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Solar power for some? Energy transition injustices in Kerala, India

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Abstract

The Indian government advocates for a major shift from national reliance on coal to more renewable energy sources. While these aspirations are laudable, a political ecology review reveals the uneven power relations associated with the introduction of renewable energy in the southern Indian state of Kerala. Drawing from fieldwork, research traces how Kerala government solar projects, including schemes to promote rooftop solar, prioritize middle- and upper-class consumers. Historically marginalized communities, including people living below the poverty level and *Adivasis* (indigenous peoples), are not a priority for the state agency implementing renewable energy and thus are not beneficiaries of cleaner energy. This disconnected approach builds from and exacerbates historical political and resource inequalities and enables the persistence of social and environmental injustices, even while moving towards a lower-carbon future. This model does not allow for all residents to actively engage in decision-making about energy processes and proves to be a missed opportunity to think holistically about development and energy in tandem. Energy democracy provides ideas to disturb this uneven power structure, with cooperatives being one possible way to implement this change. As the case of Kerala underscores, India may undergo an energy transition, but it will not be a just energy transition without significant changes.

Keywords

Solar energy, rooftop solar, just transition, India, infrastructure, climate change, environmental justice, political ecology

Energy transition injustices

Global fossil fuel dependency is responsible for the emissions of 1100 gigatons of carbon dioxide in the atmosphere since the mid-19th century (IPCC, 2018). Attributed to rising demand, energy-related greenhouse gas emissions accounted for two-thirds of all global emissions growth

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in 2018 (IEA, 2019). Some individuals, cooperatives, nations, and institutions have taken concrete action to reduce dependency on carbon-intensive fossil fuel energy by switching to renewable energy sources. With power sector carbon dioxide reductions in advanced economies, carbon dioxide emissions flattened in 2019 (IEA, 2020). These transitions predominantly included fuel changes from coal to natural gas, higher nuclear power output, and the increased use of renewable energy (mainly wind and solar photovoltaic) (IEA, 2020).

Although this energy transformation includes changes from carbon heavy fossil fuel sources to climate friendlier renewable energy sources, the transition is not inherently just for people and ecosystems. As emerging evidence reveals, distributive, procedural, and recognitional injustices may accompany renewable energy infrastructure, often mirroring energy injustices related to fossil fuel projects (Bedi, 2019; Sareen and Kale, 2018; Yenneti et al., 2016). Current and potential injustices across the lifecycle of renewable energy include lost labor, toxic exposure among workers, lack of access to renewable energy sources, land dispossession, enduring energy poverty cleavages, and ecosystem degradation. Power and access to resources, or the lack thereof, are critical to these injustices (Healy and Barry, 2017). Fundamental to these power imbalances are who stands to gain from land transfers associated with renewable energy, who can afford cleaner renewable energy, and who ultimately bears the cost of land dispossession or other challenges associated with renewable infrastructure. Political ecology analysis may inform the discussion of injustices and power imbalances associated with energy transitions. With much literature lacking acknowledgement of how sustainability is informed and shaped by power relations, political ecology frames the role power plays in encouraging or thwarting energy transitions (Lawhon and Murphy, 2012).

This article examines energy transition injustices in India, a country undertaking a major energy overhaul. Indian government officials aspire to bring higher development standards for citizens, particularly for those living below the poverty line. However, these development goals are not pursued in tandem with the energy transition. As a result, dispossession may accompany renewable energy projects and provision, particularly for the nation's most vulnerable. A case study from the state of Kerala exemplifies how energy transition efforts exclude marginalized residents. Heralded as a development exemplar, inequities persist in Kerala. As the state stumbled in efforts to introduce large-scale renewable infrastructure, government officials pursue approaches which reify existing political, social, and economic hierarchies. This practice leads to the examination of who benefits from India's energy transition and if solar energy is for all in the nation? This research uses a political ecology lens to examine power imbalances associated with solar energy programs. Collectively, this sheds light on how power unevenness determines who has access to and benefits from the energy transition. This acknowledgment and documentation are important first steps towards reimagining a more just energy transition.

Research draws from a review of policy documents and public statements, and from fieldwork in Kerala. Analysis of central and state government policies and press releases provided insights into the narratives guiding environment, energy, and development transitions in India. While many of these documents are publicly available, the author also received some policy documents and statements from interviewees. While a Fulbright-Nehru Research and Academic Excellence Scholar, the author and research assistants completed 110 individual survey interviews with residents living in and around solar sites in four districts of Kerala in 2018. The residents shared information about their access to electricity, their knowledge of solar energy, their understanding of climate change, and their development challenges. To complement the fieldwork surveys and policy document reviews, the author interviewed 22 solar entrepreneurs, government officials, journalists, nongovernmental organization representatives, and academics. These respondents shared knowledge on India's energy transition, solar energy.

This work contributes to the burgeoning literature on energy transitions by exploring how renewable energy projects can deepen existing inequalities and by providing ideas to make the energy

transition more just. To contextualize India's energy transition, the article opens with an examination of the energy transition literature. Political ecology is presented as a theory to explore the social, economic, and political imbalances associated with energy projects and access. Next, energy democracy provides one approach to understand how the energy transition may be more equitable for all, regardless of gender, political influence, education level, economic clout, caste, or land ownership. While a distinct context, the German energy transition experience reveals how participatory energy democracy may empower residents to make decisions about their energy futures, particularly through cooperatives. The Kerala experience represents these ambiguous trends. As state officials prioritize rooftop solar panels, they have pointedly decided that renewable energy is only for middle-and upper-class consumers and alienated other residents who would like to benefit from solar energy. This highlights the structural disjuncture between how the government addresses the development and renewable energy goals, which is a challenge plaguing India beyond Kerala. In closing, the article explores who solar energy is for, and what could be done to allow all residents to have voice and decision-making power in relation to India's energy transition.

Energy transitions and resident participation

Examinations of the energy transition offer the opportunity to document ideas and assumptions about electricity and the role that cultural and economic affluence play in shaping this (Strauss et al., 2016). The energy transition involves, "major changes in buildings, energy, and transport systems that substantially enhance the energy efficiency, reduce demand, or entail a shift from fossil fuels to renewable inputs. These system transitions entail not only technical changes but also changes in consumer behavior, markets, institutions, infrastructure, business models and cultural discourses" (Geels et al., 2016: 577). These changes could be the largest global transition since the industrial revolution. However, many current transition models don't explicitly explore who benefits or suffer from efforts to reduce greenhouse gas emissions. This leaves many questions regarding associated power imbalances. Ultimately, who has the power to promote or stop these transitions? Who benefits and who loses from the introduction of renewable energy infrastructure or the continual dependance on fossil fuels? Political ecology provides a useful framework to examine these questions, particularly in relation to social and power relations. Political ecology approaches human-environment changes and decision-making in relation to the associated costs and benefits for actors and institutions.

For the energy transition, it is fundamental to examine the social processes and power relations that guide decisions and implementation of new renewable energy technology and infrastructure. Lawhon and Murphy (2012: 365) argue that these energy transitions are largely guided by actors endowed with immense power, "elite scientists, entrepreneurs, and policy-makers" actors usually quite distant from those directly impacted by the energy infrastructure. Noteworthily, ecological, political, and economic destruction experienced intersectionally by people exacerbates marginalization (Neumann, 2014). In acknowledging these power and social imbalances, political ecology offers the opportunity to imagine an alternate structure, with new agency and power beyond the elite. Political ecologists examine resistance, politics, and power relations related to resource access and transitions. These relations stretch across scales from the global to the local, as power and access to resources may vary greatly across geographies. Political ecology frameworks unearth the uneven power dynamics related to formal, informal, and extra-legal processes, which are frequently ignored in other theorizations of resource use (Andrews and McCarthy, 2014: 8). Further, political ecology examines how actors use claims and alternate claims to encourage or block resource transitions (Robbins, 2011).

Political ecology aims to understand the uneven interactions of a range of actors, and how these relationships shape access to and control of resources. Much recent debate about the low-carbon

energy transition focuses on the economics of the energy debate, with corporations, countries, and institutions rarely mentioning the need for the transition to be "just" (Heffron and McCauley, 2018). The just transition proposes a holistic approach to this energy transformation, prioritizing justice as the world shifts to renewable energy infrastructure. The just transition is a societal goal centered on environmental justice, energy justice, and climate justice, with emphasis on the importance of human rights and reduction of inequalities across space and time (Heffron and McCauley, 2018). There is criticism that a justice-centered energy transition will not gain political traction. However, Williams and Doyon (2019) argue that an unjust transition will not be sustainable and advocate for a comprehensive application of distributive, recognitional, and procedural justice. These justice ideals are encapsulated in energy democracy. The need for more democracy in energy processes responds to the reality that, "key resources are managed by elites through 'top down' environmental governance and management" (Routledge et al., 2018: 78). As institutional economic and social systems may deepen injustices during the transition, energy democracy offers the potential for active participation in energy choices, including by residents not historically endowed with power (Fairchild and Weinrub, 2017).

While there is limited energy democracy research centered on the experience of marginalized groups (Van Veelen and Van Der Horst, 2018), Weinrub and Giancatarino (2015) maintain that participation of communities of color, Indigenous peoples, low-income peoples, and other marginalized communities is essential to ensure a just and democratic energy future for all. Historical injustices provide context for democratic and power imbalances which perpetuate the sidelining of communities, including in energy systems. Centering marginalized voices in energy democracy processes acknowledges that there are, "those who have benefitted enough from the current globalized capitalist system to be economically secure or privileged relative to those struggling to survive" (Weinrub and Giancatarino, 2015: 7).

To disturb power imbalances, there are calls to return to the origins of citizenship- namely democracy, collective action, rights, and cooperative ownership- to restore the agency of citizens in their energy decisions (Lennon et al., 2020). The cooperative model is one potential avenue to make energy processes more participatory. The International Cooperative Alliance defines cooperatives as, "an autonomous association of persons united voluntarily to meet their common economic, social, and cultural needs and aspirations, through jointly owned and democratically controlled enterprise" (Birchall, 1997). Distinct from a solely for-profit model, a cooperative approach can offer individual decision-making power for members and can provide the space for members to define their social and economic goals (Yildiz et al., 2015). With global membership exceeding 800 million people, cooperatives- from fishing to housing to health- have helped to reduce poverty (Birchall and Simmons, 2013).

Concerning energy, cooperatives could be solely owned and operated by residents or could operate in collaboration with partners. While the cooperative model has a long history in India, renewable energy cooperatives are currently most prolific in Canada, Denmark, Germany, the United States, and the United Kingdom (Viardot, 2013). In contrast with models which encourage resident participation, the energy cooperative approach allows residents to be decision-makers about their energy future. Worker energy cooperatives provide the opportunity for laborers to have ownership, voting power, and gain from the revenue derived from their labor. Wright (forthcoming) details how worker energy cooperatives benefit the broader community and foster democratic values by providing economic stability, self-sufficiency, and resilience.

While not perfect, the German example provides insights into undertaking the energy transition with active citizen participation. In particular, the German example provides lessons learned for other countries- including India- embarking on energy transitions. Germany's innovative energy transition (*Energiewende*) to a low carbon and affordable energy supply has gained international recognition among policymakers and researchers (Moss et al., 2015). Over the last 25 years,

successive German governments have committed to phasing out nuclear energy in the short-term and coal in the mid-term, involving significant infrastructure transformations (Hake et al., 2015). The German energy democracy model focuses on community-generated energy, as a critical way to equitably distribute resources, fight climate change, and build a better quality of life through communities (Morris and Jungjohann, 2016).

Energy cooperatives (*Energiegenossenschaften*) represent the collaborative efforts of Germans working together to invest in large-scale solar and wind installations. Both the financial incentive program and the cooperative structure ensure that Germans across socioeconomic levels can access renewable energy. Collectively, the German energy transition provides emerging insights into how citizens may engage actively with the decisions about their energy sources and access. This model indicates the possibility for a more participatory form of energy planning and practice. With Kerala's rich cooperative history, this could provide the opportunity to create more inclusive energy systems. For example, research on dairy cooperatives in India cautions that specific steps are necessary to ensure equitable gender participation (Dohmwirth and Hanisch, 2019).

India's transition

The German example demonstrates that it is possible to have an energy transition from below, with residents, across income levels, actively engaged in decisions about their energy futures. The energy transition is particularly challenging for India, a democracy with a 60% dependency on indigenous coal sources. The German example is pertinent, as Germany remains heavily dependent on coal for 40% of the nation's electricity even as it transitions away from fossil fuels. Increasing energy demand presents both an opportunity to provide electricity to those living in energy poverty and a challenge to balance the associated carbon dioxide emissions. Since 2000, energy use among India's population of over a billion people has almost doubled (IEA, 2015). National energy demand is predicted to increase 2.7–3.2 times between 2012 and 2040 (Niti Aayog, 2017). In 2018, India was responsible for 11% of the global increase in primary energy demand, with coal for power generation dominating the nation's use of over 35 million tons of oil equivalent (IEA, 2018). Rising carbon dioxide emissions have accompanied this increase in energy demand. As the greenhouse gas most responsible for climatic change, heightened carbon dioxide emissions in India are a source of national and international concern. With the energy sector accounting for 70% of total greenhouse gas emissions in 2010, India's energy, industrial, agricultural, and waste sectors emitted 2136.8 million tons of carbon dioxide equivalent (MOEFFC, 2015).

Indian government officials publicly promote a transition of the nation's energy system towards renewable forms of energy. In 2010–2011, the government pledged $189 million USD for the Jawaharlal Nehru National Solar Mission and clean energy fund (Khare et al., 2013). With an annual potential of 6000 million gigawatts of energy from an average of 250–300 sunny days per year, solar energy has the greatest potential to meet energy demand in India, compared with other renewable energy resources (Tripathi et al., 2016). Nationally the "provision of rooftop solar and 10 percent renewable energy is now mandatory under Mission Statement and Guidelines for development of smart cities" (Kerala State Planning Board, 2021: 14). To achieve these objectives, the Kerala state government introduced a Solar Photovoltaic Program with both off-grid and on-grid rooftop programs (ANERT, 2021).

Indeed, from 2005 to 2015, Indian adoption of electricity from renewable energy sources substantially increased from 2 to 13%. India's Prime Minister acknowledges the importance of energy to fulfill the nation's development requirements:

> The prosperous still have a strong carbon footprint. And the world's billions at the bottom of the development ladder are seeking space to grow … Democratic India must grow rapidly to meet the aspirations

> of 1.35 billion people, 300 million of whom are without access to energy … Climate justice demands that, with the little carbon space we still have, developing countries should have enough room to grow (India's Prime Minister Narendra Modi, Paris Climate Meeting. November 30, 2015)

Despite the climate justice claims-making by the Prime Minister, in practice, India's energy transition is pursued separately from development projects. In the Indian context, the question remains if the energy transition will be accessible and affordable for all? Launched preelection by the ruling BJP government, the $2.5 billion *Saubhagya* scheme (good luck plan) aimed to bring low-cost electricity to all Indians by 2018. Under the plan, each household would be considered electrified if it had an energy meter, wiring for a LED bulb, and a place to charge a cell phone. In contrast to the case highlighted in this research, the Saubhagya scheme explicitly connected development and energy objectives, with the program targeting those living below the poverty line without electricity. Although the energy provided was not necessarily from renewable sources, this plan is a step in the right direction towards an integrative approach to addressing development and energy challenges in tandem.

In the period from 2017–2018, the government announced that over 8 million households received electrification, while over 26 million households remain without electricity access (GOI, Ministry of Power, 2018). Lauding this accomplishment, Prime Minister Modi declared on Twitter, "28th April 2018 will be remembered as a historic day in the development journey of India. Yesterday, we fulfilled a commitment due to which the lives of several Indians will be transformed forever! I am delighted that every single village of India now has access to electricity" (Modi, Twitter: 4/29/18). Under the Saubhagya scheme, there are varying estimates of national electrification. The Indian government reports that 99% of households received electricity by 2019 (IEA, 2021), while a Rockefeller Foundation report (Dayal, 2019) estimates an 82% electrification rate. Power outages, poor electricity quality, and the unaffordability of grid-electricity (Dayal, 2019) hamper individuals and businesses alike. Additionally, there are discrepancies between electricity availability and connectivity. For example, only 86% of residents are hooked up to electricity infrastructure located within 50 meters of their home. The number declines for agriculturalists, with only 70% of agriculturalists connected to electricity infrastructure within 50 meters of their residence (Bali et al., 2020).

The International Energy Agency (2021) warns that the Covid-19 pandemic health and economic crisis may lead vulnerable households to again become energy impoverished, with the potential for 40 million Indians unable to pay for electricity services. This energy poverty enhances development cleavages, including poverty, human health, education, gender disparities, life expectancy, and bodily capabilities (Sovacool and Dworkin, 2014).

Even before the pandemic, in practice, the Indian energy transition is problematic for several connected reasons. First, historical development inequalities exacerbate energy poverty for around a third of India's population, which complicates the introduction of renewable energy infrastructure. This uneven development derives from the politics associated with electricity access, which benefits state elites (Kale, 2014). Drawing from states with one-sixth of the nation's land, Gujarat and Rajasthan, Sareen and Kale (2018) examine how the promotion of industrial-scale solar energy privileges actors and companies endowed with power, while opportunities for residents to engage in procedural justice were largely performative.

Second, there is a patchwork of states implementing India's national renewable energy targets. State investment in solar infrastructure reflects political and economic relationships with the central government run by a Hindu right-wing party, rather than a demonstration of energy poverty or geographical appropriateness (Chatterjee, 2019).

Third, there is emergent evidence of large-scale renewable sites displacing or dispossessing vulnerable peoples, with land playing a critical role in these processes. Large-scale renewable energy

projects require contiguous land, a resource in short supply in India. Following patterns of land loss for highways, mines, and Special Economic Zones, there have recently been major land conflicts associated with renewable energy infrastructure. Yenneti et al. (2016) detail land dispossession among historically marginalized communities in the state of Gujarat for the introduction of solar mega-projects. The enclosure of common land in Gujarat led to a substantial livelihood loss for residents highly dependent on land-based subsistence.

Fourth, related to the first challenge, access to and benefits from renewable energy follow patterns of uneven development in India. Even in Indian states with high levels of electrification, there are major barriers to making the transition to renewable energy accessible to all. The following section details the uneven nature of renewable energy access in the Southern Indian state of Kerala (see Figure 1).

Solar energy for some?

The case of Kerala demonstrates barriers to meeting India's national renewable energy targets and the possible injustices associated with solar projects. As one of India's 12 wealthiest states (International Energy Agency, 2021), the state of Kerala has been frequently heralded for development accomplishments, including high literacy, health, and education indicators (Raman, 2010). Despite impressive development feats, unevenness remains in the state, particularly among indigenous communities (Adivasis) and scheduled castes. Scheduled castes and Adivasis are predominantly landless, not benefiting significantly from Kerala's land reforms (Government of India, 2008). Scheduled castes and Adivasis makeup 30.33% of the state's poor, representing about 11% of Kerala's population (Ministry of Rural Development, 2011).

While not the state with India's largest renewable energy infrastructure, Kerala is an instructive state to examine regarding the implementation of major initiatives in support of the energy transition. Kerala is home to a range of innovative large- and small-scale solar energy projects including floating solar power plants, solar lanterns, solar crop driers, and solar vaccine refrigerators. The state's initiative to welcome a range of these technologies provides a fertile opportunity to explore solar introduction and anticipation. Simultaneously, the state, which enjoys high human development indicators and economic growth rates, faces major obstacles to implementing renewable energy. Although projects to support India's energy transition vary immensely across the nation's distinct geographies, there are applicable lessons for other states from Kerala. Further, the power imbalances apparent in renewable energy access and infrastructure mirrors uneven access to power prevalent throughout India.

The Government of Kerala's Energy Policy 2013 encourages solar energy to, "contribute to long term energy security of the State of Kerala as well as ecological security by reduction in carbon emission" (Government of Kerala, Energy Policy, 2013). The policy document emphasizes that solar energy could simultaneously meet the state's energy deficit and achieve carbon dioxide emission reductions for national climate change goals. In tandem, Kerala highlights that it is the first Indian state to create an Energy Management Center to address, "energy generation and conservation-based employment and poverty alleviation programs" (Energy Management Center, 2018). In practice, however, how the state government implements and describes solar goals are quite distinct. In particular, the development and poverty alleviation elements of the state government's ambitions have been largely abandoned as the complex realities of transitioning energy systems emerge.

Kerala pledged to install 500 Megawatts (MW) of solar energy by 2017. As of December 2019, the state has installed 140 MW of solar energy infrastructure. The state revised the 2030 goal of 2500 MW of solar photovoltaic energy to 1870 MW (MNRE, 2020). In Northern Kerala, the Kasaragod Solar Park is a major reason for the state's stalled large-scale renewable energy push. Originally slated to be a 200 MW project, the Kasaragod solar park only generates 50 MW of

Figure 1. India Reference Map. Author Jim Ciarrocca.
Data source: ESRI Living Atlas. Received June 15, 2021.

power. Some Adivasi residents without legal land titles lost their lands and livelihoods to make way for the contiguous solar park, which fueled local political opposition and thwarted the park's expansion (Bedi, 2019). Acquired land for the park and associated infrastructure bifurcated villages and reduced agricultural fields for residents.

Although Kerala's Energy Management Center's early work promoted the need for an integrated approach to renewable energy and development, their rhetoric did not match practice. In part, this is

because the state's attempt at utility-scale solar energy infrastructure faltered with the significant reduction of the Kasaragod project. This smaller-scale solar park led the Central government to rescind subsidies for the project, thus creating financial constraints on the Kerala government.

The Kasaragod protests underscore the state's failure to implement utility-scale renewable infrastructure, leading the state to devote additional funds to rooftop solar and to promote the economic benefits of renewable energy entrepreneurs. The greatly reduced Kasaragod project and other energy transition setbacks led the Kerala government to pivot attention towards economic justifications for the renewable energy transition. A state government official explained that solar is, "an economic initiative rather than an environmental initiative" (11/1/18 Interview). This claim-making echoes recent state reports and government narratives. Notably, this is distinct from earlier accounts which emphasized that the energy transition would reduce energy poverty and reduce carbon emissions (Government of Kerala, 2013). Members of the Government prominently use economic incentives to promote renewable projects. For example, a government official noted, "the cost of power generated from solar is now cheaper than the cost of power you get from the Kerala electricity board" (10/16/18 Interview). The reframing of renewable energy targets around economic justifications further pushed these initiatives from development goals, which may not be quantifiable using market logic. While economic justifications for renewable energy are not inherently problematic, they can encourage decision-makers to center programs around economic results. In Kerala, this market logic approach disincentivized policymakers from viewing the energy transition as an opportunity to improve development standards for all in the state. This discouraged state government officials from looking for creative ways to achieve development and renewable energy goals in tandem. This claim-making further entrenches power imbalances in the state, regarding who can afford and access solar energy.

The shift to an economic emphasis for Kerala's energy transition has implications for which projects the government prioritizes and who are the primary beneficiaries of renewable energy. To meet ambitious national renewable energy goals, government officials currently emphasize that solar is for, "high-end domestic consumers" (10/17/18 Interview). Another government representative emphasizes that Kerala's state solar energy programs focus on the "upper class and upper-middle class" (10/16/18 Interview). The government adjusted their projects to rooftop solar initiatives to focus on these constituents. As of December 2019, Kerala installed 41.75 MW of rooftop solar capacity, with the Central government subsidizing 23.46 MW of this total (MNRE, 2020). An energy consultant explains that it is difficult for the state government to scale up the rooftop solar initiative. "They can go for larger rooftop installations, but still the distribution companies are not really geared to this expectation. To have that kind of rooftop" (9/28/18 Interview). While other state utility boards express concern about a mass exodus of paying consumers turning to rooftop solar, the Kerala State Electricity Board promotes them through a subsidy program.

An employee working for the Government notes that the implementing agency is:

> more concentrated on rooftop. As far as we are concerned, we believe that this is a realistic goal. For those high-end domestic consumers … achieving this is not unrealistic. But we have to create that environment in which the consumer as well as the integrator contractor should be able to do it fast and there should be an ease of doing business. That environment we have to create. We are trying our level best to create such an environment where the people can buy a solar plant or order a solar plant easily. They get a good quality system and insurance (10/16/18 Interview)

The focus on "high-end" consumers with financial means is evident in the Kerala government's eBay-style website for buying solar-related products, called BuymySun.com (see Figure 2). The Buy My Sun web portal connects government verified renewable energy companies, vendors, service providers, installers, and inspectors. Aneesh Prasad with the Agency for New and

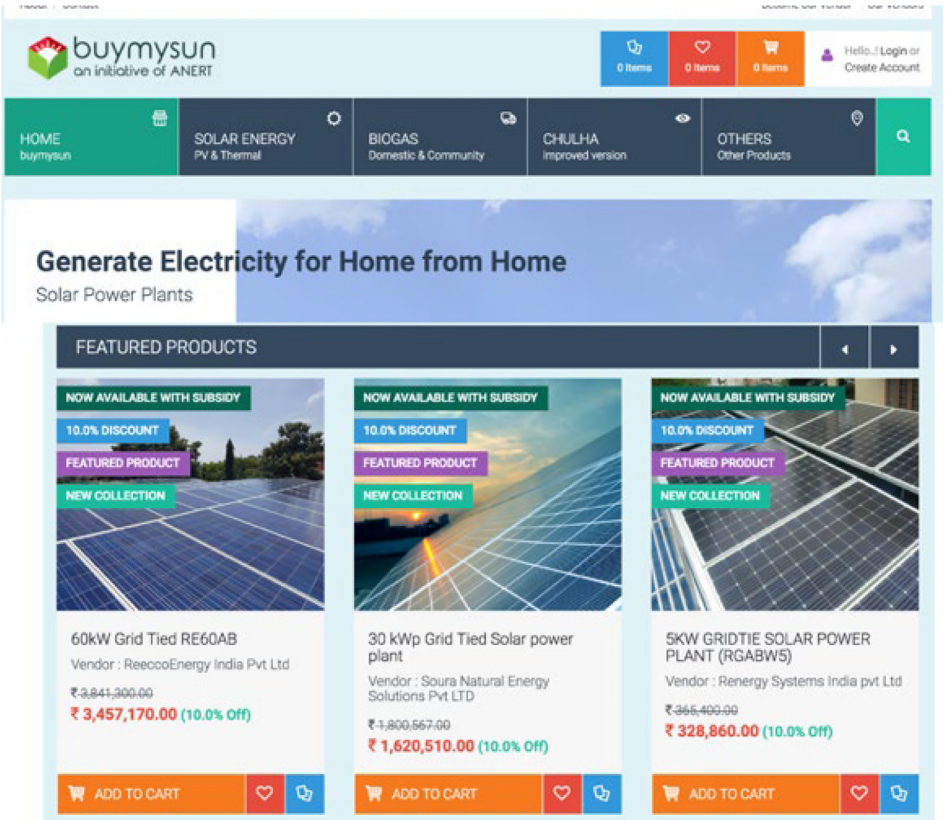

Figure 2. Kerala government buy my sun website
Accessed October 29, 2018: http://buymysun.com.

Renewable Energy Research and Technology, Government of Kerala (ANERT) noted, "ANERT has introduced an online portal 'Buy My Sun' to ease purchasing and installing. Delays in providing net-metering alone went over 18 months and with the introduction of the online portal, have come down to three months" (Koshy, 2020). Although the site may be innovative for the class of people who can afford the renewable goods, the products offered would be unaffordable for many in Kerala. For example, the first featured product in Figure 2 advertises a 60 kW Grid system. Priced at 3,457,170 INR ($45,689 USD), the grid is beyond the economic means for most Kerala residents.

The Kerala Government provides further resources for consumers interested in solar energy, by advertising the Central Government's solar calculator (see Figure 3). The Ministry of New and Renewable Energy's Solar rooftop calculator estimates the costs and benefits of installing a solar rooftop system. The below example, for the state of Kerala, projects that a solar rooftop system would cost 100,000 INR ($1321 USD) without a government subsidy or 70,000 INR ($925 USD) with a government subsidy. Again, most Kerala consumers would be stretched to afford such a system. This approach furthers the state government's claims about their core audience for the solar energy program.

Both the state and central government websites are geared towards consumers with the economic capacity to invest in rooftop solar initiatives. The emphasis on middle-and upper-class consumers

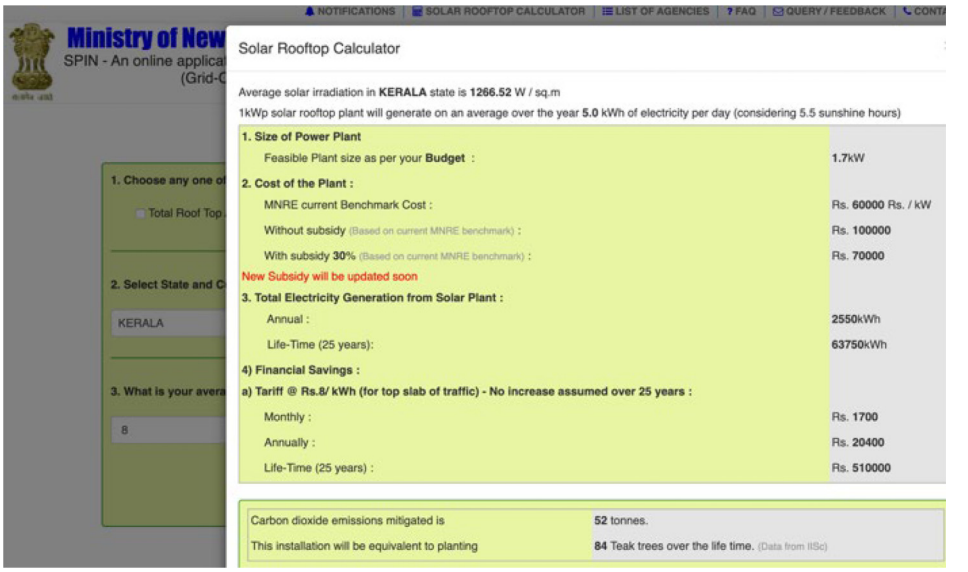

Figure 3. Ministry of new and renewable energy solar rooftop calculator
Accessed May 5, 2020: https://solarrooftop.gov.in/rooftop_calculator.

makes clean energy a luxury good, only for those who can afford it. This pushes the state away from its 2013 goals to achieve multiple developments and energy goals through the transition to renewable energy. This approach reifies historical class and caste marginalization and leads many poor residents who live in and around solar energy sites without the benefits from cheaper and cleaner energy. These narratives are countered by residents, who question their exclusion from these energy innovations. A man living next to a large solar field in Kerala explains, "the poor cannot afford solar panels. Only the rich can. So, the benefit is only to the rich. The poor mostly have houses with tiled roof. Can we install panels on such roofs? Then how much money do we need to spend for those panels?" (9/21/18 Interview).

Some residents living near solar sites included in this research expressed discontentment about the disparities between government narratives and local realities. A Chingoli resident expressed

Figure 4. Kasaragod Solar Park.
Source: Author.

Figure 5. Rooftop solar in Kerala.
Source: Author.

how the Prime Minister, "Modiji is saying that we have to build the nation through solar energy" (9/21/18 Interview). Despite this national aspiration, at the four sites included in this research, there are not efforts to make solar energy accessible for area residents. A resident close to a solar site explains how "common people can't afford solar. Because it cost around 60,000 (Indian rupees). Minister saying to us to use solar, but it is costly. Those who have money they are using solar" (9/14/18 Interview).

Many respondents note interest in having solar energy subsidized by the government, to make it accessible to all. A resident living close to a solar site explains how "the solar project is good. But (the government) needs to bring them to all houses. If energy can be generated on one's own, it is really good. But the government has to do something to provide them at subsidized prices" (10/27/18 Interview). Many residents express that they would like small-scale solar units, including cell phone chargers, lamps, and hot-water heaters. Although these smaller units would not contribute to the state or national megawatt goals, they could prove of high value to residents without electricity or with intermittent electricity supplies. A resident explains, "if the subsidy and rates could be lowered a bit, it would be better. Common people can buy solar. At least heater, solar for one or two lamps to function when current fails. Then they have to give awareness on how to do it. It would be nice if the rates can decrease little more. Maybe the rates would decrease when more people purchase them" (10/28/18 Interview).

The focus on consumers of means limits the capacity for this energy transition to be just, as not all are included. The emphasis on wealthier consumers means there is a missed opportunity to provide renewable energy benefits directly to the populations most vulnerable to climatic fluctuations. While climate change impacts all Indians, some populations are particularly vulnerable to

climatic transitions. Climate change vulnerabilities are more acute for poor peoples, indigenous peoples, coastal livelihood-dependent peoples, and agrarian-dependent communities (IPCC, 2018: 11). As large-scale renewable energy usually requires a large land area, the residents impacted are likely among the 70% of rural Indians who depend on agriculture for their livelihood (FAO, 2020). Emerging evidence reveals how mega-solar projects are responsible for land dispossession among indigenous peoples and other climate-vulnerable peoples (Bedi, 2019).

The Kerala state government aspires to increase climate literacy among all residents. The government notes that "every local government body should have a climate change adaptation plan and individuals should be educated about climate footprint of their individual actions from meat consumptions to mode of transport" (Government of Kerala and United Nations, 2018: 23). Despite these claims, in and around large-scale solar sites, the majority of respondents demonstrated a lack of understanding of how solar energy is related to climate change. This reflects a power imbalance in knowledge sharing about renewable energy and climate change. Although some of the people living in and around solar energy sites interviewed for this research had a basic understanding of what climate change is and how it impacts their lives, many could not link the solar projects to climate change mitigation. Select respondents note increased precipitation, strong winds, and agricultural losses. Kerala experienced a 100-year flood 2 months before many of these interviews were completed, so many residents had recent knowledge of excess rain and floods.

Some residents also did not understand how solar panels generate electricity. When asked if solar energy relates to climate change, a respondent living adjacent to a solar project notes, "to talk about solar energy, I need to first know what it is. What can I tell when I do not know anything about solar energy?" (9/21/18 Interview). This divide was particularly pronounced for respondents with an 8th standard education and below. A resident suggests that if we have questions about solar energy and climate change it is, "better you ask the environmentalists" (10/16/18 Interview). This mirrors the above concern that the large-scale solar projects and climate change considerations are not in the purview of residents vulnerable to weather and associated agricultural extremes. As with the solar roof panels, part of this sentiment emanates from how government officials speak about and engage (or disengage) with residents in and around large-scale renewable projects.

When speaking of the residents living close to the renewable energy project he manages, a government employee explains his perspective that, "the backward 'tribals' are the ones unaware of climate change" (10/15/18 Interview). This echoes the exclusionary sentiment expressed by government employees regarding rooftop solar projects. If the government officials tasked with implementing India's energy transition don't think the initiatives are all for all, the Kerala example reveals that the default will be to make renewable energy projects accessible for climate-educated middle-and upper-class consumers.

Exclusionary solar project implications

Data from the government supports the perceived exclusion of poor and historically marginalized communities from programs to mainstream renewable energy across the state. Of the various renewable energy programs implemented by ANERT with the Center for Management Development, a 2021 government report notes how most project beneficiaries are not from the "other backward caste," scheduled caste (SC), or scheduled tribe (ST) (Adivasi) categories. With scheduled castes and tribes representing 10% of the installed rooftop solar program, ANERT observes that individuals in these groups, "preferred low investment schemes of ANERT like Improved Chulha (cooking stove), Solar Lantern, and Biogas" (Kerala State Planning Board, 2021: 52). The Kerala state government concludes that these disparities are due to, "the lack of necessary awareness of the schemes of ANERT among tribal population and also the high investment for the schemes resulted in fewer installation of the schemes among SC/ST community"

(Kerala State Planning Board, 2021: 52). Further, there were only 1% of people in the "below poverty line" category taking advantage of these programs. This group benefited from the installed rooftop solar systems by taking loans from private lenders (Kerala State Planning Board, 2021: 55).

There are direct education costs for those not participating in the ANERT solar projects. "According to 94 percent beneficiaries, schemes of ANERT for lighting have helped children in their studies. The schemes from solar lantern to Off-grid rooftop solar power plant provide uninterrupted power supply and that enables the children in their studies" (Kerala State Planning Board, 2021: 80). During fieldwork, the author witnessed the importance of electricity for education firsthand in a range of Adivasi homes in Kerala. Although officially "electrified," some homes receive illumination from a sole light bulb. In a large family, it is challenging for students to complete schoolwork and study in the only illuminated room.

Overall, the renewable energy initiatives in Kerala fail to meet the development and energy needs of residents living below the poverty line and/ or Adivasi and scheduled caste population. A nonprofit representative who is also a solar entrepreneur articulates the need to view solar energy as a development opportunity. "For India, it (solar) is an energy resource, it is development. It is the only way to get develop our remote villages because energy accessibility is a very big challenge in the backward villages. The only electricity that can reach remote villages. Whether it is solar, biomass, or wind or even hydro" (10/8/18 Interview). Despite the importance of addressing these issues in an integrated manner, the challenges associated with implementing India's energy transition lead policymakers and planners to compromise the ideal vision for development and renewable energy in tandem.

The just energy transition: Energy for all

A political ecology review of the power imbalances accompanying solar projects, with a specific emphasis on rooftop solar, reveals the further entrenchment of wealth and elite status in Kerala.

As illustrated through the Kerala example, India's energy transition is not only about the appropriate energy source, but about inclusion, livelihoods, and engagement. With Kerala's high development indicators, the state could have become a potential place to implement the just energy transition. However, nascent renewable projects reify and deepen historical injustices in the state. Despite Kerala's impressive development accomplishments, the relative exclusion of Adivasis, scheduled castes, and poor people from solar rooftop projects represents a continuation of ongoing injustices in the state.

Government claims-making and practices lead residents, particularly the poor and historically marginalized, to conclude that solar energy is not accessible, affordable, or intended for them. This exclusionary approach is striking, as many residents expressed interest in receiving solar energy, through government programs including rooftop solar, solar lamps, solar hot-water heaters, and solar cell phone charges. Although this research draws predominantly from the Kerala context, the power and claims-making unevenness are not unique to the state. This empirical information stands as a cautionary tale for the nation, as renewable energy projects have already increased marginalization or may do so in the future if alternate energy systems are not imagined and implemented (Bedi, 2019; Sareen and Kale, 2018; Yenneti et al., 2016). The exclusion of under-represented peoples from renewable energy processes furthers unevenness and underscores the need to centralize marginalized peoples in energy processes to disrupt historical marginalization and provide new avenues for democratic participation (Weinrub and Giancatarino, 2015).

There is a demonstrated need to have energy policy, planning, and schemes that respond to and reflect local contexts, with active participation by residents (Healy and Barry, 2017: 456). The emergence of public and community-owned renewable energy represents resident-centered alternatives to the privatization of energy provision (Routledge et al., 2018: 83). Although a distinct context, the

German example demonstrates how solar projects may be implemented in an equitable and resident-centered manner. The Energiewende in Germany exemplifies how solar projects do not need to be only for the bourgeois but can become mechanisms for resident governance and empowerment. Although the financial intricacies for the Indian context merit further research, the strong history of cooperatives in India and specifically Kerala makes this a feasible option to pursue. Indian agricultural cooperatives represent a potential model for a collective approach to managing a resource.

These examples illuminate how a more participatory approach to the renewable energy system would involve active resident engagement in decisions related to the planning, distribution, and control over the solar initiatives. This engagement would not be limited to residents of means, but would expressly provide opportunities for all, across gender, caste, education, and socioeconomic status, to participate in energy democracy. Authentic engagement would deliberately include frontline energy residents at all stages of planning. Policymakers and planners must engage residents early in the energy infrastructure planning process and specifically address and reflect local preferences in the project. A key part of the political ecology of a just transition is an acknowledgment of entrenched power structures and a centering of the energy needs for all Indians, not just an elite few. In the Kerala context, this would be prioritizing the below poverty line and/ or Adivasi and scheduled caste residents to benefit from solar projects, at no or minimal investment cost.

Much further research remains to explore questions raised by this work, including the political economy of distributed (including rooftop) solar versus utility-scale renewable energy. There are ample opportunities to explore the economic beneficiaries of both distributed and utility solar energy. What are the comparative electricity costs over time? Are these costs and benefits distributed equally across socioeconomic groups? Do shareholders, private entrepreneurs, and others benefit?

The Indian government's renewable energy aspirations are a step towards reducing the nation's climate footprint. However, more work needs to be done to engage all Indians in participatory energy democracy, with the goal of not just climate change mitigation, but justice for all. Renewable energy schemes, policies, and planning efforts that ignore the land, social, ecological, and economic inequalities persistent in the nation are bound to replicate the mistakes of the past. Without these changes, India's energy transition will continue, but as Kerala example demonstrates, it will not be a just energy transition, as many Indians will not benefit from renewable energy.

Highlights

- Political ecology is a useful lens for examining power imbalances associated with energy transitions.
- A critical review of the Indian energy transition reveals injustices.
- In the state of Kerala, historically marginalized communities are not benefiting from renewable energy.
- Renewable energy efforts which ignore the land, social, ecological, and economic inequalities persistent in India deepen injustices.
- Renewable energy policy and planning should reflect local contexts, with active and meaningful resident participation.

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