

affordable energy for all

an imperative for a just energy transition

THE UNITED NATIONS (UN) SUSTAINABLE Development Goals (SDGs) are a set of 17 global goals adopted by the UN in 2015. They aim at ending poverty, hunger, and discrimination while mitigating climate change impacts. These SDGs are a common road map for peace and prosperity, for both developed and developing countries, in global partnership. Of special interest to the readers of this magazine is SDG 7, whose aim is to “ensure access to affordable, reliable, sustainable, and modern energy for all” by 2030. The first indicator of SDG 7 is access to electricity. In 2022, 91% of the world’s population had access to electricity, in contrast to 78% in the baseline year of 2000. The 20 countries with the least access to electricity are home to 76% of the global population, which is left in the dark. Sixteen of these countries are in sub-Saharan Africa (SSA), where half of the population lacks access to electricity. The sad news is that the trend is not good. The 2024 SDG 7 report confirms that the number of people without access to electricity (i.e., clean energy) increased for the first time in more than a decade, reaching 685 million in 2022 (10 million more than in 2021). New electricity connections have not kept pace with population growth, which is largely concentrated in SSA. This regression can be explained by a combination of factors: the global energy crisis, infla-

tion, growing debt overhang in many low-income countries, intensification of geopolitical tensions, and so on. However, the deployment of distributed energy systems, most often based on renewable energy, is a promising development that, according to World Bank findings, is helping to accelerate progress, especially in rural areas, where 80% of the population currently lives without electricity.

Access to electricity has emerged in the context of ecology transition as a fundamental right, but unfortunately, for hundreds of millions of people, available electricity is insufficient or unreliable; the latter group is present in developed countries, as well. In 2020, Nigeria had 77 million people without access to electricity, which is the largest number in SSA and the second-largest in the world, after India (Figure 1). The reliability of the power grid ranges there from 39% to 66%, with an average of 4.5 h of continuous access per day. For context, having access to electricity is defined in international statistics as having an electricity source that can provide very basic lighting and charge a phone or power a radio for 4 h per day, compared to less than 5 min per year without electricity in most countries of the Global North (the latter figure matching 99.999% reliability). Despite the privatization of the grid by the federal government of Nigeria to improve access to electricity, there has been no significant improvement. The consequences are broad and include barriers to health care, education, productivity,

and digital inclusion. Fortunately, new technologies, such as minigrids and solar panels for individuals, as well as long-term planning, can help expand access to energy services for the poorest populations. It is imperative to sustain the efforts to end this energy inequality and improve the lives of the most vulnerable, not only in the Global North but everywhere on Earth.

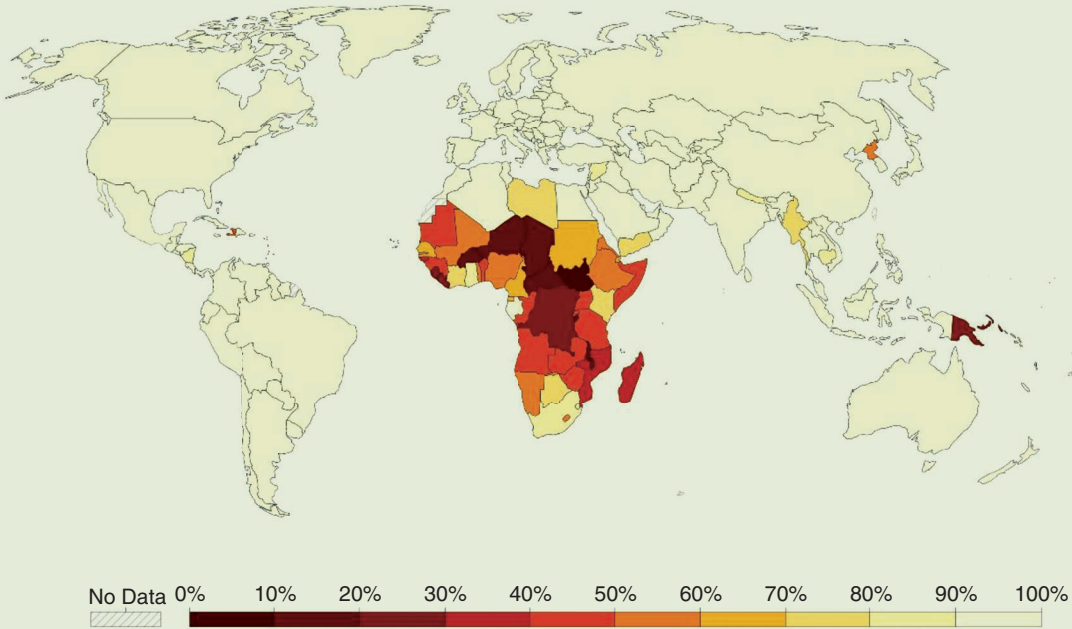
From the above reading, one may be tempted to conclude that the energy poverty issue is limited to underdeveloped countries. This is not true. Defined as “the lack of access to modern and affordable energy services,” energy poverty or inequitable access to energy is not solely a plea of SSA. Low-income households in U.S. cities spend nearly three times more on energy costs than nonlow-income households (7.2% compared to 2.3%). In addition, 14% have received an energy disconnection notice. Data have shown that too-high energy bills undermined the ability of 21% of U.S. households to buy medicine and food. The Biden administration has created the White House Office of Environmental Justice to supplement other initiatives and programs, such as the Low-Income Home Energy Assistance Program, which has not been successful so far in combating rising energy bills for low-income Americans.

Energy justice has gained prominence recently as both a societal issue and a multidisciplinary research field. Hence, the National Science Foundation (NSF) funded a workshop in 2023 entitled “NSF 2026: Priorities and

Share of the population with access to electricity, 2021

Our World
in Data

Having access to electricity is defined in international statistics as having an electricity source that can provide very basic lighting, and charge a phone or power a radio for 4 hours per day.



Data Source: Data Compiled From Multiple Sources by World Bank

figure 1. Today, four in five people without access to electricity are in SSA. (Source: “Ensure Access to Affordable, Reliable, Sustainable and Modern Energy for All,” Our World in Data; used with permission.)

Research Needs for an Equitable Energy Transition,” while the United States Department of Energy has established the Office of Energy Justice Policy and Analysis to help frame energy poverty’s impacts on policy, poverty alleviation, environmental impact, and social inequity. Furthermore, the topic has attracted the interest of the National Academy of Sciences. Its 2021 report on “Future Electric Power in the United States” identified “affordability and equity” as one of three core values to consider while building a “safe and secure and grid,” the two other core values being “sustainability and clean power” and “reliability and resilience” (Figure 2).

Indeed, this is not the first time that the magazine has ventured into the more just access to energy topic, which may be deemed a subject more suitable to social scientists and energy regulators. We are often reluctant to treat issues that can’t be solved through

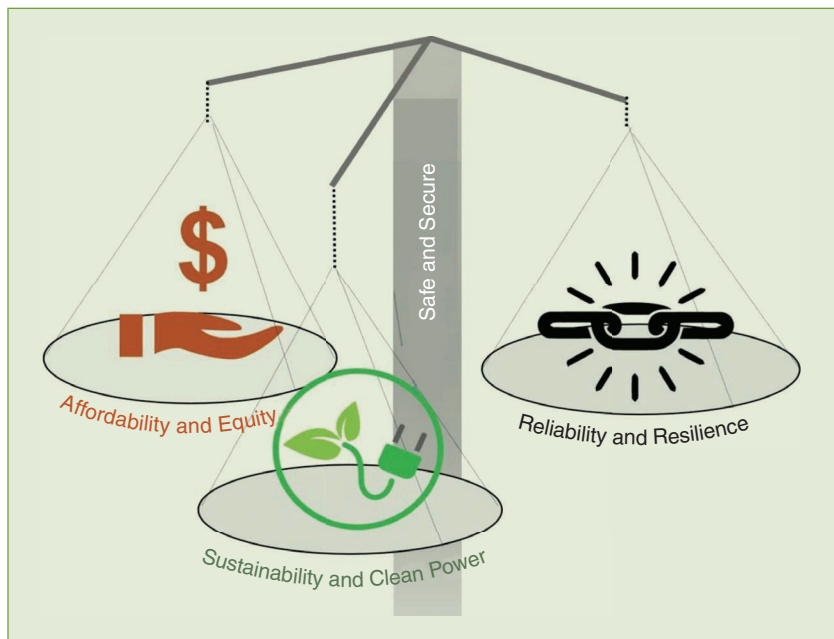


figure 2. The National Academy of Engineering’s vision for future electric power in the United States: the electricity grid should remain safe and secure and balanced in three key attributes: affordability and equity, sustainability and clean power, and reliability and resilience.

technologies developed by engineers, while simultaneously recognizing the key role of engineering in addressing such urgent societal crises through cheaper distributed energy resources (DERs) and democratized energy efficiency schemes. The *IEEE Power and Energy Magazine (PEM)* issue of September/October 2022, entitled “Powering the World: Using Initiatives to Create Smart Cities and Smart Villages,” featured a four-part article on the need for engineers to take a multidomain system-of-systems approach to alleviate poverty and consider other UN SDGs in addition to SDG 7, universal clean energy for all. Indeed, decentralized energy resources, such as low-cost photovoltaic solar and wind, can propel a massive exponentially disruptive change. These technologies can contribute to creating

zero-carbon villages in places currently facing chronic energy deficits.

European Union energy policies from 2015 onward highlight the potential for the energy community (Figure 3) to increase access to renewable energy and energy efficiency for vulnerable groups as a means to mitigate energy poverty sustainably. These new policies resulted in a surge of energy cooperatives in recent years, with 900 in Germany alone. However, recent findings question their benefit in reducing access inequalities, as, generally, green neighborhood communities tend to aggregate upscale consumers, leaving out (or ignoring the needs of) lower-scale consumers. Energy communities are a kind of social club for the “rich,” often requiring expensive new technology or high initial invest-

ment to participate in the benefits that arise from the acquisition of self-production and energy efficiency assets. For instance, participating in Tesla Virtual Power Plant requires a Tesla wall-mounted power storage device, which is not possible for low-income households in the absence of important subsidies.

In summary, whether considering the Global North, Global South, or SSA regions, paying for adequate energy is a heavy burden on many low-income households and undermines the goals of affordability and equity. Although bill payment assistance can provide short-term help, investments in energy efficiency can provide long-term savings on electricity bills. As new energy strategies and technologies are adopted by higher-income customers, care should

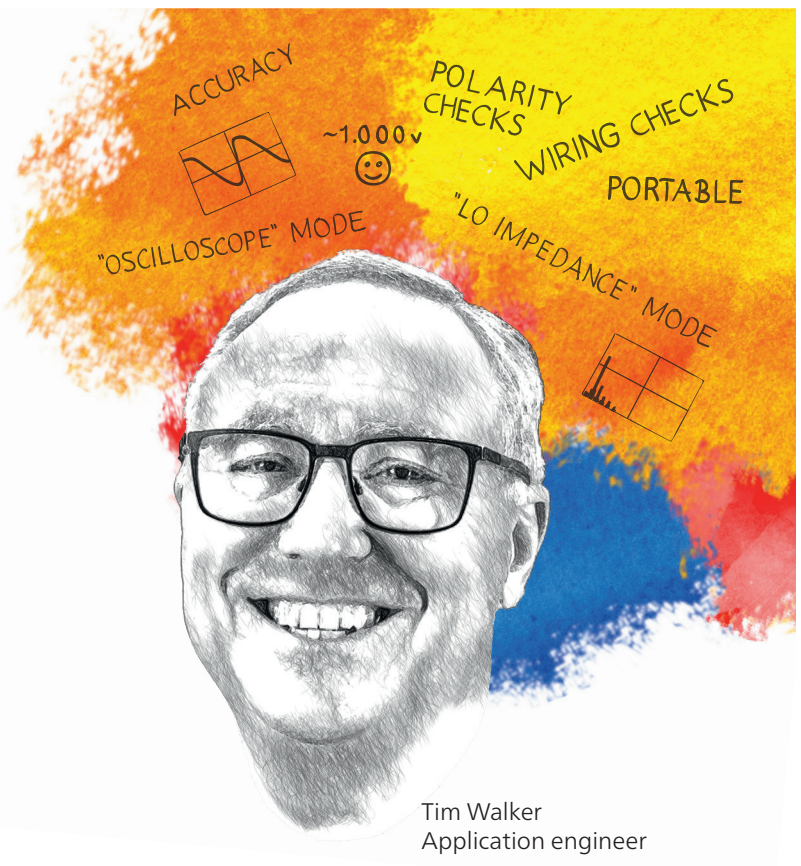
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be taken to ensure the following: 1) that electricity is an essential service that is universally available and affordable and 2) that the externalities that arise from its production and use do not disproportionately burden those who are least able to deal with them. This is true for Global North. For the Global South and SSA, increases in access to electricity must accelerate to achieve SDG 7.1. Findings from the World Bank and a good amount of evidence from scientific literature (including this magazine) concur that decentralized renewable energy is key to achieving SDG 7.1 by 2030, through deploying a combination of grid, minigrid, and stand-alone off-grid solutions that leverage the faster deployment of distributed renewables to quickly meet the current levels of demand. National and regional electrification programs using public funding to unlock private coinvestment at scale can bring these solutions to life.

The story of this issue began in a rush in early April 2023. I had been informed by the vice president of publications, who was then Prof. Bikash Pal, from Imperial College, London, that it would be in the interest of IEEE Power and Energy Society (PES) leadership and *PEM* readers to address the issue

of energy justice. Why? Because it was a hot topic with broad policy implications, on which PES might want to, or should, take a stand. The same for the *PEM* community. The NSF-sponsored workshop “Priorities and Research Needs for an Equitable Energy Transition” was about to be held in Washington, DC, USA, on 28 April 2023. The terms “energy poverty,” “energy justice,” and “equitable energy system” were trending in the energy community. At the government level, they were becoming standard keywords and requirements in major funding calls worldwide as a means to stimulate multidisciplinary R&D on climate-resilient energy systems. At the request of Jessica Bian, who was then PES president and whose leadership and foresight on this matter should be commended, we initiated a meeting with Prof. Pal and Prof. Masood Parvania, a leading expert in this field, to jump-start a special *PEM* issue on “Energy Justice/Poverty.” The schedule of magazine issues for 2024 was already published, but given the urgency of this topic, we decided to plug it into the July/August 2024 slot and displaced in time all initially planned issues accordingly. Prof. Parvania rushed to build a guest

editorial team that was able to present a full proposal to the editorial board of *PEM* at its meeting during the 2023 PES General Meeting, in Orlando, FL, USA. The proposal was approved outright with only minor modifications, but this was only the beginning of a marathon. The regular planning of the magazine mandates closing the lineup in early April (i.e., a three-month lead time from gate closure to publication), but because of the late start and the necessary steps in the review process, we closed the lineup only in mid-June, after anxiously working around the clock to fine-tune the publication material. In my opinion, we succeeded, at the end, in crafting an issue of the magazine on a multidisciplinary and barely technology-driven subject that will broaden our leadership, thanks to its focus on energy policy and social justice.

Building a resilient climate-coupled energy system requires not only technical innovation but also attention to social justice and equity. As a result, within research and practice, there has been growing interest in and commitment to energy justice. Energy justice aims to “achieve equity in both the social and economic participation in the energy system, while also remediating

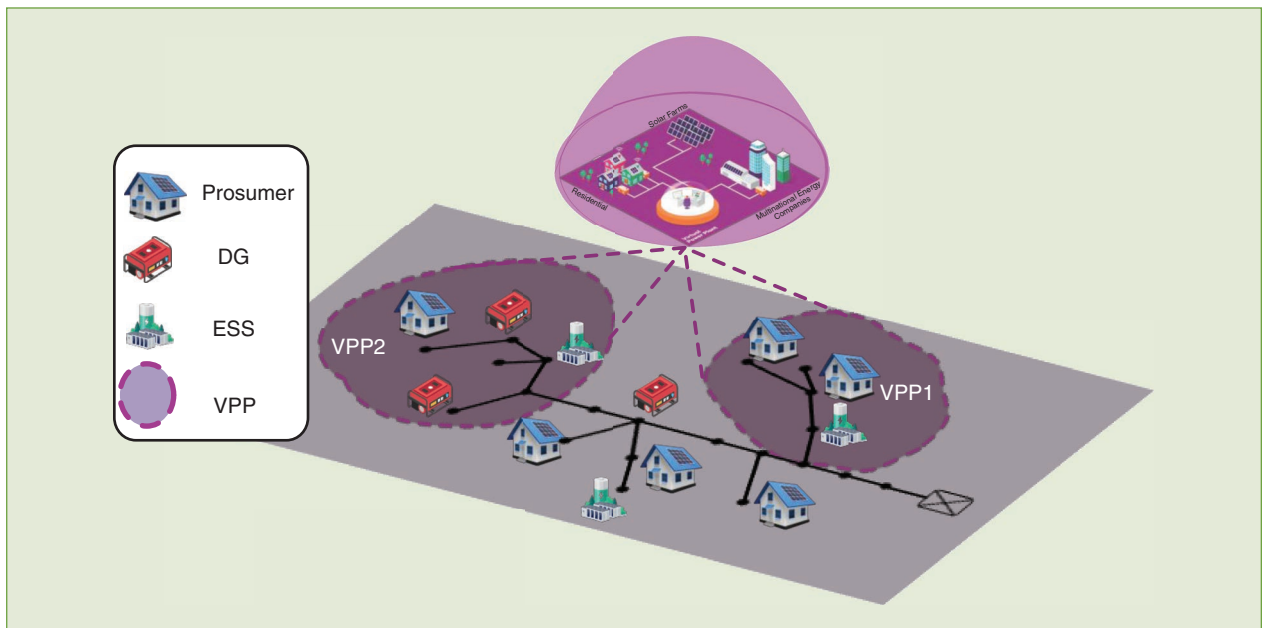


figure 3. Building equitable energy communities is an ethical imperative. DG: distributed generation; ESS: energy storage system; VPP: virtual power plant.

social, economic, and health burdens on those historically harmed by the energy system.” It also focuses on the idea that inclusive participation in, access to, and ownership of energy is foundational to a clean energy future. Through eight feature articles, we explore the technologies and policies that can enable and sustain this vision, consistent with UN SDG7 and many government policies in the Global North, Global South, and SSA. While most of the authors are from North America, their scientific background is pretty diversified, ranging from management sciences, computer sciences, economics, and public administration to electrical and energy engineering, which allows them to examine the topic from cross-sectional viewpoints. Because of time constraints, we were unable to include the perspective of inherited

countries of SSA, although one of the articles discusses the role of DERs in supporting equitable energy outcomes for disadvantaged communities. To fix this perceived gap, the editorial board of the magazine is determined to invite nonengineering-centered articles addressing policies, technologies, and economics surrounding affordable and more equitable access to electricity in these countries over the coming months.

The article “Energy Poor No More: Intelligent Approaches to Realizing Energy Well-Being,” [A8], co-authored by Corbett from Canada and Savarimuthu from New Zealand, stands out because it was specially invited by the Editor in Chief to provide an original international perspective on the topic of Energy Justice. After discussing the policy and political context of Energy

Justice in their respective countries, the authors focus on energy poverty in situations where households have access to reliable energy systems but still struggle to meet their basic energy needs. Leveraging their well-recognized expertise in digital transitions associated with the smart grid, the authors propose the Energy Well-Being Information System (EWISe). This integrated platform, which can be deployed in the cloud, collects, analyzes, and disseminates relevant information to support energy-poverty reduction at multiple levels. The potential impact of EWISe, powered by machine learning (ML) and artificial intelligence (AI), is a beacon of hope for achieving sustainability objectives in the Global North and Global South.

As a magazine committed to promoting diversity across countries, genders,



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and minority representation, we celebrate this excellent paper as an example of successfully bridging expertise from computer sciences and management sciences to inform the power and energy experts from alternative angles and viewpoints. It leverages human intelligence and AI through an EWISE solution to provide a holistic view of

sustainability challenges at the intersection of engineering and public policy.

History Column

In this issue's "History" column [A9], our irreplaceable Robert D. Barnett contributes his ninth piece to *PEM*. As always, his choice of topic is intriguing and this time focuses on the

early years of parallel operation of dc and ac generators. His approach is not only educational but also entertaining and a true pleasure to read.

Leader's Corner

It is our great pleasure to host Prof. Nirmal Nair, of the University of Auckland, as the author of our "Leader's

In This Issue

This issue focuses on emerging trends in energy justice and equity within the power sector. As the world moves toward a sustainable and resilient energy future, addressing disparities in energy access, affordability, and the benefits of technological advancements becomes crucial. Our contributors provide insightful research and case studies, highlighting strategies and solutions to ensure a just transition that leaves no community behind.

Toward that end, our guest editors have organized eight articles in this issue that highlight the range of challenges and solutions related to energy justice and equity in the power sector.

The article "Energy Justice and Equity: Applying a Critical Perspective to the Electrical Power Grid for a More Just Transition in the United States" [A1] defines an energy justice taxonomy and examines how the electrical grid can contribute to various forms of injustice. The authors highlight disparities in infrastructure resilience and the uneven distribution of grid vulnerabilities, calling for a more equitable approach to grid development and maintenance.

In "Reducing Energy Burden in the Power Sector: Metrics for Assessing Energy Poverty" [A2], the authors address the challenge of measuring and reducing the energy burden: the percentage of income spent on energy bills. They advocate for a comprehensive approach to achieving energy justice that includes weatherization, community engagement, and policy interventions to ensure that vulnerable households have adequate energy for comfort and safety.

The article "Resilience Hubs: Bolstering the Grid and Empowering Communities" [A3] explores the concept of resilience hubs as a grassroots solution to enhance community and grid resilience in the face of extreme weather events. The authors analyze the structure and benefits of resilience hubs, proposing a coordinated control scheme to maximize their impact on community well-being and grid stability.

In "Decarbonized and Inclusive Energy: A Two-Fold Strategy for Renewable Energy Communities" [A4], the au-

thors discuss the potential of renewable energy communities to support the energy transition and alleviate energy poverty. They present case studies demonstrating how renewable energy communities can reduce energy costs, facilitate access to energy assets, and promote community-based solutions to energy challenges.

The authors of "Distributed Energy Resources as an Equity Asset: Lessons Learned From Deployments in Disadvantaged Communities" [A5] review the role of DERs in supporting equitable energy outcomes for low-income, tribal, and Global South communities. They share practical examples and lessons learned to promote the broader implementation of DERs as a tool for community empowerment.

In the article "Community Participation in the Clean Energy Transition: A Procedural Justice Perspective on Meaningful Involvement" [A6], the authors emphasize the importance of community engagement. They provide tools, principles, and practices for involving affected stakeholders in clean energy projects, highlighting the benefits of proactive and meaningful community involvement to ensure the success and acceptance of energy transition initiatives.

In the article "Quantifying Energy Justice Goals in the Power Sector: Developing and Using Metrics" [A7], the authors explore the need for metrics to measure and understand the impact of energy transition investments on disadvantaged populations. They discuss the balance between urgent climate action and inclusive engagement of frontline communities to achieve equitable outcomes.

The article "Energy Poor No More: Intelligent Approaches to Realizing Energy Well-Being" [A8] investigates the concept of energy well-being and proposes the Energy Well-Being Information System, an integrated platform using digital technologies and big data. This system aims to enhance energy well-being by providing insights and tools to address energy poverty and support sustainability objectives.

—Yanli Liu, Associate Editor, Issues

Corner” column [A10] this time around. Prof. Nair is the PES vice president of education, hence the PES board member responsible for developing and promoting the PES education and continuous learning portfolio. Building on the 2024–2028 PES strategic direction reported in the January/February 2024 issue of the magazine, which includes education as one of its four pillars, the column details various opportunities to engage, volunteer, and lead through PES University and the Power and Energy Education Committee. The article focuses on empowering people to better understand how PES can deliver on the education strategy thrusts identified and help adapt and extend their current operation, scope, responsibility, and governance.

Book Review

In this issue’s “Book Review” column [A11], Frank Kreikenbaum, vice

president of analytics and application engineering at Smart Wires, presents the book *Energy 2040: Aligning Innovation, Economics, and Decarbonization*, authored by Deepak Divan and Suresh Sharma, from the Center for Distributed Energy, Georgia Institute of Technology, Atlanta, GA, USA, and published by Springer in 2024. The credentials of the authors alone should encourage readers to take a look at the review of the book and the book itself.

Wrap-Up

It is time to close this piece with the unavoidable string of well-deserved thanks. First, I extend my sincere thanks to the guest editors, Miguel Heleno, Bethel Tarekegne, and Prof. Parvania, as well as the numerous authors who kindly responded to our call for participation. A special thanks to Prof. Jacqueline Corbett, Faculty of Management Sciences, Université La-

val, Quebec City, QC, Canada. She was an early believer in this issue and helped greatly to inform my engagement in energy justice and its implications for a just energy transition and much needed reconciliation with indigenous people in the Global North and formerly colonized people worldwide. The expertise of the editors and authors in this emerging field, as well as their often out-of-the-box perspectives on issues at the crossroads of social sciences, politics, economics, and engineering, will certainly attract the interest of a broad range of readers. They also deserve a world of thanks for responding on shorter notice than usual to our request for high-quality manuscripts. I cannot go without stressing the visionary role played by Bian in nurturing the idea of this issue as well as the role of Prof. Pal in facilitating the inclusion of this originally unplanned issue into the highly competitive 2024 lineup of



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the magazine. Regarding the scientific content, the work of Yanli Liu, associate editor, in proofreading the initial versions is very much appreciated. Her discretion and timeliness at all stages, including the “[In This Issue](#)” contribution to this editorial, were much appreciated.

Given the political and sometimes speculative aspects of the concept of energy justice, which is yet an unsettled science, we are aware that, at times, you may have divergent opinions and views on the matter. This is why we are very interested in reading your letters in response to opinions expressed in the editorials and articles published in this issue. Publishing a letter to the editor gives voice to the people this magazine serves. You can drop your letter as a Word file attachment to powerandenergymagazine@gmail.com.

To know more about future issues up to the first half of 2025, you can visit our website. On this occasion, I invite you to suggest subjects within the scope of the magazine that you would like us to address. You can simply drop an e-mail to me at innocent.kamwa@gel.ulaval.ca. We will discuss new topics to be featured in the magazine in 2025–2026 at the next editorial board meeting, to be held during the 2024 PES General Meeting, in Seattle, WA, USA, and rank all ideas received in terms of perceived reader interests and guest editors’ commitment.

For Further Reading

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vol. 13, no. 1, 2023, Art. no. 16, doi: [10.1186/s13705-023-00388-2](https://doi.org/10.1186/s13705-023-00388-2).

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Appendix: Related Articles

[A1] B. K. Sovacool, S. Carley, L. Kiesling, and M. Heleno, “Energy justice and equity: Applying a critical perspective to the electrical power grid for a more just transition in the United States,” *IEEE Power Energy Mag.*, vol. 22, no. 4, pp. 18–25, Jul./Aug. 2024, doi: [10.1109/MPE.2024.3393942](https://doi.org/10.1109/MPE.2024.3393942).

[A2] D. Nock, A. J. Jones Jr., S. Bouzarovski, H. Thomson, and D. J. Bednar, “Reducing energy burden in the power sector: Metrics for assessing energy poverty,” *IEEE Power Energy Mag.*, vol. 22, no. 4, pp. 26–37, Jul./Aug. 2024, doi: [10.1109/MPE.2024.3408770](https://doi.org/10.1109/MPE.2024.3408770).

[A3] A. Farley, H. Belnap, and M. Parvania, “Resilience hubs: Bolstering the grid and empowering communities,” *IEEE Power Energy Mag.*, vol. 22, no. 4, pp. 38–48, Jul./Aug. 2024, doi: [10.1109/MPE.2024.3412876](https://doi.org/10.1109/MPE.2024.3412876).

[A4] J. Mello, J. Villar, R. J. Bessa, A. R. Antunes, and M. M. Sequeira, “Decarbonized and inclusive energy: A two-fold strategy for renewable energy communities,” *IEEE Power Energy Mag.*,

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