




Electrification: Opportunities for social justice and social innovation

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While much of the research and investment on electrification focuses on technology and materials, the transformation away from fossil fuels to a more regenerative, sustainable future that relies on renewable energy also provides huge opportunities for advancing social justice. Unfortunately, society has so far underinvested in the research and development, demonstration, and deployment of social innovations in this energy transformation, so many electrification initiatives have disproportionately benefited wealthy communities and countries and exacerbated social injustices, economic inequities, health disparities, and further concentrated wealth and power. Energy democracy provides a valuable framework to identify and disrupt these trends and leverage the transformative opportunities for social innovation and social justice with electrification. As the sourcing and recycling of new and different materials required for renewable energy generation expands, social justice must be prioritized. To enable a just transition, investing in social innovation in how and where materials are sourced and recycled is essential.

Energy justice: Investing in social change and social innovation for electrification

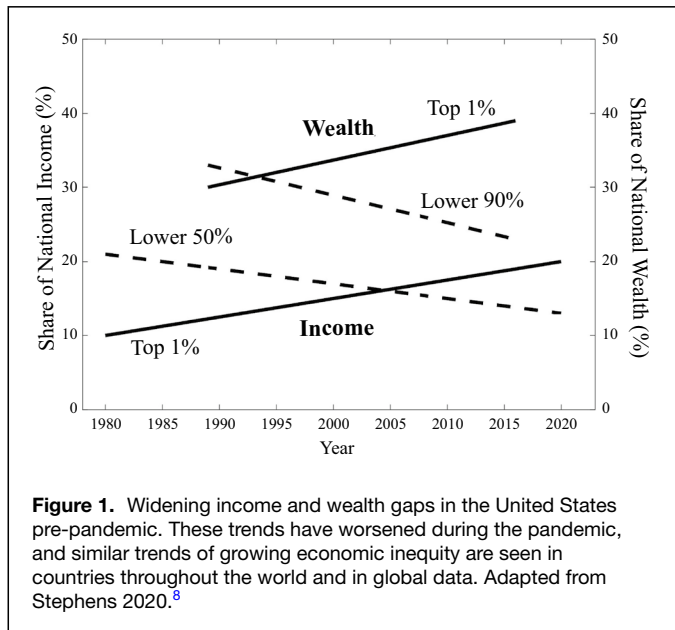
Electrification and the global energy transformation away from fossil fuel reliance toward a more sustainable, climate resilient renewable-based energy system have potential to advance social justice. With growing economic inequities in communities throughout the world (**Figure 1**), the transformation to more distributed renewable energy systems provides an opportunity to redistribute wealth and create well-compensated jobs for those in marginalized communities that have experienced systematic underinvestment. The legacy of injustices associated with energy,¹ particularly the racialized harm of fossil fuel reliance,² is recognized in the concept of energy justice, which highlights the importance of social justice concerns in energy transitions.³⁻⁵ The burgeoning field of energy justice emphasizes that to leverage the potential for social justice in electrification, more attention and investments are needed in understanding social change and promoting social innovations related to energy.⁵⁻⁷ In addition to technological innovations, social innovations are critical to ensure an equitable and just transformation.⁸

Striving for a future where every community in every region of the world could rely on its own regionally appropriate local mix of renewable energy sources, electrification provides opportunities for a massive redistribution of power,

literally and figuratively because the source of renewable energy is abundant, perpetual, and free. The materials shifts associated with a renewable future, including the sourcing and recycling of the range of different materials required for renewable generation (solar panels, batteries, wind turbines, and geothermal energy), for energy efficient building, for new grid and microgrid configurations, and for new modes of transportation also provide opportunities for a redistribution of economic and political power because resources from different regions of the world will be required. But if insufficient attention is given to the social, political, and economic changes associated with these material shifts, opportunities to promote social justice and advance economic equity could be missed and injustices will be exacerbated. The redistribution of power and the transformation to a more just and equitable future are not an inevitable part of electrification and the renewable transformation. How electrification and new grid configurations evolve and how the material supply chains shift, including who profits, who benefits, and who is excluded or further marginalized, depend upon how society invests in social change and leverages opportunities for inclusive social innovation.

Although scientific understanding of the many societal dangers of fossil fuel reliance has been clear for more than 40 years,⁹⁻¹¹ the transformation to renewable-based electrical

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energy systems has been slow and inadequate. With the 2021 Intergovernmental Panel for Climate Change report reinforcing the urgency for a global energy transformation¹² and with the increasing frequency and intensity of climate disruptions around the globe, the pace of change toward electrification could accelerate. But as change accelerates, it is important to recognize that for decades, resistance to renewable energy and electrification has been funded by fossil fuel interests and other members of the polluter elite¹³ who have been profiting from an energy system that continues to rely on fossil fuel combustion. Even as the price of renewables decreases, government subsidies for fossil fuels continue to slow down the pace of electrification and perpetuate fossil fuel reliance.¹⁴ The lack of urgency in transitioning away from fossil fuels also results from a lack of investment and attention to social innovation and social justice. By focusing research investments narrowly on technological innovation and engineering advancements, the social injustices of fossil fuel energy have been concealed,² and many opportunities for social innovation to accelerate social change toward electrification have been missed.

The narrow technocratic way that energy systems, renewable energy, and electrification are often framed limits public engagement and constrains collective imagination about the social change potential of electrification.⁸ To further accelerate renewable-based electrification and to ensure that the associated material shifts also promote social justice, a more inclusive and integrative approach is needed. When electrification is explicitly linked with advancing social justice, economic justice and racial justice, the benefits of change are expanded in empowering ways. Broadening the focus beyond technology and engineering and linking electrification more directly with other changes that improve people's lives diversify the

way that electrification resonates with people and communities. Embracing the ideas of energy justice, which recognizes that so many aspects of energy systems have been exacerbating inequities and perpetuating racial disparities, focusing on social change and social innovation ensures that energy system change no longer dismisses and ignores social justice. Electrification has potential to be a critical part of creating a more socially just and sustainable future. To maximize that potential, however, more investment is needed to understand the social, political, and economic changes associated with the materials required for a renewable future.

Energy democracy: Redistributing power

The idea of energy democracy provides a framework that acknowledges the potential for social justice and a redistribution of power with electrification and renewable energy. Moving away from the narrow technocratic way of viewing the climate crisis as a narrow scientific problem in need of technical solutions, energy democracy is a growing social movement that envisions a fossil fuel-free future in which individuals, households, and

communities rely on a regionally appropriate diverse mix of renewable energy with local ownership, local control, and local benefits.¹⁵ Highlighting all the social justice benefits of redistributing power, literally and figuratively through the renewable transformation, energy democracy is centered on social justice and investing in vulnerable communities. Rather than focusing narrowly and exclusively on climate action and embracing what I call "climate isolationism,"⁸ the technical goal of decarbonization and the climate crisis are often not even mentioned within energy democracy discourse¹⁶ (Figure 2). Climate mitigation and the decarbonization that results from moving to a renewable future are co-benefits of energy democracy decision-making rather than the primary driver for change. Energy democracy connects the renewable transformation and electrification with redistributing political and economic power, wealth, and ownership to create a more just and equitable world.¹⁷ The energy democracy frame recognizes the social potential for co-creation and co-ownership of a renewable future that is much more than a simple substitution of energy technologies.¹⁸ Rather, electrification and the renewable transition provides an opportunity to reverse the economic oppression associated with concentrated wealth and fossil fuel reliance by empowering local energy production and control.¹⁹

The energy democracy framework is also helpful in considering the shifts in materials and material supply chains that are a critical part of electrification. By expanding the technical considerations and also recognizing the social, political, and economic changes that are possible with electrification, there are multiple opportunities for the materials changes associated with electrification to contribute to a more socially just and equitable society. As the sourcing and recycling of new and different materials required for renewable energy generation

expands, energy democracy provides a valuable way to assess changes in materials in electrification.

Three kinds of innovative activities are central to the energy democracy movement: *resisting* the legacy energy agenda that continue to support fossil fuels, *reclaiming* energy decision-making so that the public interest is prioritized over corporate interests, and *restructuring* energy systems to maximize distributed local and regional benefits.²⁰ A key feature of energy democracy is the critical recognition that “how” electrification and renewable energy are deployed will determine whether or not social justice is advanced. Energy democracy acknowledges that who is included, who is excluded, and how the benefits are distributed matters a lot. To leverage the interconnected social justice benefits, electrification and renewable energy have to be explicitly linked to investments designed to meet the needs of families and communities rather than large corporate interests.²¹ With regard to changes in materials and shifting supply chains, policies, regulations, and processes that prioritize community well-being over corporate profits are essential. Promoting these policies, regulations, and processes requires moving beyond technical innovation and the narrow carbon accounting and the technological framing that has dominated electrification policy so far.

Energy democracy is an alternative way to frame energy system change as an opportunity for investing in communities and redistributing power literally and figuratively. Energy democracy is a growing social movement that resists the concentrated power and influence of fossil fuel energy companies and recognizes that ownership of energy resources and a more equitable distribution of profits from electrification and renewable energy infrastructure could redistribute political and economic power.

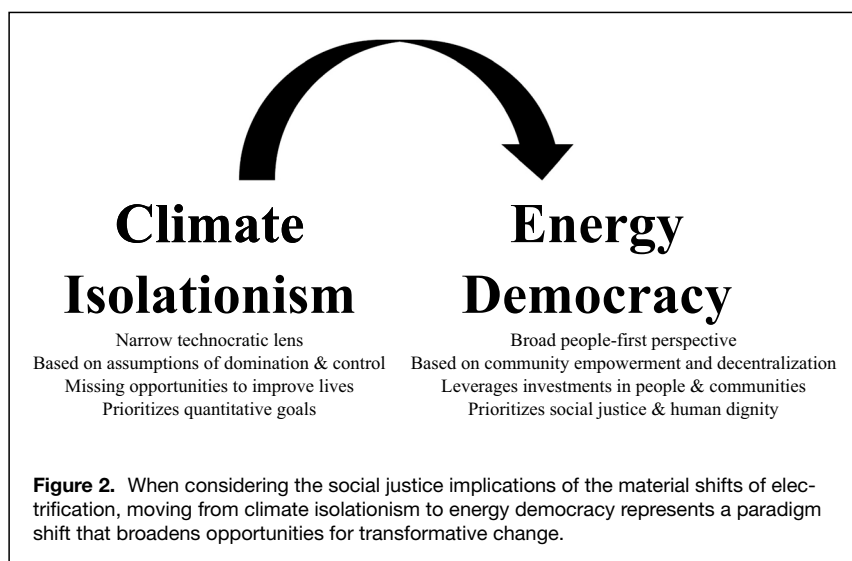
The social changes and the material changes resulting from investments in a new distributed renewable economy have huge potential to be politically and economically transformative. Investing in a future powered by renewables, including

wind (both onshore and offshore), solar power (utility scale and household scale and community solar), as well as geothermal and maybe micro-hydro, wave, and tidal—allows more people, communities and organizations to benefit and be involved—and could bring widespread benefits by allowing for local and community owned energy. Electrification and renewable energy have this revolutionary potential because every community and region of the world has access to renewable resources once society invests in the technology to leverage those resources to harness renewable-based electricity. Renewable resources (sun, wind, water, and geothermal heat) are not only perpetual and abundant, but they are also reliable and free for everyone. In a renewable-based society, the cost of energy no longer includes the costs of fuel—rather energy costs are diversified to cover the costs of the materials, production and transportation of renewable technologies, batteries, and other materials used for buildings.

While every community around the world has access to some kind of renewable resources whether it is sun, wind, water, or geothermal heat, not every community has access to the materials and resources required to harness renewable energy and generate renewable electrons. As the materials supply chain changes with more renewable generation and more efficient use of energy, there are huge opportunities to transform traditional extractive mining practices and distribute material recycling processes to ensure that local communities and under-invested-in households and communities benefit. As demand for silicon production increases for solar panels and more lithium is needed for batteries, then what social innovations are needed to ensure that the benefits of extracting more of these materials are distributed among those in need? How can public investments in material recycling (i.e., PV and battery recycling) be distributed to incentivize the creation of well-paying secure jobs for marginalized communities and under-developed countries? How can women-owned and minority-owned businesses be prioritized in changes in

the materials supply chain? Can sustainable processes for material development for insulation of buildings be incentivized based on local materials in under-developed countries? Recognizing that jobs are being lost in the fossil fuel supply chain during this transition, it is essential that there is public investment to create new jobs for those households and communities most reliant on fossil fuel-related jobs.²²

The transformative principles of energy democracy provide a valuable lens to guide participation, governance, and leadership of the changes in materials supply chains in electrification. Distributing the economic benefits and the political power to expand who is involved in electrification



decision-making to better connect with other social priorities will enable the development of more integrated transformative policies like the Green New Deal.²³ Building and fostering multiracial, multiethnic, gender-balanced coalitions of ambitious and optimistic advocates of transformative change require expanding expertise and engagement in energy decision-making. With this expansion, opportunities are possible for a more just, sustainable, and equitable future with prosperity for all. Only when substantial investments are made in social innovations that redistribute power to the people by linking energy decision-making with critical social justice issues including equitable access to jobs, education, health care, housing, transportation, and food, will the transformative potential of electrification to advance social justice be realized. Without adequate investment in social change, electrification is likely to continue to benefit those who already have concentrated wealth and power.⁸

Why diversity is essential for social justice through electrification

Diversity matters in electrification because for too long, concerns of vulnerable communities have been minimized and dismissed in energy policy and energy innovation while white male-dominated fossil fuel interests have profited from exploiting marginalized people. With major changes in supply chain, it is more important than ever to expand representation in decision-making so that decisions with social justice principles at the core. Without diverse leadership in energy system change, the United States has invested in concentrating wealth and power rather than investing in the basic needs of people and communities.⁸ Research shows us that when women, people of color, indigenous peoples, and people from other marginalized groups show up in leadership spaces where they have been historically excluded, they bring with them different lived experiences and different perceptions of risk that lead to more socially just outcomes.²⁴ Research also shows that more diverse teams, more diverse organizations, and more diverse sectors are more innovative.²⁵ So for electrification and the renewable transformation to leverage opportunities to advance social justice and social change with the shifts in material supply chain, diverse leadership and broad societal engagement are essential.

Energy justice and electrification

In the past 10 years, energy research with a focus on social science has developed an emerging field of energy justice which highlights the social justice potential of energy transitions and the injustices of so many energy policies.⁵ As electrification accelerates and new supply chains are expanded, it is critically important that energy innovations and energy policymakers integrate the valuable social science research of energy justice. In addition to acknowledging the potential to advance social justice with energy system changes, raising awareness about the embodied energy injustices of fossil fuel combustion could

provide additional motivation and inspiration for accelerating electrification and renewable energy.¹

Conclusion

Electrification does not necessarily mean a more just and equitable society. How electrification evolves, including who profits, who benefits, and who is excluded or further marginalized from the changes in material flows and supply chains, depends upon how society invests in social change and leverages opportunities for inclusive social innovation.

By expanding the technical considerations and also recognizing the social, political, and economic changes that are possible with electrification, this article highlights the opportunities for the materials' changes associated with electrification to contribute to a more socially just and equitable society. As the sourcing and recycling of new and different materials required for renewable energy generation expands, social justice must be prioritized. Given the legacy of social injustice associated with fossil fuel use, it is sometimes assumed that renewable energy and electrification will necessarily advance social justice; however, whether this happens depends on how the transformation evolves, how the new material supply chains are adjusted, who is included, who is excluded, and how the costs and benefits are distributed.

To maximize the potential for electrification to advance social justice, more investment is needed to understand the social, political, and economic changes associated with the materials required for a renewable future. To enable a just transition away from fossil fuel reliance to renewable-based electrification, social innovation in how and where materials are sourced and recycled is essential.

Given that the social, political, and economic changes that are possible with electrification are under-appreciated among most scientists, engineers, and many policymakers, more diverse voices must get involved to expand the discourse surrounding material flows, electrification, and the renewable energy transformation. Diversity among those involved in the material science of electrification is required to advance the innovative ideas that are needed for a just transition.

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Conflict of interest

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