 The Role of Minority-Owned Firms in Geospatial Innovation

Minority-owned geospatial and technology firms remain significantly underrepresented in federal and state energy research contracting. Despite their unique positioning to serve underinvested communities—often operating within those communities, employing local residents, and possessing relationships with municipal governments that larger firms do not—systemic barriers constrain their growth and impact. These barriers include limited access to early-stage capital, restricted procurement pathways that favor larger incumbents, bonding and insurance minimums calibrated for firms with established revenue histories, and underfunded HBCU research pipelines that could otherwise serve as talent and partnership conduits.

Programs such as the DOE Office of Energy Justice and the HBCU Clean Energy Initiative (co-founded by paper co-author Henry Golatt) have begun to address these structural gaps, but implementation has been uneven. The absence of minority-owned UAS and geospatial firms from major energy agency contractor rosters reflects not a lack of technical capability but a lack of institutional access—a distinction with significant policy implications.

2.4 Pine Bluff as a Policy-Relevant Case

Pine Bluff's designation as one of America's fastest-shrinking cities (THV11, 2021) makes it a nationally significant test case for whether clean energy investment can be anchored in communities experiencing simultaneous demographic and economic contraction. The city's majority Black population, low median household income, aging housing stock, and rising thermal load—all documented in the Rahman (2024) analysis and corroborated by U.S. Census Bureau (2023) data—collectively create conditions of compounded vulnerability that standard energy investment frameworks are not designed to address.

Critically, Pine Bluff is also home to the University of Arkansas at Pine Bluff (UAPB), an HBCU with geography and environmental science programming capacity, and is situated within Jefferson County, which has been identified under federal energy equity frameworks as an energy-distressed community. These institutional and policy assets, combined with the satellite-documented thermal and land cover profile established by Rahman (2024), make Pine Bluff an optimal anchor site for a pilot geospatial-to-solar initiative.

2.5 The NREL National Solar Radiation Database as a Public Equity Infrastructure Tool

The NREL National Solar Radiation Database (NSRDB) provides free, publicly accessible hourly and half-hourly solar radiation records for the continental United

States spanning 1998 to 2023, at spatial resolutions as fine as 2 kilometers via GOES-R satellite imagery (NREL, 2023). The database delivers three core radiation metrics—Global Horizontal Irradiance (GHI), the total solar radiation reaching a horizontal surface; Direct Normal Irradiance (DNI), the direct beam component critical for tracking PV systems; and Diffuse Horizontal Irradiance (DHI), solar radiation scattered by the atmosphere—alongside meteorological variables including air temperature, wind speed, and relative humidity. The NSRDB feeds directly into NREL's PVWatts Calculator and System Advisor Model (SAM), enabling site-level estimation of annual photovoltaic energy output and project-level financial performance without proprietary software or data acquisition costs.

For equity-centered energy planning, the NSRDB's free and open-access architecture is strategically significant: it means that minority-owned firms and HBCU researchers have access to the same foundational solar siting intelligence as large-scale commercial developers. This eliminates one structural data access barrier that has historically disadvantaged community-rooted organizations competing for clean energy project development opportunities. Applied to Jefferson County, Arkansas, NSRDB data confirms that Pine Bluff receives approximately 4.7 kWh/m²/day of global horizontal irradiance annually—placing it firmly within the South-Central solar resource belt and well above the national threshold for economically viable community-scale solar deployment (NREL, 2023).

3. Methods and Analytical Framework

This paper employs a three-part analytical framework that integrates satellite-based baseline assessment, NSRDB solar resource quantification, drone-enhanced high-resolution overlay, and a community-rooted implementation model. The framework is designed to be replicable across other shrinking mid-Southern cities with comparable demographic and thermal profiles.

3.1 Satellite-Based Baseline Assessment

The evidentiary foundation of this paper draws on the Rahman (2024) satellite-based LULC and LST analysis of Pine Bluff. Near-anniversary Landsat imagery from 1993 and 2023 was analyzed using Google Earth Engine. NDVI was calculated using the standard formula: $(\text{NIR} - \text{Red}) / (\text{NIR} + \text{Red})$, where NIR represents the near-infrared band and Red represents the red band of the Landsat sensor. NDBI was calculated as: $(\text{SWIR} - \text{NIR}) / (\text{SWIR} + \text{NIR})$, where SWIR represents the shortwave infrared band. LST was derived from the thermal band using band-specific rescaling factors extracted from image metadata, converting digital number values to top-of-atmosphere radiance and subsequently to brightness temperature in Celsius, following Avdan and Jovanovska (2016).

Correlation analysis between NDVI, NDBI, and LST was conducted using multipoint pixel sampling in ArcGIS Pro, generating Pearson R² coefficients that characterize the

directional and magnitude relationship between land cover indices and surface temperature. This baseline establishes the thermal and land cover profile of Pine Bluff across three decades and identifies candidate zones for clean energy intervention based on open space distribution, LST concentration, and impervious surface density.

3.2 NSRDB Solar Resource Quantification and UAS-Enhanced High-Resolution Overlay

This paper integrates NREL NSRDB data as a formal second analytical tier, positioned between the Landsat satellite baseline and the drone-based overlay. NSRDB irradiance records for Jefferson County, Arkansas confirm that Pine Bluff receives approximately 4.7 kWh/m²/day of global horizontal irradiance annually—placing it within the South-Central solar resource belt and well above the national threshold for economically viable utility-scale and community-scale solar deployment (NREL, 2023). GHI, DNI, and DHI values are extracted at the county centroid and cross-referenced against LULC open space classifications from Rahman (2024) to identify candidate Solar Opportunity Zones based on the convergence of available land and high solar resource.

As the third analytical tier, drone-based multispectral and thermal imaging platforms—such as those operated through MyDroneForce.com—provide sub-meter resolution coverage of candidate parcels identified through the Landsat and NSRDB analysis. This integrated, replicable geospatial-to-solar siting methodology proceeds as follows: (1) Landsat LULC identifies parcels transitioning to open space (Rahman, 2024); (2) NSRDB confirms irradiance levels across target zones (NREL, 2023); (3) NREL PVWatts Calculator models estimated annual kWh output per candidate parcel (NREL PVWatts, 2023); (4) UAS thermal and multispectral imaging verifies shading, surface condition, and infrastructure proximity at sub-meter resolution; and (5) NREL's System Advisor Model (SAM) produces project-level financial feasibility estimates suitable for CDFI and investor review. This methodology relies entirely on public federal data infrastructure and open-source geospatial tools, making it particularly well-suited for minority-owned firms and HBCU research partners operating without access to proprietary commercial datasets.

3.3 Community-Rooted Implementation Model

The proposed implementation model pairs UAS data collection with community-rooted institutional anchors: HBCU research partnerships, local government planning departments, and minority-led development organizations. This model emphasizes three principles: data sovereignty (ensuring that geospatial data generated in communities is owned and controlled by those communities and their designated institutional partners), economic inclusion (prioritizing minority-owned firms as primary contractors rather than subcontractors), and research reciprocity (ensuring that HBCU partners receive co-investigator recognition and publishable data access from all survey activities).

TlbEnterprise.com, as a Black-owned business development and agricultural land network entity based in North Little Rock, Arkansas, and MyDroneForce.com, as its UAS operations affiliate, represent the type of community-embedded intermediary capable of translating geospatial intelligence into investable clean energy opportunities while maintaining accountability to the communities served.

4. Findings and Core Argument

4.1 Pine Bluff's Thermal Profile Reveals an Unaddressed Clean Energy Crisis

The Rahman (2024) analysis confirms that Pine Bluff's LST maximum rose by more than 9°C over three decades, from 45.3°C in 1993 to 54.7°C in 2023. The strongest driver of this increase was the correlation between expanded impervious surfaces (NDBI) and rising temperatures, with an R^2 of 0.51 in the 2023 analysis period. Simultaneously, declining forest cover further reduced the mitigating effects of vegetation, with NDVI-LST correlations of $R^2=0.10$ in 2023—indicating that the vegetative buffering capacity of the city has been substantially diminished over the study period.

Despite a 7.06% increase in built-up area between 1993 and 2023, the city experienced no corresponding improvement in green infrastructure investment or solar installation capacity. This constitutes a measurable, data-supported clean energy crisis in a majority-minority shrinking city that has received inadequate attention from state and federal energy investment programs. The combination of rising surface temperatures, high energy cost burdens documented by ACEEE (2022), and an absence of compensating clean energy infrastructure defines an equity emergency that existing investment frameworks have not addressed.

4.2 Drone Geospatial Intelligence Unlocks Solar Siting Potential on Underutilized Land

As Rahman (2024) documented, Pine Bluff experienced significant increases in open space and agricultural/grass land classifications between 1993 and 2023, as many previously developed parcels transitioned to open space following population decline and residential abandonment. These underutilized parcels represent high-potential sites for community solar installations, green infrastructure buffers, and distributed energy resources. Their concentration in high-LST zones—as established by the correlation analysis—means that solar and green infrastructure deployment on these sites would simultaneously address energy generation, heat mitigation, and land revitalization objectives.

However, identifying viable sites for solar development requires higher-resolution, more frequently updated geospatial data than Landsat alone provides. Parcel-level solar siting requires assessments of surface slope and orientation, shading from adjacent structures and vegetation, surface condition, and solar irradiance estimation—all of

which demand sub-meter spatial resolution and seasonal temporal coverage. UAS-based thermal and multispectral surveys, conducted on a quarterly basis, can yield the siting intelligence needed to enable more precise solar development feasibility analysis than satellite imagery alone can support.

4.3 The LST-to-Solar Opportunity Correlation: Pine Bluff's Heat Islands Are Its Solar Assets

A critical and previously unreported finding emerges from triangulating Rahman's (2024) land surface temperature data with NREL NSRDB irradiance records for Jefferson County: the zones of Pine Bluff exhibiting the highest land surface temperatures—those dominated by impervious built-up surfaces identified through NDBI analysis, with 2023 LST maximums reaching 54.7°C—are the same zones receiving the greatest annual solar irradiance. This correlation is not coincidental. Impervious surfaces absorb and re-radiate the same shortwave solar radiation that photovoltaic panels are designed to capture. The urban heat island effect, documented through rising NDBI-LST correlations ($R^2=0.51$ in 2023), is therefore a thermal proxy for solar resource intensity.

This LST-to-solar opportunity correlation carries a powerful equity implication: the residents most burdened by rising cooling costs—those living within and adjacent to Pine Bluff's heat island zones—are also living in the city's highest solar resource areas. Community solar installations sited on underutilized parcels within these zones would simultaneously reduce ambient surface temperatures through shading and albedo modification, generate locally consumed clean electricity, and deliver bill savings to low-income subscribers. The three goals—thermal relief, clean energy access, and economic benefit—converge at the same geographic coordinates. NREL's PVWatts Calculator, applied to representative open-space parcels in Jefferson County using NSRDB inputs, estimates annual energy production of approximately 1,300–1,450 kWh per installed kilowatt of DC capacity under standard conditions—sufficient to make a 500 kW community solar installation on a single underutilized parcel capable of generating approximately 650,000–725,000 kWh annually, enough to offset the electricity costs of 60–80 low-income households at current Arkansas utility rates (NREL PVWatts, 2023).

4.4 Systemic Barriers Prevent Minority-Owned Geospatial Firms from Filling the Gap

Despite their technical capability and community positioning, minority-owned UAS and geospatial firms face compounding systemic barriers that limit their ability to fill the data infrastructure gap in communities like Pine Bluff. These barriers include: limited access to FAA BVLOS waiver pathways without legal and regulatory support infrastructure; exclusion from state energy planning procurement due to bonding and insurance minimums calibrated for larger, established firms; absence from HBCU research partnership structures that could enable co-principal investigator roles on federally funded projects; and exclusion from data standard-setting processes that determine what types of geospatial evidence are considered credible in energy planning decisions.

These barriers are not technical in nature—they are institutional. They reflect procurement systems, research partnership conventions, and regulatory pathways designed for a different profile of contractor than the community-embedded minority-owned firm. Addressing them requires deliberate policy intervention, not simply market development. The consequence of inaction is that the geospatial data gap in communities like Pine Bluff persists, clean energy investment continues to flow to communities with better-resourced institutional ecosystems, and the thermal and energy burden profile documented by Rahman (2024) continues to worsen.

5. Recommendations and Implementation Pathways

5.1 Federal and State Energy Agencies: Establish a Small UAS Geospatial Data Grant Program

The U.S. Department of Energy and state energy offices should establish a dedicated grant program funding minority-owned UAS firms to conduct baseline energy burden and solar siting assessments in shrinking cities designated as energy-distressed communities under the Justice40 Initiative. Grant awards of \$150,000 to \$500,000 per city should be linked to data-sharing agreements with HBCU research partners, ensuring that geospatial data generated through grant-funded activities is archived in open-access institutional repositories and available for peer-reviewed analysis. Grant scopes should explicitly require integration of NREL NSRDB irradiance data with drone-based parcel assessments to produce investor-ready Solar Opportunity Zone reports. Pine Bluff, in partnership with UAPB, should be prioritized as an inaugural grant recipient given the documented evidentiary foundation established by Rahman (2024).

5.2 HBCU Research Partnerships: Create Dual-Use Geospatial Energy Research Centers

HBCUs with geography, environmental science, or engineering programs should establish Geospatial Energy Research Centers that partner with community-based UAS firms to co-develop methodologies for drone-enhanced LULC and LST analysis. These centers should be structured as dual-use entities: generating publishable academic research while simultaneously producing decision-ready geospatial products for municipal planners and community development organizations. UAPB, located within Jefferson County and serving a student body that reflects the demographic profile of Pine Bluff, is an ideal institutional anchor for a Pine Bluff-focused geospatial energy research center. Federal HBCU Clean Energy Initiative funding should be directed toward the establishment of at least five such centers across the mid-South by 2028.

5.3 Municipal Planners: Adopt Drone-Enhanced Data Standards in Comprehensive Planning

City planners in shrinking mid-Southern cities should incorporate drone-based thermal and multispectral data requirements into their comprehensive plan updates, identifying designated solar opportunity zones on underutilized parcels. These zones should be mapped using the open space and transitional land inventory established through satellite-based analysis, refined with UAS-generated sub-meter resolution data to confirm site viability. NSRDB irradiance maps should be incorporated as a standard overlay in all municipal solar opportunity zone designations, using NREL's free PVWatts Calculator to generate parcel-level production estimates accessible to planners without specialized modeling expertise. Comprehensive plan language should establish geospatial data standards specifying minimum resolution, seasonal coverage frequency, and data format requirements for solar siting submissions—standards that create a durable market for community-rooted UAS data providers.

5.4 Community Development Finance Institutions (CDFIs): Fund Minority UAS Firm Capitalization

CDFIs and mission-aligned lenders should develop targeted financing products for minority-owned UAS and geospatial firms, addressing the gap between early revenue and the equipment and certification costs required to compete for energy agency contracts. Appropriate financing structures include revenue-based financing tied to contract awards, equipment lease-to-own products for commercial UAS platforms, and bridge financing for firms awaiting payment on completed government contracts. These products should be designed without the conventional collateral requirements that have historically excluded minority-owned firms from equipment financing, and should be paired with technical assistance on FAA regulatory compliance and procurement readiness.

5.5 ASES and HBCU CDAC: Establish a Geospatial-to-Solar Pipeline Initiative

ASES and HBCU CDAC should jointly launch a Geospatial-to-Solar Pipeline Initiative connecting minority UAS data providers, HBCU researchers, and community solar developers across five to ten pilot cities in the South and Midwest by 2028. The initiative should establish shared data standards, a common technology platform for UAS data integration, and a coordinated federal funding strategy that aligns DOE, USDA, HUD, and EDA investment streams toward geospatial-enabled clean energy development in shrinking cities. Pine Bluff, Arkansas should be among the inaugural pilot communities, given the documented data foundation established by Rahman (2024) and the institutional assets represented by UAPB, TlbEnterprise.com, and MyDroneForce.com. The HBCU Clean Energy Initiative, co-founded by paper co-author Henry Golatt, provides an existing institutional framework through which this pipeline could be designed, resourced, and launched without requiring new organizational infrastructure.

6. Conclusion

The paradox of Pine Bluff—a city shrinking in population but growing in surface heat and energy burden—illustrates why standard clean energy investment frameworks consistently miss the communities that need them most. Satellite-based remote sensing, as demonstrated by Rahman (2024), establishes the thermal and land cover baseline with rigor and reproducibility, confirming that built-up expansion and vegetation loss are driving measurable temperature increases even in a city losing residents. But satellite data alone is insufficient to unlock the site-specific solar siting, parcel-level energy assessment, and community trust-building required to translate geospatial intelligence into clean energy investment at the neighborhood scale.

Drone-enhanced geospatial intelligence, delivered by community-embedded minority-owned firms and anchored in HBCU research partnerships, offers a scalable and equity-centered pathway to fill this gap. The analytical framework presented in this paper—integrating satellite-based baseline assessment, NSRDB solar resource quantification, UAS-enhanced high-resolution overlay, and community-rooted implementation—provides a replicable model that other shrinking mid-Southern cities can adapt to their local institutional and geographic contexts.

The work of organizations like MyDroneForce.com and TlbEnterprise.com represents not merely a business opportunity but a civic responsibility: to ensure that the communities most burdened by the legacy of disinvestment and rising thermal load are the first, not the last, to benefit from the clean energy transition. The Cityscapes Summit 2026 community is well-positioned to catalyze the cross-sector partnerships—between federal agencies, HBCUs, minority-owned firms, municipal planners, and community lenders—that can turn geospatial evidence into solar-powered community futures. The data foundation exists. The institutional assets are present. The policy mechanisms are available. What remains is the coordination and commitment to act.

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Cities at the Center of the AI-Energy Transition: Building Inclusive Urban Energy Innovation Ecosystems

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Abstract

The United States is entering a new infrastructure era defined by artificial intelligence, electrification, and climate resilience. Cities are now the primary operating environment for this transformation—not utilities, not federal laboratories, and not isolated technology sectors. The central question is no longer simply how we generate clean energy. It is who owns the infrastructure, who shapes the innovation systems, and which cities capture the economic value.

This white paper argues that the AI-energy transition creates both an urgent governance challenge and a historic economic opportunity for American cities. Drawing on bibliometric analysis of 24,740 energy-related journal articles across three Southern metropolitan regions, federal funding data spanning 2010–2022, and 28 in-depth interviews with energy researchers, we document persistent, measurable exclusion of Historically Black Colleges and Universities (HBCUs) from the energy innovation ecosystem—and propose concrete structural interventions capable of converting that exclusion into inclusion before the architecture of the emerging AI-energy economy becomes permanently consolidated.

The central argument is twofold. First, HBCU exclusion from energy R&D is not a capacity problem—it is a structural problem produced by specific institutional mechanisms, and it is therefore addressable through deliberate structural reform. Second, that reform is now economically urgent: HBCUs are underutilized metropolitan assets, not peripheral institutions, and cities that fail to integrate them into regional innovation ecosystems are forfeiting workforce capacity, infrastructure resilience, and federal capital access at precisely the moment those assets are most competitively valuable.

≈1%

HBCU share of federal energy R&D funding

10%

of Black undergrads enrolled at HBCUs

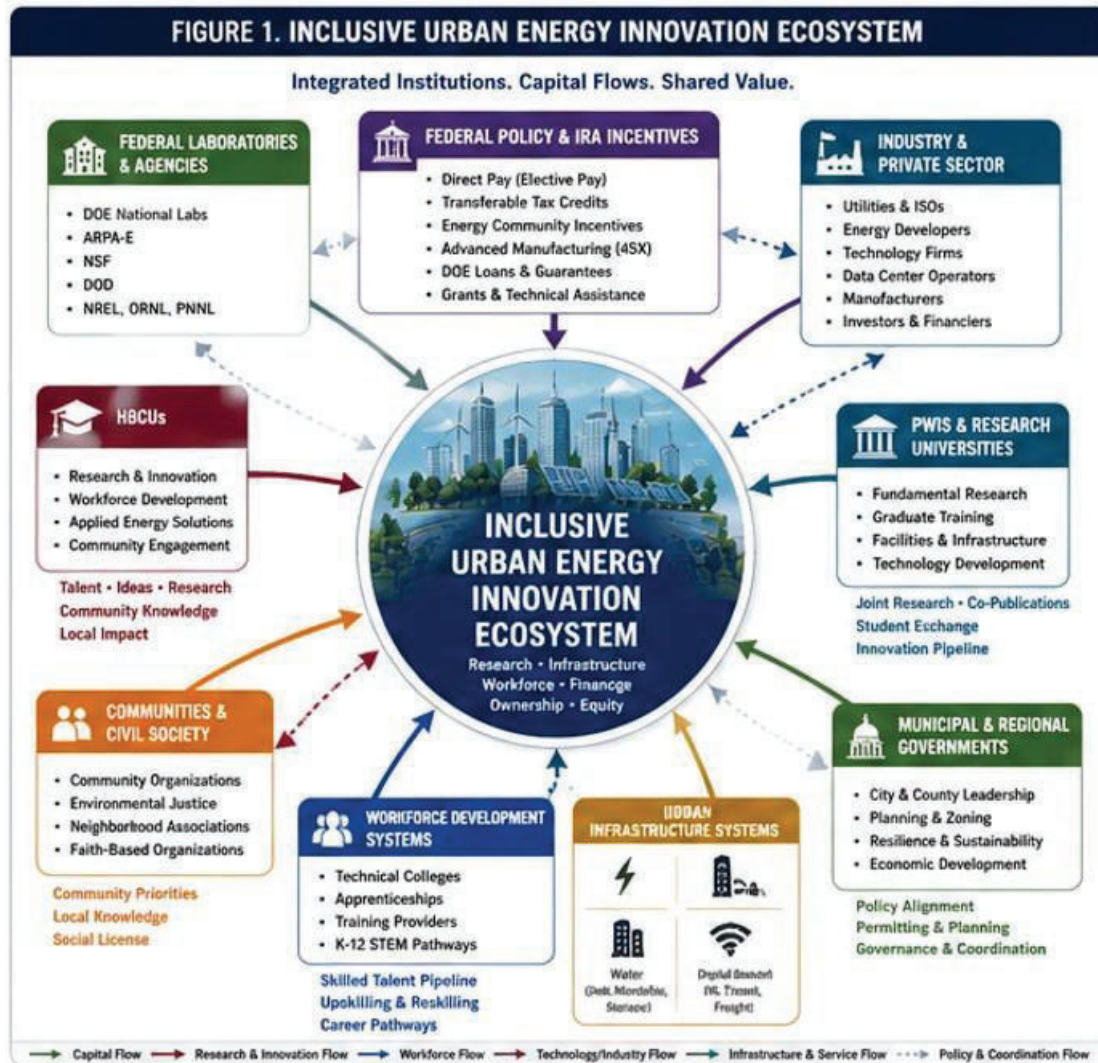
100–500 MW

per hyperscale data center facility

\$369B+

IRA clean energy investment (2022–2032 est.)

Figure 1 (see below): Inclusive Urban Energy Innovation Ecosystem — A systems-level diagram illustrating interconnected relationships among HBCUs & Universities, Cities & Governments, Utilities & Grid Operators, Federal Labs & Programs, Industry & Manufacturing, Infrastructure Finance & IRA, Workforce Development, and AI & Data Centers. Arrows indicate flows of capital, research, workforce, infrastructure, commercialization, ownership, and policy coordination. The figure reinforces that the AI-energy transition is an integrated metropolitan systems challenge—not an isolated research or utility sector issue



1. The Structural Geography of Energy Innovation

1.1 A System Built Without HBCUs

The modern U.S. energy innovation system was forged during and after World War II. Federal investments in nuclear science, aerospace, advanced materials, and computing established enduring ecosystems centered around federal laboratories and elite research universities. Institutions such as MIT, Stanford, Georgia Tech, and the University of California system became long-term beneficiaries of sustained federal contracting and deep industry integration.

HBCUs were deliberately excluded from that formative period. The Morrill Acts of 1862 and 1890, while establishing land-grant institutions for Black Americans, created a bifurcated system with systematically unequal resource allocations. The post-World War II era further entrenched these disparities: federal science agencies channeled resources through institutional networks from which HBCUs were largely absent—whether through segregation policy, lack of indirect cost infrastructure, or the absence of pre-existing federal contracting relationships.

The contemporary data confirm this inheritance. Across DOE, DoD, and NSF from 2010 to 2022, HBCUs accounted for approximately 1% of total federal energy-related higher education R&D expenditures—despite HBCUs enrolling 10% of Black undergraduates and producing a disproportionate share of the nation's Black science and engineering talent.

Agency	Total R&D	HBCU Total	HBCU Share
DOE	≈\$20.8B	≈\$180M	0.9%
DoD	≈\$50.7B	≈\$530M	1.0%
NSF	≈\$62.0B	≈\$620M	1.0%
TOTAL	≈\$133.5B	≈\$1.33B	≈1.0%

Table 1. Federal Energy-Related Higher Education R&D Expenditures, 2010–2022 (NSF HERD Survey). Approximate Values.

1.2 The Compounding Gap in Industry Partnerships

Industry-sponsored research disparities are even more pronounced. HBCU industry R&D shares declined from 0.21% to 0.11% of total national industry-sponsored university R&D between 2010 and 2022—even as overall corporate R&D at universities grew by more than 50%. On average, HBCUs captured approximately one-eighth of their federal R&D share from industry partners.

This gap reflects limited technology transfer infrastructure, smaller applied research portfolios, and the near-absence of formal corporate partnership agreements at most HBCU campuses. It also reflects a self-reinforcing cycle:

without industry visibility, HBCUs cannot build the IP portfolios and tech transfer track records that attract corporate partners; without corporate partners, they cannot build visibility.

1.3 Regional Innovation Profiles

Our bibliometric analysis of 24,740 energy journal articles across North Carolina, Georgia, and Florida reveals substantial regional variation—and confirms that exclusion patterns are not uniform.

Metro Region	Leading HBCUs	Fed R&D Share	Industry R&D Share
Miami, FL	Florida Memorial Univ.	2.0–2.5%	<0.5%
Atlanta, GA	Clark Atlanta, Morehouse, Spelman	~1%	<0.5%
Research Triangle, NC	NC Central University	~0.9%	0.2%
Greensboro, NC	NC A&T, Winston-Salem State	1.2%	0.9%

Table 2. Regional HBCU Energy R&D Profiles, 2010–2022

2. AI Infrastructure, Cities, and the New Urban Energy Economy

2.1 AI Infrastructure Is Now a City Governance Issue

Artificial intelligence infrastructure is no longer a tech sector issue. It is an energy, water, housing, and city governance issue. Hyperscale data centers now require 100 to 500 megawatts per facility—the equivalent electricity demand of a mid-sized American city—operating 24 hours a day with no tolerance for intermittency. Projected U.S. data center electricity demand will grow more than 50% between 2024 and 2030, and data centers are expected to consume more than 8% of total U.S. electricity by 2030.

This growth is reshaping metropolitan regions across four interconnected systems simultaneously. On energy, grid interconnection queues are overwhelmed and new transmission infrastructure is urgently needed. On water, hyperscale cooling systems consume millions of gallons per day, competing directly with housing and agricultural systems. On housing, data center corridor development drives land speculation and displacement in peri-urban communities. And on governance, incentive packages are routinely offered to

data center operators without enforceable community benefit terms—meaning cities absorb infrastructure burdens without contracted returns.

Cities that lack the analytical capacity, institutional partners, and governance frameworks to manage this convergence will find AI infrastructure expanding within their boundaries in ways that reshape their tax base, housing markets, and grid reliability without generating proportional community benefit.

2.2 The Strategic Contradiction Cities Must Solve

The AI-energy transition confronts city leaders with a structural contradiction that existing governance frameworks were not designed to resolve. AI infrastructure demands firm, continuous 24/7 power—baseload electricity that cannot tolerate the intermittency of wind and solar. Climate goals, by contrast, require integrating large shares of intermittent renewable sources into grids designed for flexible consumption. Cities must solve both simultaneously, and the systems through which they must do so—energy, water, housing, transit, and digital infrastructure—were not designed for this convergence.

The result is that energy systems can no longer be planned separately from land use, housing, resilience, workforce, and digital infrastructure. Metropolitan regions that continue to treat these as separate policy domains will find themselves unable to capture the economic value of AI infrastructure investment while also meeting climate commitments and maintaining housing affordability. Integrated urban energy governance—connecting energy planning to housing, water, workforce, and digital infrastructure—is no longer an aspirational policy goal. It is an operational necessity.

"Cities must solve the AI-energy contradiction simultaneously—and the systems they must use were not designed for this convergence."

2.3 The Infrastructure Risk Cities Cannot Ignore

For city leaders and planners, the fiscal and governance risks of the AI-energy transition are concrete and immediate. Six dimensions of exposure deserve direct attention.

Grid reliability exposure is perhaps the most immediate: cities bear the fiscal costs of grid failures through emergency response, critical services disruption, and lost economic productivity—yet have limited control over grid planning decisions made by utilities and federal regulators. Land speculation and displacement represent a parallel risk: data center corridor development drives peri-urban land costs upward, accelerating residential displacement and straining city affordable housing budgets precisely in communities that can least absorb those pressures.

Water competition is an underappreciated fiscal risk: hyperscale cooling demands compete directly with municipal water systems in climate-stressed metros. Infrastructure without inclusion compounds these pressures: communities absorb infrastructure burdens—noise, emissions, grid stress,

increased traffic—without proportional economic participation or ownership. Workforce leakage drains the tax base: regions without clean energy workforce pipelines export trained talent and import contractors, neither of which builds local fiscal capacity. And energy affordability pressure is rising: electricity rates driven up by new large loads disproportionately strain low-income residents and city housing subsidy budgets.

Without intentional governance, cities repeat a familiar pattern: infrastructure expansion without equitable participation in ownership or long-term economic value. The institutional mechanisms required to break that pattern—community benefit agreements, HBCU workforce pipelines, Direct Pay financing structures—are available. What is required is the governance commitment to use them.

2.4 IRA Capital Flows and Urban Infrastructure

The Inflation Reduction Act is not only the largest climate legislation in U.S. history—it is a fundamental restructuring of who can own clean energy infrastructure. By creating direct ownership pathways for cities, nonprofits, public universities, and HBCUs, the IRA transforms the institutional architecture of clean energy finance in ways that have no precedent in U.S. energy policy.

Before the IRA, clean energy finance depended on federal competitive grants, utility-controlled incentives, philanthropic capital, and state programs—all of which systematically routed resources away from institutions without established sponsored research infrastructure or tax liability. After the IRA, new pathways exist: Direct Pay for cities, nonprofits, and HBCUs; transferable tax credits accessible by emerging partnerships; Energy Community bonuses targeting historically burdened regions; Advanced Manufacturing credits for domestic supply chains; and DOE loan programs and Green Banks providing catalytic public capital alongside enforceable Community Benefit Agreements.

Three IRA mechanisms are particularly consequential for HBCU-adjacent communities and city leaders:

◆ **Direct Pay (Elective Pay) — Cities, Nonprofits, and HBCUs Can Now Own Infrastructure**

For the first time in U.S. energy policy, Direct Pay provisions allow nonprofits, public universities, municipalities, and tribal governments to monetize clean energy tax credits directly—without requiring a tax liability. This is transformative for HBCUs, city governments, and community development organizations that have historically been excluded from infrastructure ownership. Campus microgrids, community solar installations, EV charging networks, and district energy systems can now be financed through mechanisms that generate direct cash returns to HBCU-affiliated and city-affiliated projects.

◆ **Transferable Tax Credits — New Private Capital Pathways**

IRA transferability provisions allow clean energy tax credits to be sold to third parties, enabling smaller institutions and emerging HBCU–industry partnerships to monetize incentives without requiring large tax appetites. This creates new pathways for co-investment between HBCUs and private capital partners, lowering barriers to large-scale clean energy project development that have historically excluded HBCU-affiliated institutions.

◆ **Energy Community Bonuses and Justice40 Alignment**

Many of the metropolitan regions anchored by HBCUs—Gulf Coast, Atlanta metro, North Carolina's Piedmont, and South Florida—qualify as Energy Communities under the IRA, unlocking bonus tax credits for clean energy deployment. These designations align directly with Justice40 commitments that 40% of federal clean energy benefits flow to disadvantaged communities. HBCU-centered regional strategies are not only equitable—they are economically advantaged under current federal investment frameworks.

2.5 National Competitiveness and Strategic Infrastructure

The United States is entering a period in which energy infrastructure, artificial intelligence, advanced manufacturing, and digital systems are becoming increasingly inseparable. Global competition in semiconductors, AI computing, grid modernization, battery manufacturing, and resilient infrastructure is accelerating simultaneously. In this environment, the exclusion of major institutional and regional talent pools from energy innovation ecosystems is no longer solely an equity concern—it is a national competitiveness challenge.

The convergence of AI infrastructure and energy systems presents a particularly urgent strategic issue. Hyperscale computing facilities require enormous volumes of reliable electricity, thermal management systems, transmission capacity, and advanced power electronics. The United States simultaneously faces growing shortages of engineers, grid modernization specialists, energy systems analysts, cybersecurity professionals, and advanced manufacturing talent. HBCUs represent one of the nation's most underutilized assets in addressing these constraints: NC A&T is the largest U.S. producer of Black engineers, FAMU has sustained industry partnerships in applied engineering, and Morehouse, Clark Atlanta, and Spelman maintain active research programs in materials science, AI, and energy modeling.

HBCUs collectively enroll approximately 10% of Black undergraduates in the United States but receive only 1% of federal energy R&D. That ratio represents not just an equity gap—it represents a structural mismatch between the nation's stated workforce development goals and its actual investment patterns. The Inflation Reduction Act, CHIPS and Science Act, and related industrial policy

initiatives now create an opportunity to correct that mismatch before the concentration patterns of the mid-20th century become permanently embedded in the emerging AI-energy economy.

Cities capable of integrating HBCUs into regional energy innovation ecosystems gain concrete competitive advantages: stronger workforce pipelines, greater infrastructure resilience, expanded access to federal investment, and a broader coalition for industrial recruitment. Metropolitan regions that fail to broaden participation risk underutilizing local talent while exacerbating infrastructure inequality and social instability in communities that are already energy-burdened.

"Underutilizing HBCU capacity is not an equity abstraction. It is a national competitiveness error with measurable economic and strategic costs."

3. The Framework: Inclusive Urban Energy Innovation Ecosystems

The future energy economy will not be built by any single actor, but by interconnected institutions. Innovation ecosystems succeed when infrastructure, finance, research, workforce, and deployment operate together—and when the institutions anchoring those systems include, rather than exclude, the HBCUs, community organizations, utilities, and municipal governments that shape metropolitan life. Drawing on empirical findings, regional innovation theory, and the Triple Helix model of university–industry–government relations, we propose a six-element framework for building inclusive, urban-centered energy innovation ecosystems.

Element 1: HBCU–PWI–Industry Research Triads

Collaborative teams co-led by an HBCU, a Predominantly White Institution (PWI), and an industry partner—with shared IP rights, transparent governance, and explicit capacity-building resources for the HBCU—represent the most direct mechanism for addressing both the inclusion and tokenism problems simultaneously. These triads must be structurally distinct from conventional subcontracting arrangements. When industry partners set shared governance expectations, distribute IP rights equitably, and define substantive leadership roles for HBCU researchers as conditions of engagement, they counteract the tokenistic collaboration patterns currently documented in co-authorship networks.

Element 2: Federal Laboratory Integration

Federal laboratories represent one of the most underutilized mechanisms for inclusive innovation. Partnership Intermediary Agreements (PIAs) authorize national labs to collaborate with universities, nonprofits, and small businesses on technology transfer and commercialization—precisely the kind of structured engagement that could provide HBCUs with access to federal datasets, advanced instrumentation, and mission-relevant research problems. DOE and

DoD should require that UARCs (University Affiliated Research Centers) and PIA agreements include meaningful HBCU sub-agreements with substantive research roles and dedicated funding streams. Howard University's leadership of UARC-RITA demonstrates this potential: the center brings explicit capabilities in AI and tactical autonomy and represents the first DoD UARC led by an HBCU consortium.

Element 3: Regional Clean Energy Corridors

The future of inclusive energy innovation may emerge through regional clean energy corridors that integrate research institutions, digital infrastructure, advanced energy systems, manufacturing, workforce development, and community benefit agreements. Three corridors merit particular attention:

- Miami Climate Resilience Corridor: Integrating FMU, FIU, University of Miami, and Florida Atlantic in coastal resilience, smart energy systems, and AI-driven infrastructure planning—with local small Climate businesses such as Solis Power and Exowatt and Beacon Council as deployment anchors
- Atlanta Climate Innovation District: Leveraging the Georgia Institute of Technology and the Atlanta University Center consortium—Clark Atlanta, Morehouse, Spelman—with growing NSF and DOE funding in materials science and data-driven energy modeling.
- North Carolina Clean Energy Manufacturing Corridor: Building on NC A&T's established partnerships with Boeing, Lockheed Martin, and Siemens Energy in grid modernization, advanced materials, and EV systems

Element 4: Equity Metrics in Federal Funding and Contracting

Embed HBCU participation requirements—with clear deliverables, governance roles, and accountability mechanisms—as evaluation criteria in DOE, DoD, and NSF energy R&D solicitations. The Justice40 Initiative, which commits that 40% of the benefits of federal clean energy investments flow to disadvantaged communities, creates precisely this political and policy opening. Federal agencies should require reporting on HBCU subcontract amounts, publication co-authorship, and patent co-inventorship as standard program metrics.

Element 5: HBCU Research Infrastructure Investment

Direct investment in laboratory modernization, sponsored research administration, tech transfer office capacity, and faculty research time is a prerequisite for HBCU participation in large-scale federal programs. Infrastructure grants modeled on the NSF EPSCoR program—but scaled to the magnitude of the gap they are intended to address—represent the most direct mechanism for building the capacity that federal contracting mechanisms currently require. AI infrastructure companies can also strengthen these investments by partnering with HBCU boards of trustees, academic leaders, and community stakeholders to

coordinate infrastructure planning, align resources, and ensure that federal investments deliver lasting benefits to HBCU campuses and surrounding communities.

Element 6: Inclusive Clean Energy Finance and IRA Deployment

The IRA introduces unprecedented opportunities for inclusive participation in energy infrastructure deployment. Elements 1 through 5 address the research and institutional dimensions of HBCU exclusion. Element 6 addresses the deployment and finance dimension—the mechanisms through which research is converted into owned infrastructure, economic activity, and community wealth. HBCUs, municipalities, and regional coalitions should leverage IRA tools to establish clean energy deployment partnerships tied to workforce development, technology commercialization, and community ownership.

Strategic deployment opportunities directly relevant to HBCU campuses and surrounding communities include campus microgrids financed through Direct Pay, community solar serving HBCU-adjacent low-income households, resilient district energy systems co-developed with utilities, EV charging infrastructure tied to HBCU workforce training, thermal storage and long-duration storage R&D commercialized through regional corridors, grid modernization partnerships leveraging HBCU advanced materials and engineering programs, energy-efficient affordable housing integrating HBCU architectural and engineering programs, and clean energy advanced manufacturing anchored in HBCU regional corridors.

IRA Advanced Manufacturing Credits — A Strategic Opportunity for HBCU Corridors

Advanced Manufacturing Production Credits (Section 45X) and Investment Tax Credits for domestic manufacturing facilities represent a particularly powerful opportunity for HBCU-anchored regional corridors. NC A&T's partnerships with Boeing, Lockheed Martin, and Siemens Energy position the North Carolina corridor to compete for battery, transformer, and grid systems manufacturing. The Atlanta University Center's materials science capabilities and FMU's Climate Resiliency Center focus offer similar entry points. Federal agencies and industry partners should prioritize HBCU participation in IRA-supported manufacturing through procurement incentives, technical assistance, and co-development frameworks.

3.1 Implementation Pathway

Achieving inclusive urban-centered energy innovation requires more than isolated pilot programs or symbolic partnerships. It requires coordinated institutional sequencing capable of integrating research, infrastructure deployment, commercialization, workforce systems, and capital formation over time. The following phased pathway provides a practical framework for cities,

universities, federal agencies, and industry partners seeking to operationalize the six-element model.

Phase I — Research and Institutional Integration

Initial efforts should focus on integrating HBCUs into existing regional research ecosystems through structured HBCU–PWI–industry collaborations, federal laboratory partnerships, and shared infrastructure agreements. Key priorities include research co-authorship and joint proposal development, laboratory modernization and instrumentation support, sponsored research administration capacity building, formalized federal laboratory engagement through PIAs and UARCs, and development of regional innovation governance structures.

Phase II — IRA Deployment and Infrastructure Partnerships

Once institutional collaboration pathways are established, regional coalitions should transition toward deployment-focused infrastructure initiatives enabled by IRA finance mechanisms: campus microgrids, community solar, EV charging infrastructure, district energy systems, utility partnership agreements, and workforce-aligned infrastructure deployment. This phase converts research participation into infrastructure ownership and long-term economic participation.

Phase III — Commercialization and Manufacturing Ecosystems

Long-term competitiveness requires integration into domestic clean energy manufacturing and commercialization systems. Regional innovation corridors should pursue advanced manufacturing partnerships, technology commercialization pipelines, supply chain integration, startup incubation, energy technology demonstration platforms, and industry co-development agreements. The IRA's advanced manufacturing incentives create a historic opportunity for HBCU-centered regional corridors to participate directly in emerging clean energy industrial supply chains.

Phase IV — Regional Economic Transformation

The ultimate objective is the creation of resilient regional innovation economies capable of sustaining long-term wealth creation, workforce development, and infrastructure ownership. Mature ecosystems should integrate municipal planning, utility modernization, resilient housing systems, climate adaptation, advanced workforce pipelines, clean transportation systems, digital infrastructure planning, and community wealth-building strategies. Inclusive urban energy innovation ecosystems are ultimately regional economic development systems—not merely research collaborations.

4. Policy Recommendations for Cities

Most of the actions below are executable under existing federal authority and current IRA structures—they do not require new legislation. They require commitment, coordination, and governance intentionality from four categories of

actors: cities, utilities, HBCUs and universities, and industry.

For City and Regional Leaders

- Designate energy innovation districts anchored by HBCUs, with explicit roles in regional clean energy corridor planning and federal funding access
- Require community benefit agreements with enforceable local hiring, energy affordability, and workforce training terms as conditions of data center and energy infrastructure permits
- Integrate energy, housing, water, and digital infrastructure planning through unified metropolitan strategy frameworks—these systems cannot be governed separately in the AI-energy transition era
- Use IRA Direct Pay provisions for municipal clean energy projects to demonstrate the ownership model and build city-HBCU co-development capacity
- Establish IRA technical assistance offices within economic development agencies to help HBCUs, CDFIs, and community organizations navigate Direct Pay and transferable tax credit mechanisms
- Create urban energy innovation intermediaries—public-private organizations with PIA-like authority to broker HBCU–federal lab–industry partnerships at the regional level

For Utilities and Grid Operators

- Prioritize HBCU-adjacent grid modernization partnerships and provide transparent interconnection pathways for campus and community solar projects
- Pilot district energy and thermal storage systems in partnership with HBCU campuses as demonstration and commercialization platforms
- Expand community solar programs specifically targeting energy-burdened households in HBCU-adjacent communities, using IRA incentives to reduce barriers
- Create dedicated interconnection pathways for small-scale distributed generation projects affiliated with HBCU campuses, community solar programs, and municipal energy initiatives

For HBCUs and Universities

- Build IRA Direct Pay deployment programs on campus—beginning with solar, storage, and EV charging—as anchors for broader regional clean energy corridors
- Launch HBCU–PWI–industry research triads with shared governance, co-IP agreements, and substantive HBCU leadership roles from the outset
- Develop technology transfer and commercialization capacity through partnerships with federal labs, regional innovation intermediaries, and

- industry co-development programs
- Anchor workforce pre-apprenticeship pipelines connecting HBCU campuses to clean energy career pathways across the regional value chain

For Industry Partners

- Co-develop IRA-eligible projects with HBCU partners as substantive co-leads, not subcontractors—with shared IP, shared governance, and shared economic returns
- Establish co-IP agreements and shared governance frameworks that prevent the tokenistic collaboration patterns currently documented in energy research partnerships
- Fund workforce training at HBCU campuses through community benefit agreements tied to data center and clean energy infrastructure projects
- Prioritize local hiring requirements in community benefit agreements, with HBCU workforce pipeline programs as a contracted supply mechanism
- Leverage transferable tax credits to structure HBCU co-development partnerships—sharing credit value to enable institutions with limited tax appetite to participate meaningfully in project finance

IRA Mechanisms: A Reference for City and HBCU Leaders

The table below summarizes the IRA provisions most relevant to HBCU-centered urban energy strategies, providing a practical reference for practitioners and policymakers navigating implementation.

IRA Mechanism	Relevance to HBCUs & Cities	Strategic Application
Direct Pay (Elective Pay)	Allows nonprofits, public universities & municipalities to monetize tax credits without tax liability	Campus microgrids, community solar, district energy, EV charging
Transferable Tax Credits	Credits can be sold to third parties; lowers capital barrier for smaller institutions	HBCU–industry co-development; commercialization of campus clean energy projects
Energy Community Bonus	Bonus credits (up to 10%) for projects in qualifying communities; some HBCU regions qualify	Gulf Coast, Atlanta metro, NC Piedmont, South Florida corridors

45X Manufacturing Credit	Production credit for domestic clean energy manufacturing components	NC A&T, AUC, FMU corridor manufacturing partnerships
48C Advanced Manufacturing ITC	Investment tax credit for qualifying advanced energy manufacturing facilities	Regional clean energy manufacturing hubs co-anchored by HBCUs

Table 3. Key IRA Mechanisms for HBCU-Centered Urban Energy Strategies

Why Cities Should Care

The energy transition is increasingly unfolding at the metropolitan scale. Cities are now the primary operating environments for AI infrastructure, electrified transportation, resilient power systems, advanced manufacturing, climate adaptation, and digital connectivity. Decisions regarding energy infrastructure deployment increasingly shape housing affordability, tax base growth, land use patterns, workforce competitiveness, and long-term economic resilience.

For city leaders, the exclusion of HBCUs from regional innovation ecosystems represents not only an equity concern but also a missed economic development opportunity. HBCUs function as anchor institutions in many metropolitan regions, supporting workforce development, entrepreneurship, cultural identity, and local economic activity. Integrating these institutions into energy innovation ecosystems can strengthen local supply chains, improve workforce retention, increase access to federal investment, and expand community participation in infrastructure ownership.

Conversely, infrastructure systems developed without inclusive governance mechanisms risk intensifying displacement, infrastructure inequality, and economic fragmentation. Data centers, transmission corridors, energy generation assets, and advanced manufacturing facilities are reshaping metropolitan geographies. Cities that fail to integrate equity into infrastructure planning may absorb rising infrastructure burdens without capturing proportional economic benefits.

The future competitiveness of metropolitan regions will depend not only on infrastructure deployment itself, but on who participates in designing, financing, operating, and benefiting from that infrastructure.

Conclusion

The exclusion of HBCUs from the U.S. energy innovation ecosystem is documented, durable, and structurally produced. Our findings establish that HBCUs receive approximately 1% of federal energy-related R&D funding and a fraction of that from industrial partners—not because of institutional incapacity but because the mechanisms through which energy research is funded and

organized systematically foreclose their participation. The AI-energy transition does not resolve that structural problem automatically. But it does raise the cost of inaction: the metropolitan regions that fail to integrate HBCUs into their energy innovation ecosystems are now forfeiting workforce assets, infrastructure resilience capacity, and federal capital access at a moment when those assets are uniquely valuable.

The Inflation Reduction Act fundamentally changes the landscape of that challenge. It creates, for the first time, a set of deployment and finance mechanisms—Direct Pay, transferable tax credits, energy community incentives, and advanced manufacturing credits—that are accessible to the nonprofits, public universities, and municipal governments that have historically been excluded from energy infrastructure ownership. The question is whether cities, federal agencies, utilities, and industry partners will act with sufficient intentionality to ensure those mechanisms reach HBCU communities—or whether the IRA's benefits will flow through the same concentrated institutional channels that have perpetuated exclusion for eight decades.

The next generation of energy infrastructure will not be built solely through technological innovation. It will be built through decisions regarding institutional access, infrastructure ownership, capital flows, workforce systems, and regional governance. The Inflation Reduction Act creates an unprecedented opening to broaden participation in these systems before the architecture of the emerging AI-energy economy becomes permanently consolidated.

The opportunity before cities is therefore larger than energy transition alone. It is the opportunity to redesign regional innovation ecosystems in ways that align technological advancement with inclusive economic development, infrastructure resilience, and long-term community participation in wealth creation. Whether that opportunity is realized will depend on the willingness of public institutions, federal agencies, industry leaders, and metropolitan regions to treat inclusion not as a peripheral social objective, but as a core component of national energy and economic strategy.

"The question is not whether America will build a new energy economy. The question is which cities will shape it, who will own it, and whether communities will participate in the prosperity it creates."

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Anchored but Excluded: Identifying and Overcoming Systemic Barriers to HBCU Participation in Regional Energy Innovation Systems

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Abstract

Earning a doctorate is widely treated as a pathway out of inequity, yet for Black scholars in the energy fields the degree alone is far from sufficient—and their exclusion carries costs well beyond the academy. Drawing on a bibliometric analysis of 24,740 energy-related articles and U.S. Department of Energy grants across three metropolitan regions, paired with 28 interviews, we document persistent underrepresentation in research output and funding alongside structural, institutional, and interpersonal barriers facing Historically Black Colleges and Universities (HBCUs) and Minority-Serving Institutions (MSIs). Because innovation is regional and relational, excluding these anchor institutions weakens metropolitan innovation ecosystems and steers the benefits of public clean-energy investment away from the communities that most need them. Closing these gaps requires treating research-capacity building as an economic development strategy—through sustained capacity investment, reformed grant review, intentional mentorship, and partnerships that ensure marginalized communities share in the clean-energy transition.

Keywords: clean energy equity; HBCUs and minority-serving institutions; regional innovation systems; inclusive economic development; workforce development; anchor institutions; urban competitiveness

1. Introduction: A Problem Hidden in Plain Sight

The transition to a clean-energy economy is reshaping cities, labor markets, infrastructure, and regional development—yet the institutions positioned to benefit are not equally represented. This study asks a single question: what systemic barriers limit the participation of Black energy researchers and HBCUs/MSIs in regional energy innovation systems, and what reforms would create more equitable and effective research ecosystems? The question reaches well beyond higher education, bearing directly on metropolitan competitiveness, workforce development, and community wealth creation.

We frame the inquiry through regional innovation systems and cluster theory, which treat innovation as the product of universities, firms, and laboratories linked by proximity within a region rather than the work of isolated individuals (Cooke 1992, 2001; Porter 1998, 2000). Conventional wisdom holds that advanced education resolves inequity; our evidence contradicts it. Even Black researchers with doctorates in engineering, physics,

and chemistry encounter systematic obstacles—sometimes overt, but more often the cumulative dynamics of funding networks, infrastructure, and tacit knowledge that quietly determine who advances. Viewed regionally, this is not a private career problem but a structural feature of how innovation ecosystems are built, and thus a legitimate object of urban and economic policy.

Why Cities Should Care

Excluding HBCUs from regional energy innovation systems forfeits local expertise, inclusive workforce pathways, and the chance for marginalized communities to benefit from clean-energy investment; because HBCUs are key community anchors, investing in their research capacity strengthens regional innovation and inclusive urban growth (Taylor and Luter 2013). The disparities are not marginal—HBCUs and MSIs account for as little as 0.7 percent of energy research output in some major regions, a level of exclusion that represents real innovation capacity left unbuilt.

2. Historical Context and Approach

The modern U.S. energy research system was forged during World War II and the Cold War, when federal investment built national laboratories and channeled extramural funding to research-intensive universities, cementing their regions as innovation centers. Black institutions were largely excluded—an exclusion that was statutory as well as cultural. The First Morrill Act (1862) endowed the land-grant universities that became today’s energy research leaders, while the Second Morrill Act (1890) extended land-grant status to HBCUs but required a state match that segregated Southern governments withheld. The consequences persist in funding and in the workforce: Black workers comprise only about 8.5 percent of the STEM workforce (National Science Foundation 2024), and as Table 1 shows, HBCUs received roughly 1 percent of DOE and NSF grant dollars between 2000 and 2020—a pattern an independent 2025 analysis confirms, finding HBCUs have averaged under 1 percent of federal R&D funding despite representing about 3 percent of four-year institutions (Partridge, Santos, and Sheppard 2025).

Federal Agency	Grants to HBCUs (\$ mil)	HBCU Share of Total (%)
Dept. of Energy (DOE)	242	1.1%
Dept. of Defense (DOD)	56,900	10.0%
Nat. Science Fdn. (NSF)	662	0.9%
Environmental Prot. (EPA)	23	1.4%

Table 1. Federal research grants awarded to HBCUs relative to all universities, 2000–2020.

Source: Adapted from Advancing Equity in Energy Research (Patterson et al. 2025). Dollar figures in millions.

Our study combined two methods across three regions chosen because each contains both HBCUs (or MSIs) and research-intensive Primarily White Institutions (PWIs) within one innovation system: Atlanta, Miami, and the combined Charlotte–Raleigh–Durham

region. A bibliometric analysis, built on established definitions of the scope of energy research and development (Dooley 2000; Archambault et al. 2009), collected 24,740 energy-related articles published in 2010–2022 by authors at these institutions, paired with DOE grants from 2020–2022; this let us identify researchers without snowball sampling and match-pair Black and non-Black researchers at the same institution. We then conducted 28 semi-structured interviews (19 Black, 9 non-Black) across PWIs, HBCUs/HSIs, and federal laboratories. The match-pair design is essential: where peers in the same setting report markedly different experiences, the difference cannot be attributed to the formal institutional environment alone.

3. Findings: Layered and Largely Invisible Barriers

3.1 Disparities in research output and funding

Underrepresentation in the regional research record is stark and consistent. HBCUs and MSIs produced only 5.8 percent of energy journal articles in the North Carolina region, 11.4 percent in Miami, and just 0.7 percent in Atlanta. DOE grant shares track closely, and dollar shares fall lower still—evidence that the grants HBCUs do win tend to be smaller (Table 2). Crucially, the capacity is not absent: institutions such as North Carolina A&T State, North Carolina Central, and Florida International show real, growing capacity. This implies that a blind, across-the-board funding increase would not translate quickly into output, whereas targeted, capacity-aware investment would.

Region	HBCU/MSI Share of Journal Articles	HBCU/MSI Share of DOE Grants (count)	HBCU/MSI Share of DOE Grant Dollars
Charlotte–Raleigh–Durham, NC	5.8%	4.2%	1.3%
Atlanta, GA	0.7%	1.4%	0.7%
Miami, FL	11.4%	11.7%	8.4%

Table 2. Regional shares of energy research output and DOE grants held by HBCUs/MSIs.

Source: Adapted from *Advancing Equity in Energy Research* (Patterson et al. 2025). Journal output covers 2010–2022; DOE grants cover 2020–2022.

3.2 Infrastructure constraints at HBCUs—and persistent barriers within PWIs

Interviews revealed why the gaps persist. HBCU researchers described chronic shortfalls: little or no research budget, long waits to replace basic equipment, startup packages a fraction of those at PWIs, no pre- or post-award support staff, and teaching loads of two to four courses per semester against zero to one at peer PWIs. Some reviewers, interviewees reported, rejected proposals on the assumption that an HBCU “would not have the capacity to conduct the proposed research,” even when applicants held federal grant records in the millions. Yet strong infrastructure did not eliminate inequity: Black researchers at PWIs described a system in which “money only flows to

certain people”—those already in established networks—while new faculty struggled to find collaborators or mentors. One who had worked at both summarized the bind: “At HBCU, you are underfunded. At PWI, you are treated differently.”

3.3 Recognition, mentorship gaps, and network exclusion

The most common theme among Black interviewees was a denial of professional recognition: a tenured associate professor mistaken for a graduate student; colleagues called “lucky” to have been hired during a diversity initiative; an idea dismissed in a meeting only to win assent when a white colleague repeated it minutes later. Because nearly all Black interviewees reported such episodes while their matched non-Black peers did not, the pattern is systemic rather than incidental. Black women described an added layer, navigating what two called the “old boys’ club” amid acute retention problems—and research documents that women and minority instructors receive systematically lower student evaluations (Williams 2007; Chavez and Mitchell 2020; Heffernan 2022). Compounding this is unequal access to tacit knowledge—which journals and grants carry weight, how to cultivate program officers—that normally transfers through mentorship but fails those who cannot find a mentor of similar background. Tellingly, the response was adaptation: many built networks at other institutions—harder, self-constructed pathways that underscore the structural rather than individual nature of the barriers.

4. Systemic Implications for Cities and Regions

Read through the regional innovation lens, these findings describe an “odd triangle”: PWI researchers network mainly among themselves, federal-lab researchers struggle to penetrate PWI networks, and HBCU researchers struggle to reach federal labs. Because innovation diffuses through such relationships, severing them fragments the ecosystem and slows the spread of knowledge—and the disadvantage compounds, since reviewers reward demonstrated track records, so funded institutions win still more while those long denied funding fall further behind (the “Matthew effect”; Merton 1968). The stakes are sharpest for the communities these institutions anchor: HBCUs and MSIs sit in neighborhoods that bear disproportionate energy burdens, so shutting them out of research capacity shuts their communities out of the transition’s upside—the jobs, the local firms, the chance to shape technologies to local needs. Cities seeking equitable growth should therefore treat research-capacity building not as a diversity initiative but as core economic development that keeps public clean-energy dollars compounding within the region rather than leaking past the communities that need them most.

5. Recommendations

Closing these gaps will not happen through grants alone. We group recommendations into three domains, each aimed at durable capacity rather than isolated projects.

- **Research.** Commission longitudinal studies of how research capacity develops at under-resourced institutions over a 10–15-year horizon, and map regional

innovation networks to show where HBCUs are connected to—or severed from—PWIs, federal labs, and industry.

- **Policy.** Expand DOE and other federal capacity-building programs; establish regional clean-energy innovation hubs that require verified HBCU participation rather than nominal inclusion; and reform grant review to assess institutional potential, not prior funding history alone, which structurally disadvantages institutions long denied the chance to build a record. Customizing federal mentor-protégé and national-laboratory partnership programs would directly address the network exclusion documented here.
- **Institutional.** Invest in the unglamorous foundations of capacity—pre- and post-award administration, shared infrastructure, faculty development, and mentorship networks connecting Black researchers across institutions. PWI–HBCU partnerships should require verified capability-building by the under-resourced partner, and institutions should formally credit the disproportionate DEI service that otherwise becomes its own barrier to advancement.

6. Conclusion

As federal clean-energy investment accelerates, the question is no longer whether regions will innovate, but who will participate. For Black energy researchers and the institutions that anchor their communities, the path remains shaped by subtle, cumulative barriers built into regional innovation systems over more than a century. Fully integrating HBCUs and Black researchers into regional energy ecosystems is essential not only for equity but for maximizing the returns of the transition: inclusive innovation is not a constraint on growth but a prerequisite for sustainable urban development and resilient regional economies.

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From Exclusion to Pathways: Reframing Research Access, Institutional Power, and Energy Justice in Clean Energy Innovation

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Abstract

This paper examines how structural inequities shape participation, legitimacy, access to funding, and leadership within clean energy research and innovation systems, with particular attention to Black researchers, Historically Black Colleges and Universities (HBCUs), Minority-Serving Institutions (MSIs), community-based organizations, and other underrepresented stakeholders. Drawing on scholarship on systemic barriers in research, academic engagement, institutional change, and energy justice, it argues that exclusion in clean energy research is not simply a diversity problem, but a design problem embedded in funding rules, institutional classifications, professional norms, and assumptions about who counts as a researcher. Using a pathways-oriented analytical framework, the paper examines four interrelated domains: funding equity and access, implicit bias and institutional practice, HBCU and MSI leadership, and energy justice and community engagement. It shows how research status hierarchies, including R1 and R2 designations, structure opportunity in ways that reinforce inequity. In response, the paper outlines recommendations centered on inclusive eligibility rules, capacity-building investments, participatory and community-engaged research models, equitable partnerships, revised review criteria, and institutional accountability. It concludes that a just clean energy transition requires not only technical innovation but also a redistribution of research power, recognition, and resources.

Keywords: clean energy research; energy justice; research equity; HBCUs and MSIs; community-engaged research
Introduction

Introduction

The clean energy transition is often framed as a technological and economic challenge, but it is also a question of who is authorized to produce knowledge, set agendas, define expertise, and benefit from innovation. Persistent disparities in research funding, institutional prestige, publication access, network visibility, and organizational capacity leave many of the communities most affected by environmental burdens and energy insecurity underrepresented in the systems intended to design solutions (Sovacool et al., 2016; Romero-Lankao et al., 2023).

Calls for equity in clean energy research must therefore move beyond representation alone and confront the structural rules that determine who is recognized as a legitimate researcher, which institutions are treated as research-ready, and what forms of evidence are considered rigorous.

This paper asks a foundational set of questions: Who decides who is “in” and “out” of research? Why do conventional pathways privilege highly resourced universities, tenured investigators, and established publication records? What happens when community residents, practitioners, small businesses, or under-resourced faculty possess relevant expertise but do not fit the dominant mold of the academic researcher? These questions are especially urgent in clean energy, where the consequences of exclusion are both social and material. Communities facing higher energy burdens, infrastructure neglect, pollution exposure, and chronic underinvestment are often the least represented in funded research and leadership pipelines, even though they may hold the practical knowledge, relational trust, and local insight needed for more effective and just solutions (Jenkins et al., 2016; Romero-Lankao et al., 2023; Sovacool et al., 2016).

The paper argues that barriers facing Black energy researchers and other underrepresented stakeholders are not isolated obstacles, but interconnected features of a broader research ecosystem shaped by institutional classification, reviewer expectations, funding architecture, historical inequities, and implicit norms of merit and credibility (U.S. Government Accountability Office, 2025; Hultgren et al., 2024). Drawing on scholarship on universities and public action, broadening participation, energy justice, community-engaged research, and research capacity building, it develops an analysis across four domains: funding equity and access, implicit bias and institutional practice, HBCU and MSI leadership, and energy justice and community engagement.

Background and Literature Review

Defining the Research Problem: Who Counts as a Researcher?

At the center of this discussion is a deceptively simple question: What is a researcher? In conventional academic practice, the term often refers to a person formally affiliated with a university or research institute, trained in disciplinary methods, positioned to secure grants, and expected to produce peer-reviewed outputs. This definition appears neutral, but in practice, it operates as a gatekeeping mechanism. It privileges those with institutional affiliation, protected time, access to administrative support, publication histories, and social capital within established scholarly networks (U.S. Government Accountability Office, 2025; Hultgren et al., 2024). By contrast, community leaders, residents, practitioners, public-interest organizations, and faculty at under-resourced institutions may generate valuable knowledge but still be excluded from formal recognition, principal investigator roles, or funding eligibility (Castro-Diaz et al., 2024; Jenkins et al., 2016).

This mismatch matters because clean energy challenges are rarely solved by technical expertise alone. Research on community engagement and equity in renewable energy has shown that successful transitions require procedural fairness, trust, local knowledge, and meaningful participation in decision-making, not simply downstream consultation (Romero-Lankao et al., 2023; Wüstenhagen et al., 2007). Participatory research in energy justice similarly argues that co-produced and community-engaged methods are essential for bridging the gap between energy justice theory and practice (Castro-Diaz et al., 2024). When funding systems fail to recognize these forms of expertise, they limit both innovation quality and equitable impact.

The hierarchy of institutional status reinforces this problem. Under the updated 2025 Carnegie research activity methodology, Research 1 institutions are those that spend at least \$50 million annually on research and development and award at least 70 research doctorates, while Research 2 institutions spend at least \$5 million and award at least 20 research doctorates (The Carnegie Classification of Institutions of Higher Education, 2025). Carnegie also now recognizes a Research Colleges and Universities category for institutions outside the R1/R2 group that still maintain meaningful research activity. These classifications are descriptive, but in practice, they often become proxies for quality, readiness, and eligibility in grant review and partnership decisions. As a result, the prestige associated with research classification can harden into a hidden screening device that disadvantages HBCUs, MSIs, teaching-intensive campuses, and community-based organizations, even when they are closely connected to the populations and problems under study (U.S. Government Accountability Office, 2025; Hultgren et al., 2024).

Analytical Framework

This paper uses a pathways-oriented analytical framework to examine how exclusion is produced across the clean energy research ecosystem. Rather than treating inequity as the result of individual deficits, the framework focuses on the institutional rules, evaluative norms, funding structures, and partnership arrangements that shape who can enter, lead, and benefit from research. The analysis is organized across four interrelated domains—funding equity and access, implicit bias and institutional practice, HBCU and MSI leadership, and energy justice and community engagement—which together show how research power is distributed and where redesign is most needed.

Argument

1. Funding Equity and Access

Funding is one of the clearest ways in which inequity becomes institutionalized. Eligibility requirements, proposal conventions, indirect cost assumptions, expectations about prior awards, and the need for sophisticated pre-award infrastructure can all favor institutions already well positioned in the research ecosystem (U.S. Government Accountability Office, 2025).

Research on MSI participation in grant peer review further suggests that

underrepresented institutions often face disparities in institutional resources, limited social capital, and uneven access to the review networks that shape funding cultures (Gallo et al., 2022). These disadvantages directly affect whether investigators can identify opportunities, assemble teams, prepare competitive budgets, meet compliance requirements, and manage awards after funding is secured.

For Black researchers at HBCUs and other under-resourced institutions, these burdens are often compounded by high teaching loads, limited staff support, fewer graduate assistants, a pressure to serve multiple institutional functions simultaneously (Aker et al., 2025). In such settings, the standard model of the principal investigator as a grant-specialized, publication-intensive, administratively supported academic does not reflect lived reality. Even when targeted programs exist, such as NSF's HBCU Undergraduate Program and MSI-focused opportunities, the broader funding environment continues to reward preexisting capacity rather than building it (National Science Foundation, 2026). A 2025 U.S. Government Accountability Office report further noted that HBCUs, Tribal Colleges, and MSIs have long faced barriers to securing federal research funding, despite federal recognition of their role in the research and development ecosystem (U.S. Government Accountability Office, 2025).

These patterns raise an important question for clean energy funders: are current review systems evaluating excellence, or are they rewarding accumulated advantage? If the lead institution must already look like a traditional research university, then access to resources remains tethered to historic inequities. A pathways approach would instead redesign funding around inclusion. This could include lowering unnecessary eligibility barriers, allowing community-based organizations or small businesses to serve as lead applicants where appropriate, creating planning and partnership grants, expanding proposal development assistance, revising merit review criteria to account for community relevance and collaborative design, and offering capacity-building support as a core component of grantmaking rather than a secondary afterthought.

2. Implicit Bias and Institutional Practice

If funding structures shape who can enter the research ecosystem, institutional practice helps determine whose expertise is recognized once they are inside it. Implicit bias in research systems does not always operate through overt exclusion. More often, it appears through default assumptions about competence, professionalism, objectivity, and credibility. In academic and funding settings, these assumptions can shape how reviewers interpret institutional affiliation, publication records, disciplinary methods, and communication styles. They can also influence whether collaborative work with communities is treated as rigorous scholarship or as peripheral service. Because bias is embedded in routine procedures, it often remains invisible to the people reproducing it, including researchers, practitioners, funders, institutional leaders, and community intermediaries (Hultgren et al., 2024; Gallo et al., 2022).

A perspective by Gardner, Thierry, Rowlandson, and Steinberger (2021) argues that

universities should move “from publications to public actions,” emphasizing that traditional academic roles and impact pathways are insufficient in emergency contexts and that institutions should explicitly recognize advocacy, engagement, and public action as part of academic work.

Although their focus is climate and ecological emergencies, the broader implication is relevant here: institutions construct their own norms of legitimacy. If universities and funders privilege only narrow forms of productivity or neutrality, then they also narrow who can be seen as a credible contributor to urgent societal challenges. This is especially problematic in clean energy research, where social legitimacy, community trust, and implementation pathways are central to impact. Institutional practice can therefore either reinforce or interrupt exclusion. Practices that reinforce bias include overreliance on elite institutional markers, informal networking as a substitute for open opportunity, vague expectations about who appears “ready” to lead, and evaluation rubrics that undervalue mentoring, engagement, applied research, and community-based evidence. By contrast, bias-aware institutional design would require reviewer training, transparent decision criteria, diversified review panels, recognition of multiple forms of expertise, and stronger accountability for equity outcomes. The issue is not to abandon standards, but to examine whether current standards are valid for the problems being addressed and fair to the range of contributors needed to solve them (Gardner et al., 2021; Gallo et al., 2022; Hultgren et al., 2024).

3. HBCU and MSI Leadership

These institutional norms have significant consequences for who is authorized to lead research, not just participate in it. HBCUs and MSIs are often discussed as beneficiaries of inclusion, but this framing is too limited. They should also be recognized as leaders in research design, talent cultivation, cultural competence, and problem definition. In many cases, these institutions have deep experience serving students and communities historically excluded from mainstream research systems. They are therefore not simply alternative venues for participation; they are strategic sites of knowledge production that can reshape the priorities and methods of clean energy research (Akter et al., 2025). Yet HBCU and MSI leadership is routinely constrained by structural underinvestment. Federal and philanthropic initiatives have created important opportunities, including programs designed to strengthen STEM education, support research initiation, and build broadening-participation research centers. Still, targeted programs alone cannot overcome a system in which many institutions remain comparatively undercapitalized, understaffed, and evaluated against norms developed around wealthy, doctorate-intensive universities. If underrepresented faculty must teach heavily while also mentoring students, carrying service burdens, and building administrative systems from limited resources, leadership opportunities will remain uneven unless funders and partner institutions intentionally redistribute support (Akter et al., 2025; U.S. Government Accountability Office, 2025). Accordingly, a more equitable model would position HBCUs and MSIs not merely as subcontractors or recruitment partners, but as agenda-setters, principal investigators, and co-equal hosts of research infrastructure. This means funding

long-term organizational capacity, supporting interdisciplinary centers, enabling faculty release time, resourcing graduate and undergraduate research pipelines, and rewarding partnership models that transfer authority rather than simply distributing tasks. It also means questioning the assumption that leadership legitimacy flows only from institution-wide prestige. In many instances, the institution best suited to lead a project is the one with the strongest community relationships, contextual knowledge, and commitment to equitable outcomes, even if it lacks R1 status (Akter et al., 2025).

4. Energy Justice and Community Engagement

Taken together, these questions of access, legitimacy, and leadership point to a broader normative issue: why representation in research matters for justice, as well as effectiveness.

Energy justice offers a useful framework for addressing that question. It is concerned not only with the distribution of energy benefits and burdens but also with procedural fairness, recognition, and meaningful participation (Jenkins et al., 2016; Sovacool et al., 2016). Recent work in clean energy and participatory research argues that equitable transitions require more than efficient technologies or well-designed policies; they require methods that treat affected communities as knowledge holders and co-producers of solutions. Community-based participatory research, participatory energy justice, and related approaches therefore challenge the traditional separation between expert and subject (Castro-Diaz et al., 2024).

This perspective is especially important when considering underrepresented and vulnerable communities that have been excluded from energy planning and clean energy innovation despite experiencing disproportionate harm. If these communities are consulted only after agendas are set, they remain outside the core of research power. By contrast, when they help formulate questions, identify metrics of success, assess implementation barriers, and interpret findings, research becomes both more democratic and more actionable. Literature on renewable energy project engagement underscores that trust, context, and procedural inclusion affect project acceptance and equity outcomes. The same principle applies to research systems themselves (Castro-Diaz et al., 2024; Romero-Lankao et al., 2023; Wüstenhagen et al., 2007).

For a call for papers centered on pathways in clean energy research, this has two implications. First, rigorous work should include studies that investigate exclusion not only within universities but across the broader ecosystem of utilities, local governments, financial institutions, philanthropic organizations, and intermediary bodies. Second, solutions-oriented scholarship should welcome methods that integrate qualitative and quantitative evidence with participatory design, community partnership, and institutional analysis. Such an approach does not weaken rigor; it better aligns rigor with the social realities of energy transition (Castro-Diaz et al., 2024; Jenkins et al., 2016).

Recommendations and Implementation Pathways

This section translates the paper's central argument into action. It outlines recommendations for funders, universities, research partners, and ecosystem leaders that can broaden access, redistribute authority, and build durable capacity for more equitable participation in clean energy research. Together, these implementation pathways emphasize that inclusion requires not only new opportunities but also changes in how legitimacy, leadership, and research excellence are defined and supported.

The central challenge is not simply to identify barriers, but to redesign the pathways through which people and institutions enter, lead, and influence clean energy research. A pathways framework should therefore operate at multiple levels simultaneously. At the funding level, agencies and foundations should broaden eligibility, simplify early-stage access, create planning and seed opportunities, and treat capacity building as part of excellent research design rather than as a charitable supplement. At the review level, evaluators should assess community relevance, partnership equity, and implementation potential alongside technical merit and prior productivity. At the institutional level, universities and research centers should expand definitions of scholarly contribution, invest in proposal development support for under-resourced faculty, and reward work that advances public impact, community partnership, and equity. At the ecosystem level, lead institutions should share authority, budget control, authorship, and decision-making with HBCUs, MSIs, community-based organizations, and practitioners (Castro-Diaz et al., 2024; Akter et al., 2025; U.S. Government Accountability Office, 2025).

Several actionable strategies follow from this framework. First, funders should pilot inclusive principal investigator models in which community-based organizations, public-interest intermediaries, and smaller institutions can lead or co-lead projects when they demonstrate contextual expertise. Second, partnership solicitations should require evidence of equitable governance rather than symbolic inclusion. Third, targeted investments should support faculty release time, grant administration infrastructure, and research development at HBCUs and MSIs. Fourth, calls for papers and conference processes should explicitly welcome mixed-methods, community-engaged, and practice-based contributions that examine institutional barriers and test pathways for change. Fifth, data collection and accountability mechanisms should track not only who receives funding, but who sets agendas, leads teams, and benefits from downstream recognition. Finally, mentorship and network development should be treated as infrastructure for equitable participation, not optional professional development (Akter et al., 2025; Gallo et al., 2022; U.S. Government Accountability Office, 2025).

Importantly, solutions must avoid reproducing deficit narratives. The problem is not that underrepresented researchers or institutions lack promise; it is that the system often mistakes historical concentration of resources for proof of greater merit. A pathways approach, therefore, shifts the question from whether underrepresented actors are ready to lead to whether the system is willing to recognize and resource the leadership already present (Akter et al., 2025; Gallo et al., 2022).

Conclusion

Clean energy research cannot achieve equitable outcomes if the structures that define expertise, opportunity, and legitimacy remain exclusionary. This paper argues that exclusion in clean energy research is not merely a matter of underrepresentation but the result of pathways shaped by funding architecture, institutional classification, prestige hierarchies, professional norms, and incomplete models of who counts as a researcher (Gallo et al., 2022; Hultgren et al., 2024). By situating that argument within a broader literature on research access, institutional change, and energy justice, and by analyzing it across four domains—funding equity and access, implicit bias and institutional practice, HBCU and MSI leadership, and community engagement—the paper shows how inequity is reproduced across the research ecosystem.

Reframing the problem around pathways rather than deficits opens a more productive agenda for research and action. It invites scholars, funders, and institutional leaders to redesign how access is structured, how leadership is recognized, how partnerships are built, and how research excellence is evaluated. The recommendations outlined here point toward implementation pathways that broaden eligibility, strengthen institutional capacity, support equitable governance, and center community-engaged forms of knowledge production. If the clean energy transition is to be both effective and just; it must expand not only through access to technologies but also through a redistribution of knowledge-making power. In that sense, the future of clean energy innovation depends as much on institutional redesign as on scientific discovery (Castro-Diaz et al., 2024; Jenkins et al., 2016; Sovacool et al., 2016).

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Powering Inclusion: Language Equity as a Gateway to Clean Energy Workforce Development

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Dr. Pamela L. Golatt is an Administrator with Columbus City Schools with expertise in English Learner (EL) education policy and urban school reform. She holds an EdD in Educational Administration from The Ohio State University, where her doctoral research examined the challenges and opportunities of ESL/ELL education in the Forrest City School District — a pseudonym for a fictional Columbus, Ohio urban school district used in Dr. Golatt's dissertation research. Her work sits at the intersection of language acquisition, equity, and community workforce development.

Abstract

The clean energy sector — particularly solar photovoltaic (PV) installation and wind turbine technician roles — represents one of the fastest-growing segments of the U.S. economy. Wind turbine service technicians are projected to grow 50% by 2034, and solar PV installers by 42%, making these among the top two fastest-growing occupations nationally (U.S. Department of Labor, 2024). A significant and rising share of the workers filling these roles are Hispanic/Latino immigrants or individuals with Limited English Proficiency (LEP): 24% of solar workers identify as Hispanic or Latino (IREC, 2024). Yet the linguistic infrastructure of the energy workforce training sector has not kept pace with its demographic reality. Drawing on original doctoral dissertation research examining ESL/EL education in urban school districts (Golatt, 2020), this paper argues that the same language acquisition barriers facing K–12 English Learners (ELs) persist — largely unaddressed — into the adult workforce. This paper proposes applying evidence-based ESL instructional frameworks — particularly sheltered instruction, primary language support, and family-school/community-employer partnerships — to energy sector workforce training, apprenticeships, and clean energy business development, offering actionable policy recommendations for cities, employers, and federal agencies.

Executive Summary

This policy and practice paper advances a central argument: language proficiency is not merely an educational concern — it is an economic development and workforce equity imperative. Key findings and recommendations include:

- Clean energy is a demographic reality: 24% of U.S. solar workers are Hispanic or Latino (IREC, 2024), up from 17.2% in 2019. Many are immigrants or LEP

individuals. Wind and solar are the #1 and #2 fastest-growing occupations in the nation (BLS, 2024).

- Language barriers are safety and economic barriers: LEP workers face documented barriers in comprehending onboarding, safety protocols, and certification processes (HammerTech Systems, 2024).
- Evidence-based ESL frameworks apply to the energy sector: Sheltered instruction, primary language support, and community-employer partnerships — proven in K–12 EL settings — can and should be adapted for clean energy workforce training.
- Latino-owned businesses are leading in green adoption but face structural funding and language barriers; 88% have adopted at least one green/sustainability initiative (Stanford Latino Entrepreneurship Initiative, 2024).
- Five policy recommendations are advanced: multilingual training standards, a Sheltered Energy Instruction Protocol (SEIP), expanded multilingual safety infrastructure, LEP-inclusive business development, and K-to-career EL pipelines.

Section 1. Introduction: The Intersection of Language, Labor, and the Clean Energy Economy

The United States is in the midst of an energy transition of historic proportions. Driven by the Inflation Reduction Act of 2022 (IRA) — the single largest climate investment in U.S. history — the clean energy sector is experiencing unprecedented growth in deployment, employment, and economic activity. Solar photovoltaic installation and wind energy are at the forefront of this transformation, not only as technology sectors but as labor markets that are reshaping the American workforce.

The numbers are striking. According to the U.S. Bureau of Labor Statistics, wind turbine service technicians are projected to grow by 50% between 2024 and 2034, making this the single fastest-growing occupation in the entire U.S. economy. Solar photovoltaic installers rank second, with a projected growth rate of 42% over the same period (U.S. Department of Labor, 2024). The solar and storage industries together employed 464,053 U.S. workers in 2024, with solar alone accounting for 280,119 jobs — more than three times the employment of the entire U.S. coal industry (IREC, 2024).

Yet behind these headline figures lies a demographic reality that has received insufficient attention from policymakers, workforce development agencies, and clean energy employers alike. The Interstate Renewable Energy Council's (IREC) 2024 National Solar Jobs Census reports that 24% of solar workers identify as Hispanic or Latino — up from 17.2% in 2019, a seven-percentage-point increase in just five years, exceeding the national Hispanic workforce average of approximately 19%. Many of these workers are immigrants. Many are individuals with Limited English Proficiency (LEP). They are, in short, building America's clean energy infrastructure — often in environments that have not been designed for their linguistic success.

This paper draws a direct line between two arenas that have rarely been connected in policy discourse: the education of English Learners (ELs) in urban K–12 school districts, and the workforce training of LEP adults in the clean energy sector. The connection is not merely analogical — it is developmental. Research conducted in Franklin County, Ohio (the Columbus metropolitan area) found that 23.6% of foreign-born persons are under the age of 18 (U.S. Census Bureau, 2016). The EL students in Columbus City Schools today are the energy workforce of tomorrow. The language barriers they face in the classroom — if unaddressed — will follow them into the job site, the apprenticeship program, and the small business loan office.

"Language proficiency is not merely an educational concern — it is an economic development and workforce equity imperative."
— Dr. Pamela L. Golatt, EdD

Dr. Golatt's doctoral dissertation, completed at The Ohio State University, examined the problems and opportunities of ESL education in an urban school district serving a large immigrant and EL population. The lessons from that research — about what works, what fails, and what is at stake when language is ignored — provide the evidentiary foundation for this paper's policy proposals. Applied with intention to the clean energy sector, these lessons offer a roadmap for building a workforce infrastructure that is not only green, but genuinely inclusive.

Key Data Point

Wind turbine service technicians and solar PV installers are the #1 and #2 fastest-growing occupations in the United States, projected to grow 50% and 42% respectively by 2034. The median annual wage for wind turbine technicians is \$62,580; for solar PV installers, \$51,860 (U.S. Department of Labor, 2024).

Section 2. The LEP Worker in the Energy Sector: Prevalence and Profile

To understand the challenge and the opportunity at the heart of this paper, it is necessary first to define the population in question. Consistent with the framing established in Dr. Golatt's dissertation research, the term LEP worker encompasses individuals whose primary home language is not English, including those described as non-English speaking (NES), limited English proficient (LEP), and non-native English speakers — terms used across the literature to identify persons for whom English is acquired rather than native (Echeverria et al., 2004; Harris & Hodges, 1995; McLaughlin & Vogt, 1996). This population is not marginal to the U.S. workforce; it is central to it — and nowhere more so than in the clean energy sector.

2a. Solar and Wind: A Hispanic and Immigrant Workforce

The IREC National Solar Jobs Census 2024 documents that Hispanic and Latino workers now constitute 24% of the U.S. solar workforce, up from 17.2% in 2019. This

concentration is especially notable in the installation and project development segment — the hands-on, site-based work that accounts for approximately two-thirds of all solar jobs. These are the roles most directly affected by onboarding language, safety communication, and certification requirements — and the roles most likely to be held by workers who are immigrants or LEP individuals.

In the distributed wind energy sector, a parallel pattern emerges. Research on distributed wind deployments finds strong correlations with linguistically isolated communities — specifically, census tracts where "limited English speaking" household populations are at or above the 90th national percentile. In other words, the communities where clean energy is being deployed are, in many cases, the same communities where English language access is most limited.

2b. Language as a Safety Barrier

Research from Hammertech Systems (2024) documents a troubling reality in the construction and installation workforce: language barriers materially inhibit LEP workers' comprehension of onboarding documentation, safety protocols, and ongoing site processes. This is not a peripheral concern. In industries like solar installation and wind turbine servicing — where workers routinely perform tasks at height, with electrical systems, and in confined spaces — miscommunication of safety information is a life-safety issue. Contractors are actively seeking multilingual safety support solutions, not merely as a diversity initiative, but as an operational necessity.

Safety Alert

Language barriers in clean energy installation sites are not a minor inconvenience — they represent a direct threat to worker safety. Solar installation and wind turbine servicing involve high-voltage electrical systems, fall hazards, and confined space entry. When safety protocols are communicated only in English to a predominantly LEP workforce, the consequences can be fatal. Multilingual safety infrastructure is a moral and legal imperative, not a luxury.

2c. The LEP Entrepreneur: Green Leadership Under-Resourced

The story of LEP communities in the clean energy economy extends beyond the job site to the business ownership and entrepreneurship dimension — and the data here are both encouraging and sobering. The Stanford Latino Entrepreneurship Initiative's 2024 State of Latino Entrepreneurship report documents that Latino-owned businesses (LOBs) are leading on sustainability: 88% of LOBs have adopted at least one green or sustainability initiative, compared to 76% of white-owned businesses. Latino-owned businesses collectively contribute \$4.1 trillion to U.S. GDP (LBAN).

Yet these businesses face structural barriers that limit their ability to fully participate in the clean energy economy. Latino-owned businesses face approximately 60% lower loan approval odds from national banks compared to similarly situated white-owned businesses (LBAN). Language-related barriers in outreach, permitting, and business development programs further constrain their access to clean energy incentives under the IRA and related programs.

Indicator	Data Point	Source
Hispanic/Latino share of solar workforce (2024)	24%	IREC, 2024
Hispanic/Latino share of solar workforce (2019)	17.2%	IREC, 2022
Total solar workers in the U.S. (2024)	280,119	IREC, 2024
Solar & storage combined U.S. employment (2024)	464,053	IREC, 2024
Wind turbine technician job growth projected (2024–2034)	50% (fastest in U.S.)	BLS, 2024
Solar PV installer job growth projected (2024–2034)	42% (2nd fastest in U.S.)	BLS, 2024
Latino-owned businesses with green/sustainability initiatives	88% (vs. 76% white-owned)	SLEI, 2024
Latino-owned business contribution to U.S. GDP	\$4.1 trillion	LBAN
Foreign-born persons under 18 in Franklin County, OH	23.6%	U.S. Census Bureau, 2016

The evidence is clear: non-English speaking and LEP individuals are not peripheral to the clean energy economy. They are central to it. They install the panels, service the turbines, and lead businesses that are measurably more likely to embrace green practices than their white-owned counterparts. What is missing is the infrastructure — linguistic, educational, and policy — to ensure they can fully participate in its prosperity.

Section 3. Lessons from ESL/EL Education: Applying Evidence-Based Frameworks to Workforce Training

The field of English as a Second Language (ESL) education has produced a substantial evidence base over several decades — evidence about what works, what does not, and what is at stake when language learners are not adequately supported. Dr. Golatt's doctoral dissertation research, conducted in the Forrest City School District — a fictional school district in Columbus, Ohio created for the purposes of the dissertation research — contributed directly to this body of knowledge, examining ESL practices in an urban school district with a large and growing immigrant student population. The findings of

that research — and the broader literature it engaged — carry profound implications for clean energy workforce training. This section draws those connections explicitly.

3a. The Language Acquisition Timeline Problem

Perhaps the most consequential insight from the ESL research literature — and one of the most frequently ignored by policymakers — is the finding that it takes English language learners between 4 and 7 years to attain full academic English proficiency (Hakuta, Butler & Witt, 2000; Cummins, 1996). This is a far longer timeline than most institutions — schools, employers, and training providers alike — are designed to accommodate.

Golatt's dissertation research found that in the Forrest City School District (pseudonym), as in districts across the country, the institutional response to this reality was often inadequate. Research by McKeon (1994) found that 75% of non-English speaking school children are placed with teachers who have no training in second language acquisition, ESL, or bilingual education. The implications for clean energy workforce training are direct and troubling: if three-quarters of EL students are taught by instructors unequipped for their linguistic needs, it is reasonable to assume a comparable — if not greater — deficit exists among clean energy training program instructors.

Rushed, English-only workforce training programs fail LEP workers in precisely the same way that inadequate two-year immersion programs failed EL students in Golatt's research — not because the learners lack capability, but because the system lacks the infrastructure to meet them where they are.

Research Insight

English language learners require 4–7 years to attain full academic language proficiency (Hakuta, Butler & Witt, 2000). Yet most clean energy training programs — apprenticeships, safety certifications, NABCEP prep courses — are designed for delivery in days or weeks, entirely in English, with no accommodation for language acquisition stages. This structural mismatch is not the worker's failure. It is a design failure.

3b. Sheltered Instruction: A Model for Energy Training Programs

One of the most rigorously studied and validated frameworks in ESL/EL education is the Sheltered Instruction Observation Protocol (SIOP). Developed through a seven-year research project and refined through extensive field testing, SIOP consists of eight interconnected components: lesson preparation, building background, comprehensible input, strategies, interaction, practice and application, lesson delivery, and review and assessment (Echevarria et al., 2008; Kareva & Echevarria, 2013). The protocol is not a simplified curriculum — it is a pedagogical framework for making rigorous, grade-level content simultaneously accessible to language learners.

The evidence base for SIOP is compelling. Teachers trained in SIOP produced students who outperformed their peers in both reading and writing (Richards-Tutor et al., 2016). The model achieves this by making the language of instruction explicit — articulating not just content objectives, but language objectives — and by using visual supports, manipulatives, structured interaction, and scaffolded tasks to make complex content comprehensible without simplifying it.

The application to clean energy training is both logical and actionable. Solar installation training, wind turbine technician certification, electrical safety orientation, and permitting navigation are all content-rich, technically demanding domains — precisely the kinds of domains for which sheltered instruction was designed. A "Sheltered Energy Training" protocol modeled on SIOP would articulate content language objectives for each training module; use visual schematics, bilingual glossaries, and manipulative models; structure peer interaction to build both technical and linguistic competency; and embed language assessment into competency verification processes.

3c. Primary Language Support

A second foundational principle from the ESL research literature concerns the role of the learner's primary language. Richard Ruiz (1984), whose work is cited extensively in Golatt's dissertation, articulated the distinction between viewing language as a problem, a right, or a resource. Programs that view the primary language as a resource — rather than an obstacle to be overcome — consistently produce better outcomes for language learners.

The research literature is unambiguous on this point. Proper use of the primary language makes instruction more comprehensible, accelerates English acquisition, and improves content mastery (Wright, 2008). Studies of bilingual education programs have found that students in well-designed bilingual programs consistently outperform peers in English-only settings on standardized assessments — even in English — over a period of five to seven years (Thomas & Collier, 2002).

The implications for clean energy workforce training are direct. Solar and wind training programs should offer key materials, safety documentation, certification preparation resources, and onboarding processes in the primary languages of their workforce — with Spanish as the highest-priority language given current workforce demographics, but also including Somali, Amharic, Arabic, Haitian Creole, and other languages reflecting the diversity of immigrant communities in cities like Columbus, Ohio. This is not a concession to language barriers — it is a strategic investment in workforce competence. Hammertech Systems' 2024 research confirms that contractors are actively seeking multilingual language support throughout the project lifecycle, not merely at orientation.

3d. Family and Community Partnerships: Adapted to Employer and Community Partnerships

The third pillar of evidence-based ESL/EL practice with direct applicability to the clean energy workforce is the model of family and community partnerships. Golatt's dissertation research, drawing on the broader literature, found that effective programs for EL students build robust partnerships with families — communicating in the primary language, employing bilingual staff, translating documents, and creating peer-to-peer support networks among families navigating similar experiences (Richards-Tutor et al., 2016).

Translated into the workforce development context, this framework calls for employer-community partnerships that mirror the school-family model. Clean energy employers, workforce training providers, and community-based organizations (CBOs) should co-create culturally competent navigation support for LEP workers — including bilingual HR staff and safety officers, peer mentorship among workers sharing linguistic backgrounds, multilingual outreach for recruitment and advancement opportunities, and partnerships with immigrant-serving organizations capable of bridging the cultural and linguistic gap between employer expectations and worker experience.

The National Clean Energy Workforce Alliance, coordinated by IREC, has already articulated the need for community-based organizations, energy justice organizations, and workforce programs with wraparound services to remove barriers for underrepresented workers. The ESL/EL literature provides a tested, evidence-based model for what those wraparound services should look like when language is the central barrier.

ESL/EL to Clean Energy: A Framework Comparison

The following table summarizes the parallel between evidence-based ESL/EL education best practices and their proposed applications to clean energy workforce training — the core analytical contribution of this paper.

ESL/EL Education Best Practice	Application to Clean Energy Workforce Training
Sheltered Instruction Observation Protocol (SIOP): Eight-component framework using visual supports, comprehensible input, explicit language objectives, and scaffolded content delivery for EL students.	Sheltered Energy Instruction Protocol (SEIP): Adapt SIOP for installer training, safety certification, and apprenticeship programs — with bilingual glossaries, visual schematics, and language objectives embedded in all technical modules.
Primary Language Support: Use of the learner's native language as a resource to accelerate English	Multilingual Training Materials: Provide safety documentation, NABCEP certification prep, onboarding materials, and permitting

ESL/EL Education Best Practice	Application to Clean Energy Workforce Training
acquisition and deepen content mastery; bilingual instructional materials and staff.	guidance in Spanish, Somali, Arabic, Amharic, and other languages of the workforce. Bilingual trainers and job site safety officers.
Long-Term Language Acquisition Timeline: Recognition that full academic English proficiency takes 4–7 years; training and assessment designed to meet learners at their current proficiency level.	Proficiency-Tiered Training Design: Design apprenticeship and continuing education programs with multiple entry points, tiered language supports, and assessment instruments validated for use with LEP learners — not single-entry English-only programs.
Family-School Partnerships: Bilingual communication with families, bilingual staff, translated documents, parent-to-parent support networks, culturally competent community liaisons.	Employer-Community Partnerships: Bilingual HR and safety staff, peer mentorship networks among workers, partnerships with CBOs and immigrant-serving organizations, multilingual recruitment and advancement communications.
Primary Language as a Resource (Ruiz, 1984): Productive programs view linguistic diversity as an asset to be cultivated, not a deficit to be remediated.	Multilingual Workforce as Competitive Advantage: Employers serving diverse markets — including international solar supply chains and multinational clean energy companies — benefit from a multilingual workforce. Reframe LEP as a competency, not a constraint.
Bilingual Education Outcomes: Students in well-designed bilingual programs outperform English-only peers on standardized assessments over a 5–7 year horizon (Thomas & Collier, 2002).	Long-Term ROI of Multilingual Training: Contractors and employers investing in multilingual onboarding and training will see lower turnover, higher safety compliance, faster certification attainment, and stronger worker retention among LEP workers.
K–12 EL Career Relevance: ELL students are future workforce participants; language instruction should be connected to vocational contexts and career aspirations.	K-to-Career Clean Energy Pipelines: CTE programs in urban school districts with large EL populations should introduce clean energy career pathways during students' language acquisition years — connecting linguistic and vocational learning in culturally relevant ways.

Section 4. Policy Implications and Recommendations

The evidence assembled in this paper supports a set of concrete, actionable policy recommendations directed at federal agencies, state workforce boards, clean energy employers, community development institutions, and urban school districts. These recommendations are designed to be mutually reinforcing — together comprising a systemic approach to language-inclusive clean energy workforce and economic development.

Recommendation 1

Mandate Multilingual Training Standards in Clean Energy Apprenticeship Programs
Federal and state workforce agencies — including the U.S. Department of Labor's Office of Apprenticeship — should require that Registered Apprenticeship Programs (RAPs) in solar, wind, and energy storage industries provide core safety training, technical instruction, and assessment instruments in the primary language(s) of the workforce. The IRA's workforce provisions, including its prevailing wage and apprenticeship requirements, create both a mechanism and a mandate for this standard. States with large Hispanic/Latino clean energy workforces — including California, Texas, Florida, Nevada, and Ohio — should develop pilot programs for multilingual RAPs within 18 months of this paper's submission.

Recommendation 2

Adopt a Sheltered Energy Instruction Protocol (SEIP)
The U.S. Department of Energy (DOE) and the Solar Energy Industries Association (SEIA), in partnership with IREC and leading workforce training providers, should develop and disseminate a Sheltered Energy Instruction Protocol (SEIP) modeled on the evidence-based SIOP framework. The SEIP should articulate content language objectives for each module of solar and wind installer training, NABCEP certification preparation, and continuing education programs. DOE's Office of Energy Efficiency and Renewable Energy (EERE) should fund development of open-access SEIP curriculum resources in a minimum of five languages within 24 months.

Recommendation 3

Expand Multilingual Safety Infrastructure
OSHA, DOE, and state energy offices should fund a dedicated multilingual safety infrastructure initiative targeting the solar and wind installation workforce. This initiative should include: (1) translated written safety materials in all languages spoken by more than 5% of a contractor's workforce; (2) multilingual digital safety management platforms for job site documentation and incident reporting; (3) funding for bilingual safety officers at installation sites with a majority LEP workforce; and (4) OSHA 10 and OSHA 30 training programs available in Spanish as a standard offering, with additional languages available on request. Hammertech Systems' 2024 research confirms that contractors are actively seeking these solutions — federal and state investment can accelerate their adoption.

Recommendation 4

Invest in LEP-Inclusive Business Development for Clean Energy Entrepreneurs

The IRA's clean energy tax credit programs, combined with DOE's Loan Programs Office and SBA resources, represent an unprecedented opportunity to support LEP-owned businesses in the clean energy sector. Yet access to these programs requires navigating complex English-language application processes, legal documentation, and technical specifications. Given that Latino-owned businesses face approximately 60% lower loan approval odds from national banks (LBAN) and are leading on green business adoption (88% have adopted at least one green initiative, SLEI 2024), CDFIs, SBDCs, and state energy offices should develop culturally tailored, multilingual clean energy business development programs — with bilingual navigators, translated IRA incentive guides, and culturally competent technical assistance — specifically targeting LEP entrepreneurs in the solar installation, distributed energy, and energy efficiency sectors.

Recommendation 5

Build K-to-Career Pipelines in Urban EL Programs

Urban school districts with large EL populations — including Columbus City Schools and comparable districts in cities participating in the NGIN Cityscapes Summit — should develop Career and Technical Education (CTE) pathways that introduce EL students to clean energy careers during their language acquisition years. These pathways should integrate English language development with solar installation fundamentals, energy efficiency principles, and clean energy entrepreneurship — creating curricular sequences that are simultaneously linguistically supportive and vocationally relevant. Partnerships with local solar installers, utility companies, community colleges, and workforce development boards should provide work-based learning experiences that connect classroom language instruction to real clean energy job sites. Franklin County, Ohio — where 23.6% of foreign-born persons are under 18 (U.S. Census Bureau, 2016) — is an ideal pilot site for this model.

Section 5. Implications for Cities and Economic Development

The NGIN Cityscapes Summit convenes under the theme "Igniting Innovation. Powering Economies." This paper contends that the most significant innovation available to cities with large immigrant and LEP populations is not primarily technological — it is structural. It is the decision to design workforce and economic development systems that include, rather than exclude, the workers and entrepreneurs who are already driving the clean energy transition.

5a. The Urban LEP-Clean Energy Nexus

Cities with large immigrant populations are simultaneously experiencing two phenomena that, viewed together, represent both a challenge and an extraordinary opportunity: rapidly growing labor demand in clean energy — fueled by the IRA, state renewable portfolio standards, and municipal clean energy commitments — and a large, untapped LEP workforce with significant representation already in the sector. Columbus, Ohio exemplifies this dynamic. A city with one of the most diverse immigrant populations in the Midwest, home to communities speaking Somali, Amharic, Arabic,

Spanish, Nepali, and dozens of other languages, Columbus is also a city with ambitious clean energy goals and a growing solar and efficiency installation workforce.

For cities like Columbus, the question is not whether LEP workers will participate in the clean energy economy — they already are. The question is whether they will do so safely, with access to advancement, certification, and business ownership, or whether they will remain in the lowest-wage, highest-risk tiers of a sector that is otherwise producing family-sustaining careers.

5b. Community Wealth, Ownership, and the Clean Energy Dividend

One of the central themes of the NGIN Cityscapes Summit is Community Wealth and Ownership: the principle that equitable economic development is not just about job creation, but about building assets, ownership, and generational wealth in communities that have historically been excluded from economic growth. This principle maps directly onto the clean energy workforce equity agenda.

When a LEP solar installer attains NABCEP certification, they move from an hourly installation wage to a supervisory or technical credential that commands significantly higher earnings. When a Latino-owned roofing company successfully pivots to include solar installation — supported by multilingual IRA incentive guides, bilingual CDFI loan navigators, and culturally competent technical assistance — it builds business equity that can be transferred across generations. When an EL student in Columbus City Schools completes a clean energy CTE pathway and enters a registered apprenticeship upon graduation, the city retains the clean energy dividend in the community that built it.

"What if the real challenge isn't attracting wealth — but keeping it?"
— NGIN Cityscapes Summit

Language-inclusive clean energy workforce and business development is not a social welfare program. It is a community wealth strategy. It is the mechanism by which cities ensure that the green economy dividend — the jobs, the contracts, the certifications, the business equity — accrues to the communities doing the work, not merely to the firms and investors directing it.

5c. The Future of Economic Development Is Multilingual

The NGIN Cityscapes Summit also engages the theme of the Future of Economic Development — the question of what tools, frameworks, and innovations will define how cities build prosperity in the decades ahead. This paper argues that language-inclusive clean energy workforce development is precisely such an innovation.

Traditional economic development frameworks have often treated language as a barrier to be overcome by assimilation — a problem that immigrant communities would solve on their own over time. The ESL/EL research literature, and Dr. Golatt's dissertation work in particular, demonstrates that this approach fails: it fails the learners, it fails the schools, and — as this paper argues — it will fail the clean energy employers and cities that depend on a multilingual workforce without building the infrastructure to support it. The innovation is not a technology. It is a reframing: from language as a problem to language as a resource; from assimilation as the strategy to inclusion as the

investment. Cities that make this investment — that develop multilingual clean energy training programs, LEP-inclusive business development services, and K-to-career EL pipelines — will find themselves with workforce advantages that are not easily replicated. They will have a deeper, more diverse, more resilient pool of clean energy workers and entrepreneurs. They will have communities with a greater stake in the clean energy transition. And they will have demonstrated, in practice, that economic development and equity are not competing values — they are the same value, pursued with intention.

A Note for NGIN Member Cities

Cities participating in the NGIN Cityscapes Summit are uniquely positioned to serve as pilot sites and peer-learning networks for language-inclusive clean energy economic development. The NGIN model of peer city exchange, combined with the policy frameworks proposed in this paper, offers a pathway for NGIN cities to collectively develop, test, and scale multilingual clean energy workforce and business development programs — sharing lessons across city contexts and building the evidence base for national policy adoption.

Conclusion

The clean energy transition is not a future event. It is happening now, and it is being built — panel by panel, turbine by turbine, connection by connection — by a workforce that is disproportionately Hispanic, immigrant, and non-native English speaking. The workers filling the #1 and #2 fastest-growing occupations in the United States are, in significant measure, individuals who learned to work in a language they are still learning to speak. That is not a problem to be solved. It is a reality to be honored — and a challenge to be met with the same rigor and intentionality that the best ESL/EL educators have brought to their work for decades.

Dr. Golatt's research in the Forrest City School District (pseudonym) demonstrated that the barriers facing English Learners are not insurmountable. They are addressable — through evidence-based instruction, primary language support, and robust community partnerships. The evidence is clear: when the right frameworks are applied with fidelity and intention, language learners thrive. They outperform their peers. They close the gap. They build futures.

The same is possible in the clean energy workforce. A Sheltered Energy Instruction Protocol can make technical training accessible to LEP workers without sacrificing rigor. Multilingual safety infrastructure can save lives. Bilingual apprenticeship programs can accelerate certification attainment. LEP-inclusive business development can unlock the green entrepreneurship potential of Latino-owned and other immigrant-owned businesses that are already leading on sustainability. K-to-career clean energy pathways in urban EL programs can turn the pipeline — the very same young people sitting in Columbus City Schools today — into the certified installers, supervisors, and business owners of tomorrow.

What is missing is not the workers. What is missing is not the will. What is missing is the infrastructure — educational, linguistic, and policy — that says to those workers: you belong here, and this system is designed for you. The time to build that infrastructure is now. The clean energy transition will not wait. Equity cannot wait either. Cities that invest in language-inclusive clean energy workforce development are not just building a greener economy — they are building a more equitable one. And a more equitable economy is, in the end, the stronger one.

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