frontiers in Sustainable Cities

ORIGINAL RESEARCH
published: 05 March 2021
doi: 10.3389/frsc.2021.626683

Scalar Containment of Energy Justice and Its Democratic Discontents: Solar Power and Energy Poverty Alleviation

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The threats climate change poses require rapid and wide decarbonization efforts in the energy sector. Historically, large-scale energy operations, often instrumental for a scaled and effective approach to meet decarbonization goals, undergird energy-related injustices. Energy poverty is a multi-dimensional form of injustice, with relevance to low-carbon energy transitions. Defined as the condition of being unable to access an adequate level of household energy services, energy poverty persists despite the emergence of affordable renewable energy technologies, such as solar photovoltaics (PV). Historical injustices and the modularity of solar PV combine to offer new possibilities in ownership, production and distribution of cost-competitive, clean and collectively scalable energy. Consequently, emerging policy priorities for positive energy districts call into question the traditional large-scale modality of energy operations. We report from a case study of solar power in Lisbon, a frontrunner in urban energy transitions while also home to high energy poverty incidence. The study focuses on scalar aspects of justice in energy transitions to investigate whether and how solar PV can alleviate urban energy poverty. It features 2 months of fieldwork centered on community and expert perspectives, including semi-structured interviews and field observations. We mobilize a spatial energy justice framework to identify justice aspects of multi-scalar solar PV uptake. By showing how energy justice is shaped in diverse ways at different scales, we demonstrate ways in which scale matters for just urban energy transitions. We argue that small- and medium-scaled approaches to electricity distribution, an integral component of positive energy districts, can address specific justice concerns. However, even as such approaches gain attention and legitimacy, they risk structurally excluding socio-economically vulnerable users, and proceed slowly relative to large-scale solar rollout.

Keywords: solar PV rollout, energy transitions, multi-scalar governance, energy justice, national energy and climate plans, carbon democracy

OPEN ACCESS

Edited by:
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Specialty section:
This article was submitted to Urban Energy End-Use, a section of the journal Frontiers in Sustainable Cities

Received: *06 November 2020*
Accepted: *12 February 2021*
Published: *05 March 2021*

Citation:
Nordholm A and Sareen S (2021) Scalar Containment of Energy Justice and Its Democratic Discontents: Solar Power and Energy Poverty Alleviation. Front. Sustain. Cities 3:626683. doi: 10.3389/frsc.2021.626683

INTRODUCTION

The Intergovernmental Panel for Climate Change (IPCC) has indicated the importance of limiting global warming to 1.5°C to avoid catastrophic climate change (IPCC, 2018). Congruently, the World Energy Outlook Report 2019 called for "a laser-like focus on bringing down global emissions" and highlighted that "deep disparities define today's energy world" (IEA, 2019). Alongside the necessity of a rapid and deep global transformation away from fossil fuel sources, there is increasing awareness of the need to transition away from injustices traditionally associated with energy production and distribution. Fossil fuel sources usually entail a physical distance between extraction, management and distribution, and energy end-users. "Carbon democracy" is characterized by fossil fuels which are characteristically concentrated in limited geographic locations; a spatiality that limits ownership and control (Mitchell, 2009). Scouting for and extracting deposits requires heavy financial assets, technology, and equipment. Energy security has long been critical for development. Thus, energy governance is bound up with international negotiations, power posturing, and war (Mitchell, 2009; Behrens et al., 2016). The ability of nation-states to secure adequate energy resources to industrialize and modernize is instrumental in their economic development (Mitchell, 2009). The transition away from fossil fuels, then, goes beyond decarbonizing energy systems. Energy resources interact recursively with geopolitics and national development, and low-carbon energy transitions can potentially reshape these dynamics.

The need for a response to the climate crisis, the geopolitical challenges listed above and expanding renewable energy technologies call into question the traditional scale of operation and ownership in energy systems, through initiatives such as positive energy districts. Critiquing the spatial containers in which we analyze, politicize, and operationalize phenomena such as energy is not new. Fraser (2009) questions the modern territorial state as the default point of policy, control, and analysis. These emerging policy priorities highlight a justice aspect to the scales at which energy transitions take place. Large-scale, centrally controlled energy sectors have been historically riddled with injustices. In solar irradiation rich countries, like Portugal, the tangible proximity of solar energy being "right there" to capture and use inspires social imaginaries about improved energy futures (Szolucha, 2019). Renewable energy sources, like solar photovoltaics (PV), have become affordable and accessible, and increasingly able to compete with fossil fuels. Globally, solar PV has experienced substantial sectoral growth, with 119 GW global capacity installed in 2019 alone, due to its "unique ability to cover most market segments; from the very small household systems to utility-sized power plants" (IEA, 2020).

Despite the affordability and modularity of solar PV, people remain in energy poverty: a socio-material injustice characterized by a household's inability to secure sufficient energy services to meet basic needs (Horta et al., 2019). This suggests that the narrow points of control, as called out by Mitchell (2009) and Fraser (2009), may persist despite transitions to this renewable energy source, regardless of its distinctly different spatial characteristics. Global efforts to eradicate energy poverty are notable in governmental efforts in China, Vietnam, Nigeria, South Africa, Chile, Brazil, Bangladesh, Senegal, and Kenya (Aklin, 2018) and the United Nations' (UN) Sustainable Development Goal (SDG) 7, namely universal access to affordable and clean energy (UN, 2018). Energy poverty is often linked to lack of infrastructure to deliver energy services but can persist despite ubiquitous energy infrastructure due to entrenched inequalities. It constitutes a significant challenge in the European Union (EU), with high concentrations in southern and eastern Europe (Bouzarovski, 2018). In Europe, energy poverty often has socio-economic roots, but can be socio-material, due to poor-quality, energy-inefficient buildings (Bouzarovski, 2018). It persists despite the existence of clean, affordable energy sources. Indeed, studies show that low-carbon energy transitions can exacerbate existing inequities (Behrens et al., 2016; Delicado et al., 2016; Peña et al., 2017). Such energy injustices prompt constructive opposition and public efforts to imagine improved energy futures (Szolucha, 2019). Imagination is "the faculty that allows the extraordinary person to see beyond the limits of constraining reality" (Jasanoff, 2015, p.5). Emergent social imaginaries, notably positive energy districts, are often characterized by scalar changes such as small-scale, decentralized solar PV energy communities. But what potential does solar PV actually hold to alleviate energy poverty? Can solar PV enable people to transcend the entrenched narrow control of the carbon democracy?

Addressing this concern gets to the core of ensuring affordable and adequate energy access as a human right. In recent years, the EU has officially recognized access to affordable and reliable energy services as essential to human life (Hesselman et al., 2019). This is in keeping with established recognition of energy as a necessity for citizenship in one's society because it enables one to stay clean, maintain good health, exercise political rights, and support adequate living temperatures (Day et al., 2016; Brand-Correa and Steinberger, 2017). However, as Walker (2015) notes, the notion of a right to energy is complex and can be "slippery" to pin down. People have different ideas of what the right to energy entails. Contestation over imaginaries often plays out along scalar lines. Perhaps the right to energy implies governmental responsibility for large-scale infrastructure that harnesses economies of scale to provide energy services, or perhaps it means clear legal and affordable pathways to privately owned energy systems for individuals and collectives. This implicates questions of limits and balance. If energy services are free, people may use them sub-optimally, complicate grid management, and compromise a stable low-carbon energy transition. If energy costs escalate, households may be unable to secure requisite energy for wellbeing. Clearly, energy costs require balancing between such extremes. This raises the question of who influences and makes decisions that affect costs, such as fixing electricity surcharges. The governance of energy determines how an energy transition happens and to what degree various actors are involved. Decision-making for energy systems is historically deeply centralized. Emergent social imaginaries regard decisions about energy futures as delegated to decentralized, small-scale nodes, and as thereby involving

end users of energy—energy citizens—who are affected by such decisions (Szolucha, 2019). The right to energy debate highlights the prominent role scalar issues play in considerations of just energy transitions.

Consequently, attention to energy justice has spawned a vast subset of energy transitions research (Heffron and McCauley, 2017; Hiteva and Sovacool, 2017; Sovacool et al., 2017; Bouzarovski, 2018; Jenkins, 2018; McCauley, 2018; Sareen and Haarstad, 2018). The important role of scale is increasingly recognized (Bouzarovski and Simcock, 2017; Hiteva and Sovacool, 2017; Sovacool et al., 2019a). Furthermore, previous conceptualizations aim to make sense of the complex relationship between energy and people. Brand-Correa and Steinberger (2017) argue for decoupling human need satisfaction from energy use for more humane approaches to energy analysis. Day et al. (2016) seek to account for geographical and other variations by defining energy poverty through a capabilities approach which highlights context and location as important factors in availability and consumption of energy. Such conceptualizations offer means to better understand the impacts of scale on energy use and participation, a key aim in this article which extends work along these lines. Specifically, we address the energy justice effects of solar energy transitions at multiple scales. The right to energy debate makes evident that energy future contestations are frequently scalar in nature. While governments and large, long-standing energy companies have the resources to enable the rapid and broad-reaching low-carbon energy transition that the climate crisis necessitates, this transition must simultaneously address continuing energy injustices (Sovacool et al., 2019b). We therefore ask what role scale plays in energy justice, and focus our empirical enquiry on the urban spatial context where decisions are mobilized.

This paper contributes to expanding research on energy poverty, energy justice, and multi-scalar analysis through a case study in the Portuguese capital of Lisbon. It aims to present new insights into the role of scale in renewable energy transitions in terms of their implications for energy justice. We examine the potential of solar PV for energy poverty alleviation through a scalar lens: What role does scale play in low-carbon energy transitions and what is its impact on energy justice? We employ a conceptual framework of energy justice that features four mechanisms: distributive justice, procedural justice, cosmopolitan justice, and justice as recognition (Bouzarovski and Simcock, 2017; Sovacool et al., 2017, 2019a). Additionally, we focus on spatial justice in order to integrate scalar aspects.

We proceed as follows: Section Conceptual Framework draws on literature from socio-technical transition studies, features a multi-scalar focus from energy geographies, and combines this with a socio-spatial approach to energy justice in order to elaborate our conceptual framework. Section Methods describes our methods for data collection and the scope of the case study in Section Findings. The empirical analysis first reports findings on the participation of institutions and actors in multi-scalar solar PV rollout in Lisbon (in section Multi-Scalar Participation in Solar PV Rollout in Lisbon), then devotes explicit attention to scalar aspects of energy justice (in section Distinctive Scalar Aspects to Energy Justice). Section Scalar Energy Justice, Energy Poverty Alleviation, and Solar PV Rollout discusses the role of solar PV to alleviate energy poverty in relation to scale and energy justice. Finally, Section Conclusion offers concluding reflections on implications for policy and research on just multi-scalar transitions.

CONCEPTUAL FRAMEWORK

Transition Studies, Justice, and Energy Geographies

The contextual dynamics of an energy transition affects its justice outcomes. Scholarship shows that low-carbon energy transitions can amplify existing socio-economic inequalities (Bartiaux et al., 2016; Behrens et al., 2016). For instance, feed-in tariffs can increase renewable energy use, but this cost may be passed on to consumers while large energy companies profit (Peña et al., 2017). The field of transitions studies challenges simplistic notions of shifts from fossil fuels to renewable sources. Bridge et al. (2013) make a case to examine energy transitions as geographical processes. Climate change and energy security needs are reworking established patterns of scale and distribution. Transitions studies also links energy production and distribution with democracy. Moss et al. (2014) observe how a supply-oriented logic persisted through dictatorial, state-socialist, and democratic regimes in Berlin, and argue for long-term perspectives on path dependencies. Labussière and Nadaï (2018) argue for examining energy transitions in relation to democratic ideals, as many cases do not offer people a genuine chance to exercise a stake in their energy futures. In his seminal work, Mitchell (2009) explores how democratic and undemocratic processes relate to carbon-heavy energy sources.

In essence, a democratic energy transition must help transform spatial patterns of socio-economic activity to bring about a more just energy system. This entails governance challenges to shift energy systems away from reliance on remote, large-scale energy production and transmission and centralized management models. Solar PV in particular challenges the spatial embeddedness of energy production and distribution practices due to scalar flexibility and accessibility to collectives and individuals. In solar rich geographies like Portugal, studies of energy transitions emphasize participatory approaches (Campos et al., 2016) and action at the municipal scale (Campos et al., 2017), and call for stronger accountability in environmental governance in response to the climate crisis (Sareen, 2019).

Spatial Justice and Multi-Scalar Analysis

The need for multi-scalar analysis in energy transitions and environmental governance has gained traction in research on energy justice (Späth and Rohracher, 2012; Newig and Moss, 2017; Sovacool et al., 2017; Bouzarovski and Haarstad, 2018). Bouzarovski and Simcock (2017, p.642) argue that a spatial approach is vital for recognizing energy injustices, saying that "whether patterns of spatial inequality are revealed, and the forms these take, will depend on the scale of analysis employed and the material sites that are considered."

Notably, Fraser (2009) has problematized the nation-state as the traditional scale where justice is evaluated. She critiques this

Keynesian-Westphalian framing as a vehicle of injustice and argues that such a territorial approach can lead to misrecognition and misrepresentation of important justice issues. She asks: which scale of justice is truly just? The typical scale of production and distribution of energy is at the national level. Globalization has called into question the territorial nation-state as the standard scale of measurement, as this partitions political space in ways that block vulnerable groups from challenging oppressive forces. Energy technologies such as solar PV afford new flexibility and accessibility, leading people to imagine and build energy systems that challenge the national scale of operation. These lower-scale systems are often associated with idyllic descriptions like "community," "socially responsible," and "independent," terms closely intertwined with emergent positive energy districts. Yet as urban contestation reveals, drivers for energy justice are localized and contextually dependent (Hiteva and Sovacool, 2017). Bouzarovski and Haarstad (2018) argue that mainstream discussions seldom reflect an in-depth, theoretical understanding of scale in relation to rapid decarbonization strategies. Thus, multi-scalar analysis is a growing approach in energy studies and calls for explicit attention to how scalar aspects modulate the impact of energy transitions on justice.

Späth and Rohracher (2014) critique the prevalence of binary spatial characterizations in European debates on energy transitions. In Germany, government and industrial actors have argued that a transition to renewable energy sources essentially constitutes a sustainable energy system. Others hold that the German Energiewende must increase distributed generation capacity to allow for more electricity from small-scale solar PV and other projects. Beyond reducing transmission needs, they view decentralization as the only way to counter oligopolistic power over energy systems. Another study of the Energiewende reveals that social movements to strengthen local control over energy policy have created energy collectives and initiatives to re-municipalize energy utilities (Moss et al., 2015). Debates on re-municipalization often transcend legal and material ownership, and espouse spatially localized control, procedurally just participation and distributional justice (Cumbers, 2012).

A pertinent analysis of energy justice offers a framework featuring three scales: macro (transnational), meso (national and sub-national), and micro (local, proximate to energy infrastructure) (Sovacool et al., 2019a). The authors argue that energy injustices are not limited to fossil fuels or large-scale energy systems, and problematize the justice impacts of potential low-carbon energy transition technologies such as solar PV. They point out that the impacts of transitions can extend beyond single geographic territories and that such impacts become recognizable through a multi-scalar, spatial energy justice lens. Our article mobilizes these three scales of analysis in relation to a specific form of injustice: energy poverty. Like Sovacool et al. (2019b, 583) who point out that "One cannot identify and manage what they do not (currently) measure, and here, we maintain there is empirical novelty in documenting these injustices," we operationalize energy injustice based on what participants report as perceived injustices and energy poverty concerns.

Energy Justice

Energy justice is rooted in environmental justice, a field of scholarship that emerged in the 1980s and points to the uneven and thus unjust distribution of environmental effects such as climate change and pollution (Agyeman et al., 2002, 2003). For example, historical emissions by some people in rich countries impose 200–300 times more health damage on others than they experience themselves (Sovacool et al., 2016). However, environmental justice scholarship has been critiqued for inadequate influence on decision-making to address environmental failures (Jenkins, 2018). By contrast, Jenkins argues, energy justice scholarship has a targeted systems focus that aids policy uptake, and is better suited for real-world impact. A coherent analytical framework is essential to address complex challenges such as energy transitions and energy poverty. Historical energy usage has made visible a tension between top-down and bottom-up approaches to policy and participation. For wellbeing, the energy poor often need to increase energy use, whereas global environmental justice requires overall decreased energy consumption. Rolling out renewable energy presents an opportunity to deviate from traditional top-down decision processes in order to increase participation and recognition of traditionally underrepresented stakeholders. Therefore, a framework must systemically account for such conflicts and a variety of needs in energy transitions. This is in keeping with the situated and pragmatist approach to justice that Galvin (2019) proposes in his conceptualization of moral claim-making. We employ an established definition of justice as distributive, procedural, cosmopolitan, and recognition.

Distributive justice deals with how social benefits and disadvantages are allocated across society (McCauley, 2018; Sovacool et al., 2019b). Additionally, Bouzarovski and Simcock (2017) argue that the understanding and recognition of geographic disparities in energy vulnerability are key components of energy justice. They challenge "the artificial production vs. consumption binary that characterizes much energy poverty research" (Bouzarovski and Simcock, 2017, p.640), and identify mechanisms that increase energy injustices at multiple scales: landscapes of material deprivation, geographic underpinnings of energy affordability, vicious cycles of vulnerability, and spaces of misrecognition.

Landscapes of material deprivation highlight that energy poverty is spatially uneven both at supra-national (Bouzarovski and Tirado Herrero, 2017) and sub-national scales (Gouveia et al., 2017). Place-specific environmental features like housing stock quality and energy use patterns shape household vulnerability to energy poverty; thus, the scale at and spaces in which energy justice is assessed have implications for what injustices are revealed. The geographic underpinning of energy affordability implies that some countries are more pre-disposed to incidence of energy poverty due to high rates of inequality (Bartiaux et al., 2016). For instance, gentrification has changed where people live in Lisbon (Lestegás, 2019; Sequera and Nofre, 2019). Vicious cycles of vulnerability implicate the multi-dimensional nature of energy poverty, with medically

disadvantaged people often at increased risk of experiencing energy poverty, and those with pre-existing conditions more vulnerable to winter mortality (Healy, 2003). As Graham (2007, p.xi) notes, "inequalities in people's health are intimately and inextricably connected to inequalities in their material and social circumstances." We discuss spaces of misrecognition later, under justice as recognition.

Procedural justice concerns fairness in how transitions are implemented (Yenneti and Day, 2015). It helps evaluate whether decision-making is democratic. According to Sovacool et al. (2019b, p.582), "all major socio-technical transitions require open and democratic participation by a wide range of actors (including firms and consumers, as well as civil society groups, media advocates, community groups, city authorities, political parties, advisory bodies, and government ministries) to minimize unwanted impacts." We draw a distinction between institutional and non-institutional actors. An institution comprises any organized body with the capability to govern, whether formal or informal (Lund, 2016). Thus, institutions have control over energy resources and can disenfranchise or empower. Non-institutional actors are persons or groups actively involved in the promotion, production or use of solar energy, and who are thus materially affected by it. These actors hold socio-technical imaginaries, or "collectively imagined forms of social life and social order reflected in the design and fulfillment of nation-specific, scientific, and/or technological projects" (Jasanoff and Kim, 2009, p.120), that may differ from existing institutional practices.

Cosmopolitan justice is a globalized approach that recognizes the equal worth of all human beings commonly bound and protected by certain moral principles (McCauley et al., 2019). It also recognizes their collective morality beyond borders, regardless of national affiliation (Sovacool et al., 2019a). While its aspects can in principle be covered by the other dimensions of justice, we see value in ensuring explicit attention to a global perspective given the global material nature of solar energy modular supply chains and the climate challenge (Newell and Mulvaney, 2013).

Justice as recognition identifies vulnerable people at risk of worsened exposure by transitions to renewable energy sources (Sovacool et al., 2019a). It recognizes that certain populations, such as the chronically poor, ill, or the unemployed may need affirmative action, and "seeks to ensure the acknowledgment of marginalized and/or disadvantaged groups in relation to energy systems" (Lacey-Barnacle, 2020, 3). One group subject to energy injustice is the energy poor (Sovacool et al., 2016), as recognized by both the EU and the UN defining access to affordable, reliable clean energy as a human right (European Union, 2012; UN, 2018). In a spatialized sense, spaces of misrecognition refer to patterns of risk that remain overlooked, typically due to stigmatization or victim-blaming that neglects underlying drivers and patterns of injustice, leading to lack of targeted support to at-risk groups (Bouzarovski and Simcock, 2017). This offers a focused means to identify injustices of recognition.

METHODS

We apply the above analytical framework that brings together spatial and conventional dimensions of energy justice with specific reference to energy poverty and solar PV rollout in Lisbon. To do so, we draw on empirical material based on 8 weeks of fieldwork spread across two visits during November–December 2018 and May–July 2019, in the framework of a Master thesis project conducted in line with institutional guidelines and ethics requirements at the University of Bergen. The first 2-week scoping visit—funded by the European energy poverty network ENGAGER as a Short Term Scientific Mission—allowed for trialing and subsequently adjusting data collection protocols. The main 6-week stretch—funded through a Meltzer Foundation award—enabled detailed stakeholder interviewing and some participant observation with a clear interest in issues of scale in the governance of solar rollout. This ethnographic approach matches case complexity at the intersection of energy poverty, low-carbon transition, and scale. Fieldwork targeted experts and engaged citizens in solar PV rollout, in line with the multi-scalar focus, which dictated speaking to informants with various experiences of solar PV deployment. Email and telephone requests both in advance of and during fieldwork, along with snowball sampling, were used to recruit participants, who received a written overview of the project and signed consent forms prior to being interviewed. We also drew on a co-author's existing knowledge of institutions and networks relevant to solar energy in Portugal, based on a larger research project commenced in 2017 with extensive fieldwork.

Interviewing decision-makers and small- and large-scale solar PV actors and institutions provided the context for who participates and who is absent (notably the energy poor) in the solar PV rollout in Lisbon. Materials include 24 interviews with 20 different informants (some were interviewed twice) and field observations from two sectoral events: a national Roadmap to Carbon Neutral 2050 meeting on 4 December 2018 and a prosumer business model workshop at the University of Lisbon on 12 June 2019. Informants included researchers, energy community professionals, proponents and members, government officials, and three renewable energy investment firm representatives.

Interview recordings were transcribed to text and then qualitatively coded using the NVivo data analysis software. These primary data were complemented by desk study of peer-reviewed and gray case-specific literature, and a journal record featuring observations on everyday energy practices during fieldwork that served the function of cross-validation and contextualization. For a comprehensive description of methodology, please see Nordholm (2020, 38–55).

Informant selection was skewed to actors engaged in small-scale solar PV projects. Securing responses from larger actors including governmental institutions was challenging, as typical when studying elite groups (Kezar, 2003), especially as a junior field researcher. Difficulty in reaching these large institutions reveals socio-economic dynamics when "studying up" (Aguiar

and Schneider, 2016). Interviewed informants shared many reflections about large institutional solar stakeholders.

FINDINGS

Multi-Scalar Participation in Solar PV Rollout in Lisbon

We first describe the relevant stakeholders and analyze their agency in solar PV rollout. A key tenet of procedural justice is to identify participating and missing actors, and to characterize the allocation of benefits and burdens across them (Yenneti and Day, 2015; Sovacool et al., 2019b).

Institutional participants in solar PV feature governmental institutions such as the Ministry of Environment and Energy Transitions (MATE), the Directorate General of Energy and Geology (DGEG), the Energy Services Regulatory Authority (ERSE), and Lisbon's municipal energy agency Lisboa E-Nova. DGEG was the only governmental institution that responded and participated in an interview for this study; the participation of the others was determined from the readily available information due to their public roles. MATE, ERSE, and DGEG operate at the macro-, meso-, and micro-scales of solar PV rollout. They handle transnational operations in Portugal and are responsible for laws, regulations, and taxes that apply to energy infrastructure, production, and distribution. Lisboa E-Nova operates within the urban context of Lisbon with some transnational urban networks. During the study period, policymakers and regulators enabled community energy legislation, notably a collective self-consumption law that came into force in January 2020 to allow individual and collective self-consumption of renewable energy (Diario Da Republica Electronico, 2020). Other prominent institutional participants are energy companies, notably Energias de Portugal (EDP). EDP participates in and benefits from solar PV uptake across scales. At the macro-scale, the transnational company has a presence in 14 countries. At the meso-scale, it is Portugal's largest producer, distributor, and supplier of energy, and has the resources to aid a low-carbon transition for cosmopolitan justice. At the micro-scale, EDP offers a solar PV package for individual and collective self-consumption that allows users to acquire panels without common logistical, financial and temporal barriers.

Other institutional participants include civil society organizations and non-profits that represent interest groups. A notable non-profit institution is Coopérnico, Portugal's first renewable energy cooperative, located at the meso- and micro-scale. It crowdfunds solar PV installations and partners with a supplier to sell virtual solar electricity to members at competitive rates. A notable impact investing institution is GoParity, which facilitates ethical profitable investments such as small-scale solar PV projects that address SDGs such as SDG7. Finally, academic institutions play an important role, with researchers holding knowledge and legitimacy, and often called upon by policymakers to inform energy transitions. They serve to connect large- and small-scale stakeholders. This study secured participation from a representative of a renewable energy civil society group, two representatives of Hyperion investment group, two Coopérnico representatives, and a representative of GoParity. Additionally, this study had participation from nine energy poverty and solar PV researchers at University of Lisbon, NOVA University Lisbon, and the European funded research initiative PROSEU.

Non-institutional participants include investors of Coopérnico and GoParity, energy citizens who invest in small-scale solar PV projects despite a low return relative to conventional investments. Coopérnico also has non-investing members who buy its virtual solar electricity due to a good price. Five members of Coopérnico participated in this study.

Missing actors are those of lower socio-economic standing. Citizens who are not environmental or renewable energy enthusiasts are unable and/or unwilling to spend money on home solar PV or to crowd-fund solar PV projects. Our analysis found that participation was generally missing from this group without deliberative top-down action, such as an initiative led by the municipal energy agency Lisboa E-nova for a low-income housing solar PV community (Franco, 2018). This study purposefully did not seek to include these actors due to a potential injustice of recognition that could result from seeking them based on their potential "poverty" status, which entails a risk of stigma unless carried out with greater local sensitivity and concomitant resource demands than our scope of study allowed for. Work on this theme is, however, emerging (Horta et al., 2019). **Table 1** sums up participation by actors at various scales.

Distinctive Scalar Aspects to Energy Justice

Several actors expressed the idea of changing the scalar configuration of energy consumption, taxation, power, and capital as a strong motivating factor for solar PV uptake. For them, changing the scalar configuration meant more fairness in energy. For example, a member of Coopérnico stated that "The state needed to get money. So basically, over the last 20 years, citizens are paying for that need of the government" (interview dated 17.06.2019). He proceeded to talk about the "murky and very obscure" story behind energy prices in Portugal, in which the state energy company increased revenues in order to sell at a higher price (see: Silva and Pereira, 2019). He continued: "If you can do a system that the objective is not to give profit to big managers…but to use those profits to lower the cost of energy for people and for companies, I think that's fair." He gravitated to Coopérnico because the cooperative offers energy modalities other than the "big," national level incumbent industry.

Coopérnico's model shifts the distribution of energy benefits and burdens from meso- to micro-scale. Informants of this study, such as this Coopérnico member, preferred solutions that avoided bureaucracy, which suggests they were weary of traditional energy institutions. His repeated use of the word big in relation to what he saw as the systemic problems with energy suggests a mistrust of meso-scale energy operations. Several informants (four of the five Coopérnico members) also identified redistribution of capital away from large incumbent industries toward community and other micro-scale energy as a relevant

TABLE 1 | Scalar participation in solar PV by various institutions and actors in Lisbon.

	Stakeholders	Macro-scale participation	Meso-scale participation	Micro-scale participation	Participation in this study
Institutional	Governmental actors (DGEG, ERSE, REN, Lisboa E-Nova)	Regulates transnational solar stakeholders within Portugal, such as the solar auction participants.	Energy policy, renewable energy tariffs.	Lisbon low-income housing project solar community, collective self-consumption law.	Two participants from DGEG. All other governmental institutions listed here were contacted but did not respond.
	EDP	Transnationally owned and operated. Solar PV in multiple countries.	Portugal's largest energy supplier.	Offering solar panels to individual households.	Did not respond to request for interview.
	Civil society (APREN, ADENE)	APREN advises on e.g., interconnection with Morocco for trade in solar PV electricity	Important for national transition to renewably sourced energy. Coordinates large-scale public and private interests.		Three participants, two from APREN, two from Hyperion.
	Coopérnico		Supplier of 100% renewably sourced energy in Portugal.	Crowd owned and funded projects for small-scale, community-oriented projects.	Two participants.
	GoParity	Funds SDG focused projects also outside Portugal which include small-scale solar PV.		Crowd funded projects, most of which are small-scale and solar PV is a big focus.	One participant.
	Researchers		Provide actionable knowledge on solar PV rollout to governmental actors.	Growing body of research on municipal- and small-scale solar PV.	Nine participants.
Non-institutional	Coopérnico members			Environmentally focused people with keen interest to invest in community level solar.	Five participants.
	GoParity members			Environmentally focused people with keen interest to invest in community solar.	One participant (also a member of Coopérnico.)
	Ordinary citizens		Opportunity for inclusion from Coopérnico due to low energy cost. EDP solar panels.		No participants by design.
	Energy vulnerable households		Opportunity for inclusion from Coopérnico due to low energy cost. EDP solar panels.	Limited opportunity for participation via Lisboa E-Nova.	No participants by design.

theme. The flow or stagnation of capital finances the location and scale of low-carbon energy transitions, deciding which of these projects lives on and succeeds. GoParity's investment criteria put this idea to work; their capital sourcing criteria provide a low €20 entry point to investment in solar PV. The GoParity representative stated "we are giving access to everyone. To [a] community of investors" who fund social impact projects as small as €10,000 net worth, making possible many micro-scale, decentralized ambitions. "Traditional commercial banks don't fund that. We fund that" (interview dated 25.06.2019).

Problems with the built environment, and the national administration's response to this issue, were prominent iterative themes in discussions about energy poverty during interviews. Government efforts to address this material deprivation, and thereby energy poverty, included tax breaks for efficient housing upgrades. A researcher critiqued this by arguing that "they are giving the incentives and the privileges to ones who already have money and knowledge to change" (Researcher six, interview dated 19.06.2019). The government also offered financial reimbursement for energy efficiency enhancing building renovations, such as the installation of insulating double-glazed windows. However, informants argued that the national execution of these well-intentioned policies resulted in prohibitive knowledge and bureaucratic hurdles, rendering these programs inaccessible to the neediest households.

A researcher from NOVA University Lisbon (interview dated 18.06.2019) imagined a solution to the difficulty in rolling out these policies and proposed nation-wide decentralized deployment of knowledge in the form of municipal information hubs that would assist citizens in home renovation, solar panel procurement, and energy sector bureaucracy navigation. He explained the multi-scalar administrative approach as one in which "there is a central office that works with the municipalities, so they go for the programs and plans on energy efficiency together." He argued for knowledge and programs that can improve people's lives to be easily accessible and enabling across

groups with a broad range of educational and socio-economic attributes. Another researcher (Researcher two, University of Lisbon, interview dated 28.06.2019) elaborated that the energy tariff program for energy vulnerable households at most assists poverty alleviation, but not energy poverty alleviation. It lowers home electricity bills, but residents do not necessarily increase thermal comfort, which is essential for good health. Spared income is often redirected to other needs like food and medicine. Effective solutions must focus on achieving thermal comfort regardless of financial means and he mentioned solar energy communities as one possibility.

The same researcher highlighted the problem of spatially remote energy production and consumption. Lisboa E-Nova runs a citizen training program on energy efficiency, where residents of an affordable housing neighborhood solar PV community meet to discuss energy efficiency practices and behaviors, receive knowledge to decrease their energy bills, and access available support schemes. The researcher pointed out that "I would be very surprised if we could replicate this at larger scales" (Researcher two, interview dated 28.06.2019), emphasizing the scalar mismatch between improving local participation and large-scale electricity generation and distribution. He proposed a community solar peer-to-peer regulatory scheme as another means to address energy poverty, rather than a large distribution service operator. The peer-to-peer system would let owners sell energy in their community or make aggregated grid sales.

Around half of Portuguese housing stock requires extensive renovation (Palma et al., 2019). The above mentioned building renovation scheme was labeled a failure by several informants and came up unprompted in over a third of interviews. A researcher (Researcher six, interview dated 19.06.2019) flagged the "centralized point of view" of the overly demanding scheme design to illustrate how the narrow, national level, central control of these policies, and resources has been ineffective. A decentralized peer-to-peer model, like the one suggested by Researcher two, requires community cooperation and can utilize a third-party institution to access benefits usually limited to higher-scale operations. A third-party can aggregate excess solar energy and trade it on the wholesale market, removing technical barriers that hinder small-scale solar PV adoption. Two informants (see **Table 2**) highlighted the importance of networks within and across urban contexts, citing intermunicipal communities in regions as vital enablers of energy policy implementation and resource sharing. The NOVA researcher observed that of the municipalities, "most of them are small. So they cannot act alone…in some regions there is a combination of like 15 municipalities" (interview dated 18.06.2019). Thus, networks are important for small-scale solar PV actors since they allow for the aggregation and sharing of resources and knowledge. Through these networks, small-scale actors acquire and share valuable assets resulting in risk-sharing and an increase to their project's security, longevity, and potential for success. Risk sharing is part of the thinking behind the PROSEU prosumer solar PV communities as brought forth by the PROSEU representative: "The families with already installed systems, would use the savings they have to then help [vulnerable] families…that people with no money could have access to solar energy" (interview dated 17.06.2019). **Table 2** sums up the main findings above, backed by especially pertinent quotes.

SCALAR ENERGY JUSTICE, ENERGY POVERTY ALLEVIATION, AND SOLAR PV ROLLOUT

The Potential of Solar PV to Alleviate Energy Poverty

The Lisbon case gives a glimpse into the complex nature of energy justice within energy transitions. Specifically, it shows us that the scalar containers used in analysis and execution of energy operations and transitions matter for justice outcomes. For example, to exercise the potential of solar PV to alleviate energy poverty, the energy poor must be able to participate in its rollout. They must be able to experience the monetary savings and self-deterministic effects that many solar PV proponents speak of. Participation is intertwined with procedural justice, as policy and implementation processes, and the modularity of the energy technology, determine who participates and benefits. Solar PV has a broader socio-economic and scalar composition of stakeholders than fossil fuel energy sources due to flexible modularity which shapes new socio-material assemblages of energy and gives wider options for ownership and control. In Lisbon, emerging stakeholders, empowered by the accessibility of solar PV, represent constructive opposition to incumbent operators. Energy democracy, characterized by large amounts of distributed generation and less capital-intensive energy production, is a possible outcome of the tensions that shape the trajectory of emergent socio-material assemblages (Calvert, 2016). However, technological progress and resource availability do not suffice to materialize pro-poor energy futures. In Lisbon, procedural tensions facilitated networked engagement among new solar PV actors, but maintained limited opportunity for participation from energy poor households.

Building quality featured often without prompting during interviews as a leading problem in addressing energy poverty. Poor housing quality constitutes landscapes of material deprivation (Bouzarovski and Simcock, 2017), a distributive consequence that renders addressing energy poverty with solar PV challenging, based on the built environment's poor interaction with climate effects. One study found that building renovation measures provided long-term sustainable effects over energy subsidies (Gouveia et al., 2018). The 2010 government-implemented building renovation strategy, that allows residents to apply for cost reimbursement of energy efficiency-enhancing features, was rolled out nationally to be available to all citizens. Theoretically, this approach would address a root cause of energy poverty while increasing the feasibility of solar PV. Unfortunately, informants revealed the prohibitive complexity of the building renovation program in Portugal, which inadvertently limits the benefits to those in a position to acquire extra help and afford bureaucratic delays for renumeration. Two well-educated and well-connected informants (interviews

TABLE 2 | Main findings and quotes.

Finding	Details	Supporting quotes
Energy justice has distinctive scalar aspects	Changing scalar distribution of energy consumption, taxation, power, infrastructure, and capital.	"We are currently embracing self-consumption and [energy] communities."—Representative of DGEG "The state needed to get money. So basically, over the last 20 years, citizens are paying for that need of the government."—Member, Coopérnico, and GoParity "We hopefully want to (bring) a bit more power to…local communities as consumers and producers of energy."—Representative, PROSEU (European research initiative to mainstream prosumerism) "We are giving access to everyone. To [a] community of investors" and "traditional commercial bank don't fund that. We fund that."—Representative, GoParity
	Increase distributed generation and distributed knowledge.	"The public policy instruments in place, they are not tailored for low income persons or families. At all."—Researcher at the Center for Environmental and Sustainability Research (CENSE) "We are living almost in a monopoly. We have EDP and they are very strong."—Researcher six, University of Lisbon "Centralized is doing the same we have done so far, but with a different source. It's the same regime, same structure, and the same paradigm. Just changes the source… we will have the same inequalities in distribution."—Representative, PROSEU "Distributed generation…happens in many different places and there is no way of centralizing the generation."—Researcher two, University of Lisbon
Networks are important for small-scale solar actors	Small-scale solar actors aggregate in different ways to acquire benefits usually reserved for large, meso-scale operations.	"The families with already installed systems, would use the savings they have to then help [vulnerable] families…that people with no money could have access to solar energy."—Representative, PROSEU "Most of them are small. So they cannot act alone…in some regions there is a combination of like 15 municipalities…there is a central office that works with the municipalities so they go for the programs and plans on energy efficiency together."—Researcher three, NOVA University Lisbon

dated 19.06.2019 and 5.09.2019) stated they were unable to complete the paperwork themselves and had to utilize their administrative connections to finish the process. In addition, residents usually had to buy the equipment and deal with the technical requirements themselves (an additional consultation cost if they did not possess appropriate technical skills). This constitutes an extra temporal boundary as those who most need the assistance likely do not have the money to invest upfront, and even if they do, few can wait for the bureaucratically long reimbursement schedule. This can hardly be called a solution for those most vulnerable to energy poverty and this example was used by this study's informants to argue for new, small-scale configurations of energy access. Procedural and temporal complexities represent barriers for energy vulnerable households.

The Role of Scale in Energy Justice

Community and expert perceptions collected during this study indicate that the scale of solar energy rollout matters for energy justice. According to a representative from PROSEU: "Centralized is doing the same we have done so far, but with a different source. It's the same regime, same structure, and the same paradigm. Just changes the source…we will have the same inequalities in distribution" (interview dated 17.06.2019). This striking claim merits closer examination: while meso-scale, centralized energy provision has historically led to injustices, this is not inevitable. Consider the effects of Portugal's low-carbon energy transition to wind power since the 2000s, which decreased its fossil-fuel dependence "from 64% of total electric power demand in 1994 to 36% in 2014" (Peña et al., 2017, p.201). A renewable energy feed-in tariff with public subvention facilitated this massive shift (ERSE, 2020). Studies confirm that the large growth in wind power increased the price for end users (Peña et al., 2017; Prata et al., 2018). This constitutes inequitable distributional effects and supports many of the informants' claims.

The case is illustrative of distributional injustice in that it shows how the burdens of transitioning to renewable energy were distributed unfairly to end users, many of whom struggle with energy poverty. Yet, the case aids in parallel cosmopolitan justice through large-scale decarbonization at the national and global scale. This demonstrates that it is possible to have both an increase and a decrease in justice effects, depending on the scale of and spaces of recognition. It points to the potential blindspot or trade-off that can result from limited scalar containers of action and analysis. What is good for the country, may not be good for greater notions of cosmopolitan climate justice; a contestation that reveals how political trade-offs happen and the importance of acknowledging and analyzing them (Newell and Mulvaney, 2013). Deploying meso-scale energy transition addresses the global need for vast and rapid decarbonization (cosmopolitan justice) but facilitates this at the expense of end users, causing procedural and distributive injustice at the micro-scale.

Perceptions of respondents indicate a desire to address distributional injustice by changing how national energy markets function. A study of the distributional costs of Portuguese wind energy under the liberalized Iberian market regime supports this perception, showing an asymmetric benefit at play for ratepayers. It notes that the rate increase for end users "suggests some kind of welfare transfer that policies should avoid" (Prata et al., 2018, p.508).

Thus, large-scale operations have caused injustice. However, up-and-coming small-scale approaches sometimes rely on traditional, large-scale approaches to gain influence and legitimacy. Our research indicates that small-scale actors recognize that there is more control and legitimacy at larger

scales of energy operations, yet their experience tells them that just and democratic effects are happening at smaller scales. By establishing networks, they work within and match the established socio-technical structures that yield better resource access and greater control over their energy futures while maintaining the inclusivity of small-scale solar PV communities. For example, Coopérnico amalgamates small-scale community solar PV systems into a larger cohort and has become an energy supplier to secure market access. PROSEU draws on 11 prosumer, renewable energy communities across the EU and has secured competitive research funds from the European Commission. This enables the empowerment and amplification of a small-scale solar community in Portugal toward its goal of energy autonomy. In both cases, solar collectives and networks increase salutary justice outcomes through procedural, distributive, and recognition effects. Through collectives that exercise broad claims of a right to energy, energy users take on institutional and state effects through a multi-scalar identity. This widens the narrow points of control that were previously limited to a carbon-only democracy (Mitchell, 2009), creating new openings for energy justice in an explicitly spatialized, socio-economic sense.

Paradoxically, the solar panel program EDP targets to individual households presents the best current example of a horizontal solar PV rollout, by removing technical, logistical, temporal, and monetary barriers. However, there are real justice issues with the final distribution of benefits from adoption, and also in the supply chain for solar panels, which often extends beyond national borders (Barnes, 2017). It is unclear where EDP sources solar panels from, and which standards procurement complies with. By contrast, Coopérnico employs a rigorous certification process to ensure the complete lifecycle of the panels used in their projects is sustainable and humane (interview dated 14.06.2019) but they do not possess the resources at this stage to roll out a solar PV program as comprehensive as EDP's. Thus, at the macro-scale, Coopérnico's approach explicitly embodies cosmopolitan and recognition justice by taking measures to acknowledge and ensure that, for example, materials do not come from conflict zones. In this way, they ensure that their contribution to the renewable energy transition does not result in unjust global externalities. Yet, EDP utilizes its commanding multi-scalar influence to enable a horizontal diffusion of individual solar that transcends typical adoption barriers to procedural and distributive justice.

If energy transitions are mono-scalar, spaces of misrecognition are liable to arise (Bouzarovski and Simcock, 2017). Healy and Barry (2017) emphasize that national transition strategies should facilitate coalitions, consider local contexts, and include communities and citizens in policymaking. The fact that energy poverty has not been effectively addressed through either micro- or meso-scale solutions suggests the need for alternative approaches at these scales. Two interviewed researchers effectively made the argument for improved multi-level governance by positing that national-scale governance should equip and task municipalities with adjusting and implementing energy policy for horizontal diffusion of solar PV to their constituents. They argue that this would allow for location-specific distribution and greater efficacy, an argument that resonates with academic literature about multi-scalar approaches to governance. Späth and Rohracher (2012) argue that multi-level governance that integrates and implements socio-technical configurations, and differs from traditional, dominant regimes, may be advantageous for the long-term success of an energy transition. Since municipalities embody generally even territorial coverage, they argue that such micro-scale delegation of control and responsibility can enable spatial and energy justice.

Thus, national governments and large-scale institutions can and do play an essential role, both to facilitate rapid and substantial decarbonization of energy systems for cosmopolitan justice as well as to coordinate multi-scalar action. An economy built on carbon requires decarbonization efforts of massive proportions on the scale of—and layered on top of—existing carbon infrastructure to avoid the worst effects of cataclysmic climate change. The trade-off between the urgent need for large and rapid decarbonization, and ongoing injustices associated with large-scale approaches to energy provision, further underscores the need for a coherent vision and explicit commitment to energy justice across scalar approaches. Our study suggests rich scope for alternate modalities of solar PV rollout that require diverging from traditional top-down implementation in favor of policies that explicitly enable energy justice at lower scales through socially situated approaches.

There is a consequent need to consider and allow for variation in "regime structures" during transition (Späth and Rohracher, 2012). Engaging renewable energy actors across scales has a vital place in deliberate strategies for accelerated decarbonization (Calvert, 2016). Portugal's world record setting solar auctions in 2019 and 2020 saw massive participation by foreign players. A competitive market mechanism spurred rapid uptake premised on a globalist approach that more narrowly targeted, localist approaches would have unduly limited. Community energy and other small-scale approaches can and should complement a robust, multi-scalar low-carbon transition. However, as cautioned earlier, mono-scalar focuses to energy transitions appear to have their disadvantages, and micro-scale energy, favored by many participants in this study, is no exception. For instance, scholars caution against the disadvantages of localism (Späth and Rohracher, 2014; Sturzaker and Nurse, 2020). Stokke and Mohan (2001) point out how localist approaches can be mobilized by various ideological stakeholders, for instance to undermine the role of state or transnational authority. Such a tendency can hold back the critical multi-scalar role energy governance needs to play for an effective and just low-carbon transition.

CONCLUSION

Twentieth century democracy was both created and limited by fossil fuels (Mitchell, 2009). In the 21st century, we are unpacking how renewable energy recursively shapes democracy and what new limits and injustices this governance dynamic creates. Is it the same democracy with the same limits and injustices

as carbon democracy, albeit with a different socio-spatial configuration? Are these democratic maladies unavoidable as states transition to renewable energy sources? The Lisbon case illustrates how a particular approach to low-carbon energy transitions enacts complex justice outcomes and the recognition of those outcomes depends on the scales at which action takes place. Our analysis reveals how an action or policy can be simultaneously just and unjust, underscoring that comprehensive consideration of just energy transitions must be rooted in an explicitly multi-scalar perspective. It also signals the way forward for more democratic energy transitions that are mindful of how approaches selectively encourage or hinder participation. As Mitchell (2009, p.401) states: "Understanding the relations between fossil fuels and democracy requires tracing how these connections are built, the vulnerabilities and opportunities they create and the narrow points of passage where control is particularly effective." These narrow points of passage ensured that a limited group of people experienced the profits and power of fossil fuel energy sources. How does solar PV stack up? Solar PV, unlike fossil fuels, is inherently scalable from large solar parks down to the household unit, inspiring socio-technical imaginaries for more democratic energy futures. Is it inherently more democratic, or do established forms of carbon democracy overpower any potential changes? Is solar PV more democratic at some scales than others? The Lisbon case shows us that solar PV has many more "points of passage" than fossil fuels, a socio-material artifact that limits possibilities of central control and opens up to more democratic energy futures. We see emergent small-scale energy actors empowered by the modularity and affordability of solar PV. We see these actors laying claim to their energy, and exercising authority over it, by forming networks and coalitions. We see how policy enables or hinders their ability to act on their claims. Despite citizens' attempts to take decisive steps to overcome perceived shortcomings of energy governance, we note spatial variation where large-scale material shifts only sporadically accommodate local contextual aspects. This results in "islands" of increased democratic effects. Without targeted policy, landscapes of material deprivation persist despite the existence of affordable clean energy sources, and manifest as lingering energy poverty and socio-spatial patterns of exclusion in small-scale solar PV rollout.

Further investigation could explore multiple paths. First, scalar notions of energy justice would benefit from the inclusion of more voices from large institutions and governmental agencies, to examine aspects such as changing roles of electricity suppliers. Second, scalar research could interrogate interactions across scales in a single study, despite a spatial focus on the urban, as in our case study. Scholarly treatment of spatial energy justice tends to utilize different cases for each scale. Third, our study brings to the fore instances of practical approaches to energy justice that are spatially limited, such as the social housing renewable energy project of Lisboa E-Nova. Future work could explore how such innovative projects impact energy poor households and develop guidance for how to scale out and replicate these in diverse contexts.

Future studies can address the mainstreaming of energy justice in energy policy, taking point of departure in rapidly proliferating multi-scalar energy transitions. Energy justice "needs to be taken out of the abstract and placed into the realm of the practical" (Hiteva and Sovacool, 2017, p.638). A spatialized energy justice approach could help policymakers recognize the variations of injustices that can occur across various scalar configurations of the energy policy they enact. With a better understanding of the potential political trade-offs between the different types of energy justice, they can execute more inclusive energy policy. In this way, they may be able to decrease negative externalities, such as energy poverty, that can readily manifest from or be exacerbated by renewable energy transitions. It may help them better manage the complex nature of ensuring a just energy transition to create more democratic socio-technical energy futures. Finally, further research could pick up the torch on this very case, the nature of which is quickly changing. A statement by an interviewed researcher captures the complexity and rapidly evolving nature of the studied context: "And uh, if we had this conversation in 6 months' time, I would probably say a few different things." While real-world change makes for moving targets, there is clear and significant scope for impact-oriented research.

Like the Energiewende in Germany (Moss et al., 2015), aspects of escalating energy transitions are contested in Lisbon and Portugal. These contestations, and the potential of solar PV, have produced a diverse range of stakeholders with varied socio-technical imaginaries about the energy futures at stake. Who gets to realize those futures, and how, is a rapidly unfolding challenge for energy justice, and one where scale plays a central role—in communities, in Lisbon, in Portugal, and globally.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

AN led the conceptualization, framing, data reporting and writing, and data collection. SS contributed to all aspects of the paper other than data collection. All authors contributed to the article and approved the submitted version.

FUNDING

The research was supported by generous funding from the Meltzer Foundation (travel grant) and COST Action

16232 ENGAGER on European Energy Poverty (short term scientific mission) to cover the data collection costs for AN. Research time for SS was supported by a Trond Mohn Foundation grant (European cities as actors in climate and energy transformation, BFS2016REK04) and faculty funding at University of Stavanger.

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.