Scales of Energy Justice

Solar power and energy poverty alleviation

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Contents

Abstract

The threats climate change poses require rapid and wide decarbonization efforts in the energy sector. Historically, traditional, large-scale energy operations have frequently led to energy-related injustices. Energy poverty is one such injustice that has gained attention as an important issue to address within low-carbon energy transitions. Energy poverty (the condition of being unable to access an adequate level of household energy services) persists despite the existence of renewable energy technologies, such as solar photovoltaics (PV), which offer cheap, clean, and highly scalable energy. Historical injustices and the modularity of solar PV offers new possibilities in ownership, production and distribution of energy and calls into question the traditional scalar approach to energy operations. This thesis reports on a case study of solar power in Lisbon, Portugal. It investigates the potential of solar PV to alleviate energy poverty and the role of scale in energy justice in relation to renewable energy transformations. The case consists of eight weeks of field work which generated insights on community and expert perspectives. Methods used in the field are non-attribution, semi-structured interviews, and field observations. Secondary research methods included deskwork and document analysis. Interviews were analyzed using the qualitative data analysis program NVivo and through comparison to relevant grey and academic literature. I used an energy justice framework to identify and discuss justice aspects of solar PV uptake at different scales. Results indicate that energy justice is shaped in diverse ways at different scales, and that scale matters for energy justice. The Lisbon case illustrates how small- and medium-scale approaches to energy distribution can address energy justice concerns. The study finds that such approaches are gaining attention and legitimacy, but do not yet include all socio-economic groups. It moreover shows how large-scale approaches to energy are potentially well-equipped to make renewable technologies, such as solar PV, widely accessible.

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1 Introduction

As the world faces a global climate crisis, the 2018 Intergovernmental Panel for Climate Change (IPCC) report indicates the importance of limiting global warming by 1.5˚C to avoid the most catastrophic consequences of climate change (IPCC 2018). Congruently, the World Energy Outlook Report 2019 calls for "a laser-like focus on bringing down global emissions" which is accompanied by the opening line "deep disparities define today's energy world" (IEA 2019). The world needs to undergo a rapid and deep transformation away from fossil fuel sources but there is also an increasing awareness of the need to transition away from injustices associated with fossil fuels and traditional means of production and distribution. The nature of fossil fuel sourced energy produces a physical and/or figurative distance from its end users and the management, governance, extraction, and distribution of that resource. Fossil fuels are in limited geographic locations which also means limited ownership and control of this resource. Scouting for and extracting deposits requires heavy financial assets, technology, and equipment. Energy security has long been and remains critical for the development of any nation-state. For these reasons, governance of energy resources has been, in some cases, the source of international negotiations, power posturing, and war (Mitchell 2009; Behrens *et al.* 2016). Historically, the ability of nation-states to secure energy resources in sufficient amounts for industrialization and/or modernization has been instrumental in that nation's economic development (Mitchell 2009). Thus, the transition away from fossil fuels is about more than decarbonization of energy systems. It implies that energy shapes geo-politics, national development, and social welfare, and that low-carbon energy transitions offer a modality to reshape these themes.

The need for a response to the climate crisis, the geo-political challenges listed above, and the expanding renewable energy technologies, call into question the traditional scale of operation and ownership in energy systems. Justice concerns are also bringing attention to how scale matters in energy justice. Large-scale, centrally controlled energy has historically been riddled with injustices. In solar irradiation-rich countries, like Portugal, the residents can feel the energy of the sun most days giving a feeling of it being "right there" to capture and use. This inspires social imaginaries about energy futures that look different than traditional approaches (Szolucha 2019). Renewable energy sources, like solar photovoltaics (PV), have become affordable and accessible, and increasingly able to compete with fossil fuels. So technological and economic solutions to the climate crisis do exist. In particular, solar PV is experiencing

substantial sectoral growth, with 119GW of installed capacity added worldwide during 2019 (IEA 2020). The pace of solar PV development is due to its "unique ability to cover most market segments; from the very small household systems to utility-sized power plants" (ibid).

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. There is a global focus to eradicate energy poverty, as can be seen by the focused governmental efforts of China, Vietnam, Nigeria, South Africa, Chile, Brazil, Bangladesh, Senegal, and Kenya (Aklin 2018) and the United Nations' (UN) Sustainable Development Goal (SDG) 7, which calls for universal access to affordable and clean energy (United Nations 2018). The energy poverty in the above-mentioned cases are mainly due to lack of infrastructure to deliver energy services but energy poverty can also exist where energy infrastructure is everywhere. For example, energy poverty is also a significant challenge in the European Union (EU), with the highest concentration in the south and east of Europe (Bouzarovski 2018), and the EU has officially recognized affordable access to energy as a human right (Hesselman 2019). European cases of energy poverty often have causality rooted in socio-economic factors, like affordability but can also be socio-material, such as poor building quality that does not allow for energy efficiency (Bouzarovski 2018).

Energy poverty persists despite the possibility to have clean, affordable energy now. Some studies reveal that a low-carbon energy transition can exasperate existing inequities (Behrens *et al.* 2016; Delicado *et al.* 2016; Peña *et al.* 2017). Energy injustices are generating constructive opposition to traditional ways of producing and distributing energy that imagines new possible 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). These imaginaries are often characterized by scalar changes such as energy communities and other forms of small-scale, decentralized options. What is the potential of solar PV to alleviate energy poverty? Such imaginaries open a discourse that identifies access to affordable and dependable energy as a human right.

The EU has, in recent years, officially recognized access to affordable and dependable energy services as essential to human life (Hesselman 2019). However, as Walker (2015) notes, the notion of a right to energy is complex and can be "slippery" to pin down. For example, people have different ideas of what a right to energy entails, and these contested imaginaries are often scalar in nature. Perhaps it means that it is the responsibility of the government to provide infrastructure and large, economies-of-scale, production and distribution of energy services.

Perhaps this right means that individuals and collectives can own their own private energy systems, and that there should be a clear legal and affordable pathway for this ownership. It also brings up questions of limits and balance. If energy services are free, people may use them wastefully, complicating grid management and potentially compromising a successful low-carbon energy transition. If energy services are too expensive, households may not be able to secure the energy they need for good health and quality-of-life. Clearly, cost of energy services needs to reside at a point between these two extremes. This raises the question of who gets to influence and make decisions that affect cost, such as electricity surcharges. Energy governance determines how an energy transition happens and who is involved and in what manner. Decision-making for energy systems traditionally happens from a centralized point of power, but new social imaginaries see decisions about energy futures delegated in decentralized, small-scale nodes thereby involving the end-consumers who are affected by such decisions (Szolucha 2019). The right to energy debate highlights the prominent role scalar issues play in considerations of justice in energy systems.

Energy justice is a fast growing theme in 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) with scale increasingly recognized for its important role (Bouzarovski and Simcock 2017; Hiteva and Sovacool 2017; Sovacool *et al.* 2019a). As we can see from the right to energy debates, contested energy futures are frequently scalar in nature. The climate crisis demands a rapid and broad-reaching low-carbon energy transition and governments and large, long-standing energy companies have the resources to do this. Yet the energy injustices of the past and present must be addressed. Although large, utility scale energy has historically led to justice issues, it is not clear that this is always the case. However, consumers are picking up the call for new, decentralized modalities in energy services in increasing numbers. As the low-carbon energy transition moves forward, it is worth asking: what role does scale play in energy justice?

This thesis examines the potential of solar PV to alleviate energy poverty through a scalar approach to energy justice. It seeks to contribute to the small but growing body of research on energy poverty, energy justice, and multi-scalar analysis.

In the rest of this chapter, I justify my choice of topic and case study. Next, Chapter 2 presents the theoretical approach to the case study, which includes multi-scalar analysis and an energy justice framework, as well as a review of the state-of-the-art. Thereafter, in Chapter 3, I give context for the site location. Chapter 4 discusses how the case study was conducted using semi-

structured interviews, direct and participant observations, and text analysis. In Chapter 5, I present the findings of the case study through an observation of the uniquely spatial characteristics of energy justice approaches and the importance of networks to small-scale solar actors. Next, in Chapter 6, I discuss the findings and connect them to my analytical framework and broader themes across human geography. Finally, in Chapter 7, I discuss the case, what my study shows, its limitations, and areas for further research.

1.1. Selection of topic and field area

The following sections contains relevant considerations pertaining to the selection of the research topics and location. The first section covers energy poverty as a research focus, then moves on to the selection of solar PV, and finally covers the choice of Lisbon, Portugal as the location for fieldwork.

1.1.1 Energy poverty

My research topic stemmed from an interest in solutions for the climate crisis and social equity. Energy poverty is characterized by the inability of a household to secure adequate energy for its needs. Although energy poverty is tricky to track and identify, some very useful strides have been made to solve this issue. For example, according to the European Energy Poverty Observatory (EPOV), energy poverty is a multifaceted issue that cannot simply be captured by a single indicator but rather a suite of primary and secondary indicators, which are meant to be viewed and used together for a more accurate measurement (Bouzarovski 2018). Using Portugal as an example, figure 1 shows Portugal's primary indicators of energy poverty compared with other available European countries for 2016.

The primary indicators listed by the EPOV include both quantitative and qualitative datasets. The first indicator is arrears on utility bills and is determined by asking, "In the last 12 months, has the household been unable to pay on time due to financial difficulties for utility bills (heating, electricity, gas, water, etc.) for the main dwelling?" The second indicator, Hidden Energy Poverty (HEP), looks at the share of the population whose total energy expenditure is less than half of the national median. The third indicator shows the percentage of the population who pay double the national median share in energy expenditure. The fourth indicator is empirically based and reports the portion of the population who are not able to keep their home

adequately warm by asking the question, “Can your household afford to keep its home adequately warm?”

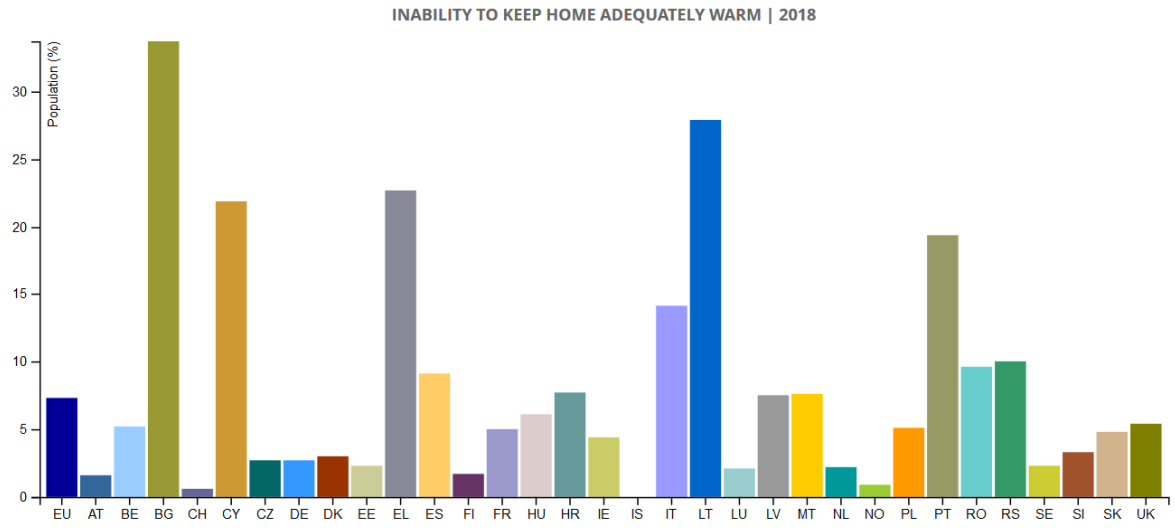

Figure 1: Empirical indicator of energy poverty in Portugal (PT), along with other European countries, in which people were asked about the ability to keep their home adequately warm (European Energy Poverty Observatory 2018).

In reviewing the EPOV primary indicators, it appears energy poverty in Portugal is not remarkable until assessing the inability for adequate warmth indicator. The first three indicators do not illustrate the presence of energy poverty in Portugal. The reason for this may be that the first indicator is misrepresentative if, for example, the housing rent includes energy costs or if people are choosing thermal discomfort to avoid arrears. Additionally, the difference may be that the next two indicators rely on quantitative datasets whereas the fourth indicator is wholly empirical. This observation, along with a review of relevant literature, suggests that further, context-based, research is needed, and that greater empirical study would be apt to generate useful insights in Portugal. The effectiveness of energy policy on energy justice is important but “has been rather neglected relative to other theoretical approaches to energy use” (Bartiaux et al. 2016). The outcomes of these actions are still developing, which makes this a timely and relevant case to examine.

1.1.2. Solar PV

The solar PV effect was first observed in 1839 and Albert Einstein began to establish the science behind this effect in 1905 (Fraas 2014). In 1956, solar PV began to gather public attention when media sources, such as the New York Times, began to write about its practical application.

Although this press drummed up enthusiastic interest, solar PV was unable to compete with its traditional energy counterparts at the time due to its high production costs.

Falling prices in fossil fuels caused interest in solar PV to wane but the space race created a surge in research around the same time (Fraas 2014). Solar PV proved to be a far more sustainable energy source for satellites than batteries, allowing them to send information back to earth for years. Further technological advances brought the price of solar down in the 1970s but major interest in renewable energy sources did not arise until the U.S. Energy Crisis of the 1970s.

The energy crisis forced Americans to look for alternatives to fossil fuels. With energy independence as the goal, the U.S. government increased spending on solar PV research and founded the Solar Energy Research Institute (Fraas 2014). Once the oil energy market stabilized in the 1980s, interest in solar waned once again but research and development did continue at a smaller scale. In the 1990s, awareness of global warming entered the public discourse renewing interest in solar PV. Since then, solar PV has grown with the assistance of various feed-in tariffs, in the United States and abroad.

Although solar PV began in the United States, China has since had a profound influence on the expansion of the industry. China's PV industry success started as early as the 1980s but it was in 2004 that things really accelerated (Huang *et al.* 2016). Solar PV experienced a sharp drop in production costs from 2000 to present largely due in part to technological and production advancements in China (ibid). China was a late entrant to the solar PV market but managed to not only catch up, but eclipse and become the world leader in solar PV production. The industry received a lot of support from both the local and central government resulting in rapid growth of the sector. In 2019, China added 30.1 GW of installed solar PV capacity, nearly double the amount the EU installed (IEA 2020). The beginning of 2020 was globally marked by a pandemic that started in China, where the global solar PV supply chain is highly concentrated. This supply chain was suddenly compromised, emphasizing China's importance in the global climate strategy and raising questions about whether the world should rely on them to this degree (Bellini 2020). Regardless, China has become the key country for solar PV in the past decade by making modular manufacturing costs competitive, pursuing accelerated large-scale solar PV rollout both at home and abroad, and exporting modules to the world.

Recently, solar PV has reached grid parity making feed-in tariffs unnecessary. Now, solar has evolved to be affordable, flexible, and scalable. It has taken on a big role in many countries" path towards decarbonization. Notably, like many other EU member states, Portugal's national

energy and climate plan 2030 foresees massive growth in solar PV. The 'hypersizability' (Walker and Cass 2007) of solar means that this technology can be rolled out for a single home, in a mega-park capable of powering thousands of homes, or anything in between. So, interest in solar PV comes from, not only governments and large energy companies, but also from communities and individuals, since solar became relatively accessible. Solar PV is a new technology that has spatial irregularities and flexibility warranting further research on the benefits and disadvantages. Bridge and co/authors acknowledge the limited understanding of spatial process in energy transitions, saying: "Notwithstanding this acknowledgement within energy studies of some of the geographical dimensions of the new energy paradigm, the way in which spatial processes shape energy systems and influence their capacity for transformation has not been a focal point for analyses" (Bridge *et al.* 2013, p.332). For these reasons, solar is a revealing technology to investigate in relation to scalar inquiries about energy transitions and energy justice.

1.1.3. Lisbon, Portugal

After considering a few locations for the case study, I settled on Lisbon, the capital of Portugal. Portugal is a western European country located within the human rights and equal opportunity focused EU. Yet, Portugal has been deemed to be an inegalitarian society (Bartiaux *et al.* 2016) with some estimates placing energy poverty as high as 22-35% of the population (Gouveia *et al.* 2017; Gouveia *et al.* 2018). As mentioned above, energy poverty is a significant problem in Portugal with serious, and at times fatal, consequences.

As a citizen of the USA, I am familiar with the existence of deep inequalities within a society that prides itself on being a champion of justice and human rights. My pursuit of human geography studies

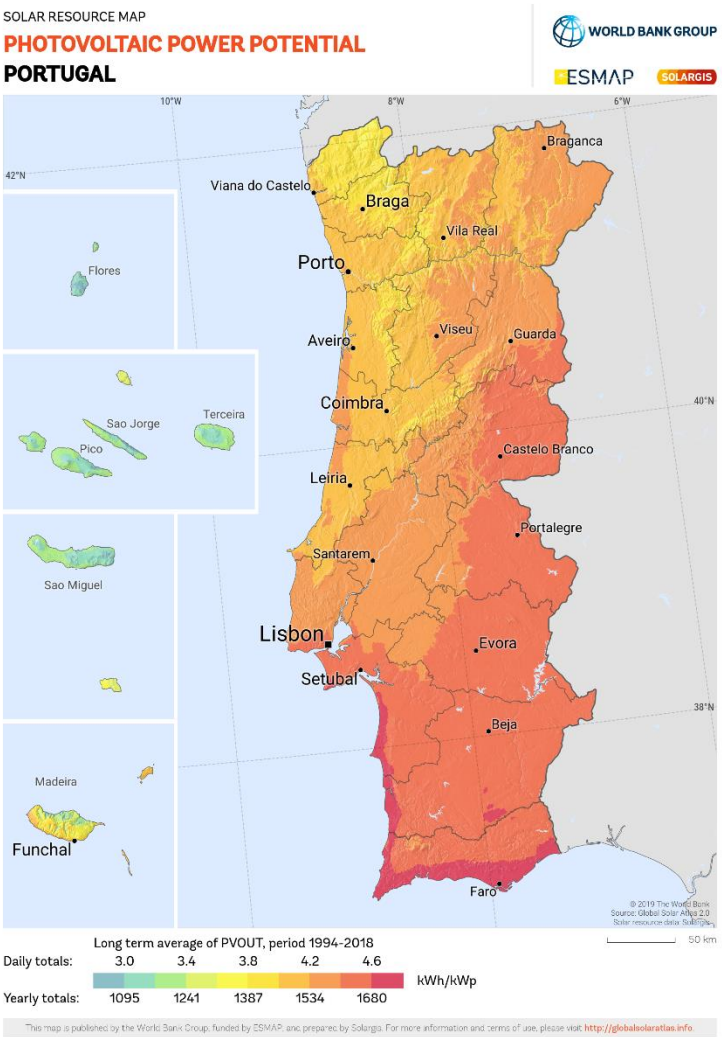

Figure 2 © 2019 The World Bank, Source: Global Solar Atlas 2.0, Solar resource data: Solargis. https://solargis.com/maps-and-gis-data/download/portugal

stemmed, in large part, from a desire to understand how this paradox happens in a prosperous nation. My choice to come to Norway for my master's studies had a lot to do with its reputation as an egalitarian society.

Lisbon emerged as a clear case choice for several reasons. First, it combined my research interests in a very timely and relevant case study on this issue of justice. Second, Portugal as a whole is highly conducive for solar PV (see Figure 2). Due to its geographic location and certain socio-economic characteristics, it is especially vulnerable to consequences from climate change (Leonel *et al.* 2019), such as the severe floods and wildfires that afflicted the country in 2017 and 2018. Third, Portugal is implementing an ambitious plan for renewable energy transformation, and solar is slated to play a large role in achieving this goal (Bellini 2018a). Lisbon is the epicenter of where energy governance decisions and key research is happening, offering a pertinent context for this case study. Portugal is further positioning itself as a leader of renewable energy within the EU (Miguel *et al.* 2018) and Lisbon has been awarded the European Green Capital 2020. Furthermore, Lisbon is home to the country's first and only (as of May 2020) renewable energy cooperative highlighting small-scale, community focused solar PV projects. The juxtaposition of the Portuguese push for large-scale energy transitions using solar against the growth of small-scale solar PV make Lisbon an interesting case for examining scalar implications of solar PV uptake. Finally, Lisbon is a location I had no personal ties to. This lack of personal connection certainly can have its disadvantages, which I discuss in the methods and methodology chapter. However, it is advantageous for the overarching goal of creating a case study that produces results with transferability beyond the Portuguese context to other cases. Additionally, my role as an interested outside can be advantageous to elicit responses that differ from how informants would respond to a researcher from their own society.

Beyond these reasons, particular socio-spatial factors make Lisbon an interesting city to examine scalar issues around energy poverty and energy justice. Portugal experienced a deep economic crisis during the great recession that started in 2008, necessitating assistance from the EU and the International Monetary Fund (IMF) (OECD/IEA 2016). In 2014, Portugal was able to exit the IMF Financial Assistance Program due to significant progress in economic reform (ibid). This economic recovery was due, in part, to the Portuguese administration's actions to adopt tourism and urban revitalization, the effects of which are apparent in Lisbon (Sequera and Nofre 2019). In addition to this, the administration took actions to attract transnational real estate investment and high-income residents and students. In Lisbon, this had

the effect of driving up rent prices and decreasing available housing stock resulting in spatial displacement of working and middle-lower classes (ibid). Another strategy to exit the financial crisis was Portugal's commitment to renewable energy with wind and solar production driving economic production (OECD/IEA 2016). Solar PV in Lisbon presents an interesting context for scalar inquiries. In a dense and urban space, rooftop solar presents an opportunity to take advantage of a better relationship between solar electricity generation and local demand (Brito *et al.* 2019). With a recent change in legislation that allows for collective self-consumption of energy (Diario Da Republica Electronico 2020), urban solar, scaled for rooftops and small collectives, became viable. It remains to be seen how solar energy will unfold in this urban context.

Lisbon is thus a suitable case study for the reasons listed above, including its commitment to solar energy and the accompanying existence of high energy poverty and excess weather mortality. Furthermore, a case study in Lisbon concerning energy poverty helps to fill a gap in existing academic literature. Although energy poverty is covered by a growing body of literature, coverage of this topic is scarce in Portugal despite its mainstream recognition (Gouveia *et al.* 2018).

1.2 Research Questions

Using Lisbon as a case enables the merging of my research interests into a timely study within a context of rapid socio-technical changes. The objectives of this study are:

1. To better understand the social impact of low-carbon energy transition.
2. To contribute to the growing body of research on energy poverty and energy justice.
3. To examine how scale impacts justice outcomes in low-carbon energy transitions.

This focus is transferable to many other urban contexts that are undergoing their own rapid socio-technical changes.

The main research question of this study, following from the objectives is: **What is the potential of solar PV to alleviate energy poverty?** This is a broad question. To narrow the focus, I examine the issue through the analytical lens of scale. In this way, I have a sub-question which is: **What role does scale play in low-carbon energy transformation and how does it affect energy justice?**

I explore this theme through a conceptual framework of energy justice and its four mechanisms: distributive justice, procedural justice, cosmopolitan justice, and justice as recognition (Bouzarovski and Simcock 2017; Sovacool *et al.* 2017; Sovacool *et al.* 2019a). This framework is important for understanding the social impact of low-carbon energy transitions, but it is quite broad. To narrow my focus and draw on socio-spatial tools from human geography, I utilize concepts in spatial justice to integrate scalar aspects. This enables me to identify and discuss the various spatial elements of energy justice.

1.3 Delimitation of field area

The city limits of Lisbon serve as the boundary of the fieldwork to the size of this project. Portugal has a varied landscape and it would not be suitable to evaluate energy vulnerability in both rural and urban settings as the causes and potential solutions can differ widely. However, since this is a scalar study, it includes an exploration of policies and action at the national level. I explore the scalar variety in solar PV rollout, and its implications for energy justice, within the urban context of Lisbon.

Figure 3: Location of Lisbon within Portugal. Taken from Google Maps 20 May 2020.

2 Theoretical Approach and Literature Review

In this chapter, I will review the relevant literature and theoretical approaches that give a launch point for the case study and accompanying fieldwork. The chapter is in three thematic sections and each section begins with defining key terms for a uniform understanding throughout the project. From there, each section broadens to include the theoretical approach that provides a lens for interpretation of the case and its collected data. The first section discusses transitions studies and energy poverty. The second section explores research on scale and discusses it theoretically within the case study context. The third section ties these themes together by conceptualizing energy justice.

2.1 Energy Transitions and Energy Poverty

The world is responding to the climate crisis with many nations undergoing a significant shift in energy not seen since the shift to liquid fossil fuels. From 2009 to 2018, total installed renewable energy capacity has increased from 1,140 GW to 2360 GW (IRENA 2020). In 2019, renewables covered 26% of the global energy supply and the International Renewable Energy Agency (IRENA) estimates that it could cover 57% by 2030 based on current trajectories. According to the Exponential Climate Action Roadmap report, emissions need to halve each decade to reduce the risk of dangerous carbon levels as established by the Paris Agreement (Falk *et al.* 2018). A significant portion of countries and societies around the world are moving to make this shift happen and contemplating the best ways to do so. For example, in 2019, the National Energy and Climate Plans were introduced as part of the Clean Energy for all Europeans package (European Commission 2019).

How an energy transition happens matters. Certain academic texts show low-carbon energy transitions can amplify existing socio-economic inequalities. (Bartiaux *et al.* 2016; Behrens *et al.* 2016). For example, a feed-in tariff has been used in certain environmental governance scenarios to increase the amount of renewable energy sources but in some cases, this cost is passed to the consumer while large energy companies profit (Peña *et al.* 2017). In an inegalitarian society, this could constitute a real burden for certain members of society resulting in serious socio-economic consequences. These dynamics are well-articulated in certain research spheres: “The structure of the global energy system and the pending consequences of climate change are among the central justice issues of our time, with profound implications for human happiness, welfare, freedom, equity, and due process” (Sovacool et al. 2016, p.2). For

these reasons, it is important for energy policy to guide the transition in a manner that is more inclusive and understanding of existing socio-economic structures.

2.1.1 Transition vs. transformation

For the purposes of this research, I demarcate transition and transformation to illustrate an important distinction showing up in energy transition discourses: that energy transition can and/or should encompass more than simply a shift in technology. In some contexts, the interchangeable use of these terms misses an opportunity to identify a more holistic transition. O'Brien (2018) makes the distinction through "three spheres of transformation" which are practical, political, and personal spheres. Through this heuristic, O'Brien emphasizes that more holistic transformations must include all three spheres. The practical sphere indicates the specific interventions and strategies that contribute to decarbonization goals directly, such as solar PV and energy efficient buildings and homes. The political sphere refers to the systems and structures that enable or constrain practical decarbonization efforts. The personal sphere represents the subjective worldviews and beliefs that influence how people see systems, structures, and associated behaviors (ibid). For the purposes of this study, the distinction between transition and transformation will serve to identify two different types of energy shifts.

I define transition as the change from one technology to another. This is the central technical focus of the decarbonization goal of energy transitions as the climate crisis necessitates a move away from fossil fuels. Transition will be the process of switching a technology in a way that does not significantly disrupt the existing system of infrastructure, production, and distribution. Using the heuristic above, transition most closely represents the practical sphere. It is the process of changing the technology with very minimal disruption to scale, ownership, production, and distribution of energy. In some cases, this is viewed as being a viable path to achieving energy sustainability (Späth and Rohracher 2014).

Others speak to a need for transitions to incorporate broader socio-economic changes and not simply an ecological shift. To do this, transitions need to be characterized by universal access to energy services in addition to security of supply from a low-carbon source (Bridge *et al.* 2013). Transformation can, for the purposes of this study, capture this need for a more holistic approach to transition. I define transformation as the socio-technical change that includes not only a change in technology, but also in the underlying social, political, and mechanical structures that influence distribution and access. A true transformation encompasses the practical, political, and personal spheres.

2.1.2. Transitions studies and geography

Transitions studies are often challenging the oversimplified view of energy transitions as a straightforward shift from fossil fuel sources to renewable sources and call into question traditional approaches. Bridge and co-authors make a case for examining energy transition as a geographical process, "involving the reconfiguration of current patterns and scales of economic and social activity" (Bridge *et al.* 2013, p.331). There is now widespread recognition that the established patterns of scale and distribution are being disrupted or reworked by climate change, the depletion of oil reserves, and the need for energy security (ibid). They introduce six concepts to aid in understanding what energy futures may look like in the transition to a low carbon economy: location, landscape, territoriality, spatial differentiation, scaling, and special embeddedness. A spatial focus allows for the possibility of multiple, co-existing trajectories of energy futures. It also highlights how the process of decarbonizing energy can be "a simultaneously creative and destructive process that significantly changes how different places are related to each other, economically, politically and even culturally, and at a range of different scales" (Bridge *et al.* 2013, p.339).

Energy transitions literature also points to the connections between how energy is produced and distributed to democracy. For example, through a case study in Berlin, Moss *et al.* (2014) observes how a supply-oriented logic has persisted through dictatorial, state-socialist, and democratic regimes, and argues for taking long-term perspectives about path dependencies in energy transitions. Labussière and Nadaï (2018) argue the importance of examining energy transition processes against democratic ideals as many iterations do not offer people a genuine chance to take part in their energy futures. They justify this claim by accounting for the domination of institutional reasoning which places the ends of the energy transitions out of the reach of the actors and entities most affected and engaged by processes of energy change. Mitchell (2009) points out a set of connections between democratic and undemocratic process and carbon-heavy energy sources in his seminal paper "Carbon Democracy." The extreme spatial concentration of carbon fuel sources enabled the emergence of certain forms of democracy in industrialized nations in which the control and benefits of energy are only experienced by a few. After tracing these connections, Mitchell observes that "the possibility of more democratic futures, in turn, depends on the political tools with which we address the passing of the era of fossil fuel" (Mitchell 2009, p.423).

In Lisbon, the energy transition is transforming the spatial patterns of economic and social activity. It brings about challenges in governance when energy production can be more than the

outmoded remote sources that require long-distance transmission and high-level management. The case of solar energy in Portugal is an example of this as it challenges the spatial embeddedness of energy knowledge, production, and distribution due to its flexible scaling and accessibility to small collectives and individuals. Energy transitions research in Portugal emphasizes more participatory approaches (Campos *et al.* 2016) and more action at the municipal scale (Campos *et al.* 2017). Additional transitions studies based in Portugal call for stronger accountability in environmental governance to match the scale of the climate crisis (Sareen 2019).

The change in the political economic landscape of energy production and distribution limits people less than previous generations and many are having some opinion and say in where their energy comes from. The scale at which energy production happens has distinctive implications that require energy companies to adapt and governments to legislatively respond. In some places, the uptake of solar by energy customers is already disrupting traditional electricity markets that use marginal costs or fixed customer charges (Solano *et al.* 2018). The incumbent energy business model allows PV customers to avoid paying their full share of fixed infrastructure costs and those costs are distributed to all other customers. Additionally, a minimum bill approach to electricity billing can increase customer cost, regardless of system size (ibid). Energy security is a priority for both governments and individual households in energy transitions. Governments must ensure continuous and uninterrupted energy sources for national security and individual households must have the building quality and financial capital necessary to secure necessary energy for a healthy home environment. In European countries, energy service is widely available through dependable infrastructure, but geographic disparities exist (Bouzarovski and Herrero 2017) in which energy vulnerable households struggle with securing enough energy. Care must be taken by governments during energy transitions to avoid jeopardizing adequate access to energy services for vulnerable groups in the process of ensuring energy security.

2.1.3 Energy Poverty

Amid the climate crisis and energy transitions is the ongoing socio-technical issue of energy poverty, which affects millions across the globe. Broadly defined, energy poverty is the inability to obtain necessary energy services to meet a household's needs (Bouzarovski 2018). Necessary energy services can include securing enough energy for thermal comfort to maintain optimal health, energy to power devices for information and education purposes, and the ability to

power cleaning devices for a healthy environment. The causes and consequences of energy poverty vary based on several factors including location, climate, infrastructure, and policy. A lack of access to sufficient energy can have severe consequences as "unequal access to energy and low human development are highly correlated" (United Nations 2018).

Solar energy transitions are an important part of decarbonization efforts. This is an important driver for greater cosmopolitan justice and these shifts in energy infrastructure happen through a change in regulations and practices which provides an opening to address energy poverty. In the past and present, energy operations have been or presently are caught in a rigid system of distribution, infrastructure, and policy. The opportunity to change the configuration of benefits and ownership to alleviate energy poverty is ripe for analysis for actionable knowledge.

In the global north, energy poverty is often the result of such factors as affordability, policy, and housing quality. In the global south, energy poverty is frequently a result of a lack of infrastructure to deliver energy services (Bouzarovski 2018). As mentioned in the first chapter, this study focuses on energy poverty causes and possible solutions for a global north, European context. In Europe, an energy poverty divide has been identified showing that southern and eastern countries have a significantly higher occurrence of energy poverty than their northern and western neighbors (Bouzarovski and Herrero 2017). Paradoxically, southern European countries with the mildest winter climates have been shown to have the worst excess winter mortality rates, whereas Scandinavian and other northern European countries were relatively unaffected (Healy 2003). Excess winter mortality is linked to energy poverty (Bouzarovski 2018), and this emphasizes why this problem is crucial to address. The built environment is a critical consideration in energy poverty. Buildings without insulation or central Heating, ventilation, and air conditioning (HVAC) have poor energy efficiency requiring consumers to use more energy services than in buildings of higher quality.

Current research and savvy administrations pose solutions on both the supply and demand side, such as the new and cost-effective solar energy transitions for the supply side and building retrofits on the demand side. However, a central challenge in exposing and treating energy poverty is to approach it through a political lens as an injustice that persists in the presence of certain ideologies and power interests (Bouzarovski 2018). In addition to distinction in incidence across countries, there are deep socio-spatial patterns that underlie where energy vulnerability is located. These are landscapes of material deprivation, which I outline in Section 2.3.2, that often exist in poorer neighborhoods and sub-national regions.

Energy poverty was a relatively overlooked issue for many years, but the creation of institutions, like EPOV in December 2016, signifies the scope and level of recognition now given to this issue. Much of this recognition is undergirded by significant research and policy work in the United Kingdom and Ireland (Boardman 1991). In addition, one of the 17 UN SDGs calls for access to affordable, reliable, clean, and modern energy for all. This rising prominence in policy and science agendas speaks to the importance of the issue and the timeliness of this research project. Despite this distinction, much remains unknown about energy poverty. For example, there is a lack of understanding about the link between energy poverty and processes of systemic change. One energy poverty researcher says these links are especially misunderstood "when it comes to the manner in which processes of socio-technical change create spatially embedded forms of inequality" (Bouzarovski 2018, p.3). He goes on to argue for researchers to assess energy poverty beyond the common approaches of poverty, access, and energy efficiency for a more geographical conceptualization. This thesis builds on such attempts.

2.2 Scale

The need for multi-scalar analysis in energy transitions and environmental governance is a contemporary development in energy justice research, the importance of which is becoming more apparent (Späth and Rohracher 2012; Newig and Moss 2017; Sovacool *et al.* 2017; Bouzarovski and Haarstad 2018). Bouzarovski and Simcock (2017, p.642) argue that scale 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." Many countries across the globe are investing in large-scale solar energy transitions to meet future energy demands (Sareen and Haarstad 2018). This trend is also happening in smaller, decentralized projects at the scale of cities, businesses, buildings, and homes (Falk et al. 2018). This section will discuss the importance of scale in justice considerations by covering relevant literature and theoretical perspectives. Finally, it will identify the scalar delineations used in the analysis of the results.

2.2.1. Territorial units of measurement

Fraser (2009) problematizes the state as the traditional unit of measurement for justice. She critiques this Keynesian-Westphalian framing as vehicle of injustice and argues that this 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 state level. Historically, national level energy has led to inequities, but it is not clear this would always be the case. Globalization has called into question the territorial state as the standard unit of measurement as political space gets partitioned in ways that blocks the vulnerable from challenging the forces that oppress them. Claims of injustices that transcend national borders get lost when channelled into the relatively ineffective state as foreign powers are rarely held accountable by such matters (ibid).

With the new flexibility and accessibility afforded to energy technologies, like solar, people are imagining and building energy systems that defy this traditional scale of operation. Many of these sub-national systems use idyllic sounding descriptive terms like 'community', 'socially responsible', and 'independent'. One study determined that drivers for energy justice are localized and contextually dependent (Hiteva and Sovacool 2017). Bouzarovski and Haarstad (2018) argue that an in-depth, theoretical understanding of scale is not reflected in current mainstream discussions about how to diffuse and expand decarbonization strategies. Scalar analysis is a growing approach in energy studies which warrants investigation of the effects scale may have on the justice outcomes of an energy system.

2.2.2. Spatial justice: how scale informs the justice we see

The notion of spatial justice helps in working through, for example, the global-local dialectic and associated processes of globalization and urbanization (Martin 2011). A task of the geographer using the spatial justice analytical lens is knowing when to align with or challenge claims concerning economic growth and justice. Marginalized places need economic investment, so proponents of spatial justice need a way to evaluate investments that are economically savvy and geographically dispersed. A spatial justice lens may assist the decision-making process to succeed in interrupting rather than endorsing existing territorial inequalities (ibid).

Martin (2011) describes a scalar dilemma in policy making through an example of urban green spaces. In her imagined scenario, the dilemma is whether to plant trees in the neighborhood benefitting only the local inhabitants or to expand the urban forest because of its broader ecological role. Targeting local inhabitants previously left out of the benefits of urban green spaces creates a local sense of justice. Alternatively, directing resources to expanding the existing urban forest, which has a broad ecological role, rings of a more inclusive, far-reaching

justice. The easy answer is to implement both scales of action, but in this scenario, economic limitations allow for only one. The choice is not clear from a purely justice-based standpoint.

I see a similar dilemma in the rollout of solar PV in Lisbon, which informed my choice of research focus. Solar energy has a unique characteristic among energy sources of flexible scalability, starting with very small modular units, like the trees in Martin's example above. A few panels might be installed on a single home or community center to form a micro-grid, or hundreds/thousands of solar panels might be installed to comprise a utility-scale solar plant capable of powering a whole neighbourhood or town. In some scenarios, economic theory might argue that the large-scale model is the most just, as it provides the lowest price per kilowatt-hour (kWh) of energy to everyone through its dispersion of the price among many consumers. However, energy bills often contain added costs that may be beyond the true cost of the electricity generated. A 2015 study on tariff design for distribution systems in Europe showed that tariffs make up on average, 69% of a household's energy bill (European Commission 2015). In this scenario, the potential advantage of the economy-of-scale pricing is submerged in the extra bureaucratic cost burden. If small-scale, micro-generated solar projects are more expensive when comparing only kWh costs, then the potential to side-step this bureaucracy may lead to them being more cost-effective. Further scalar scenarios can be seen in Portugal through the solar tender auction it held in June 2019 in which it auctioned 1.34 GW of renewable energy contracts. The auction resulted in a world record low price bid but none of the tenders went to local players (Bellini 2019). A 10 MW floor for single bid size partly explains this exclusion as integral to the auction design. All auction winners were from outside of Portugal, the implications of which are useful to analyze though the spatial justice lens.

2.2.3. Notions of scale: localism and globalism

In the aforementioned study, Martin goes on to say: "For a truly spatial justice, we need to account for place identity such that "local" claims are immediately and insistently situated as always globally related and produced" (Martin 2011, p.486). This is well and good but resonates of localism, the problems of which are only too relevant in the age of "America first" and Brexit. Mohan and Stokke (2000) argues that there is a need for critical analysis of localism and cautions against the creation of binary oppositions between, for example, state and civil society or global and local. In the case of the United Kingdom, Sturzaker and Nurse (2020) speak about the government's failure to satisfactorily address the needs of jobs, housing, and transport as the agent behind the rise in calls for decentralization, devolution, and/or localism. Such political

upheaval is happening around the world in response to globalization and speaks to the large group of people left out of said globalization's benefits.

Späth and Rohracher (2014) observe the prominence of binary spatial qualities through examples of recent European debates about what entails a sustainable energy transition. In the case of Germany, energy actors, such as the government and large parts of the energy industry, argue that a transition to renewable energy sources is nearly all it takes to achieve a sustainable energy system. In contrast, others are arguing that the German *Energiewende* needs to include an increase in distributed generation capacity to allow for more electricity from small-scale solar PV and other small-scale cogeneration projects. Beyond some technical advantages of reducing transmission lines, decentralization is, in their view, the only way to limit the power of the few oligopolies in the energy market. The authors then argue that the core of the struggle in many industrialized countries is how small scale and close to demand future electricity generation should be (ibid). Another study on the German *Energiewende* observes how a movement to strengthen local control over energy policy has resulted in energy cooperatives, energy villages, and initiatives to re-municipalize energy utilities (Moss *et al.* 2015). Debates on re-municipalization are often about more than legal and material ownership. They are about local community control, procedural justice and participation, and distributional justice (Cumbers 2012).

2.2.4. Multi-scalar analysis

According to Sovacool et al., multi-scalar analysis of energy transitions has been identified as a key gap in the field and is one of six "new frontiers" in justice research (2017). In a pertinent study about scale and energy justice, researchers identify a conceptual framework that works across 3 scales: macro (transnational and beyond any single country), meso (at the national and supra-local level), and micro (within

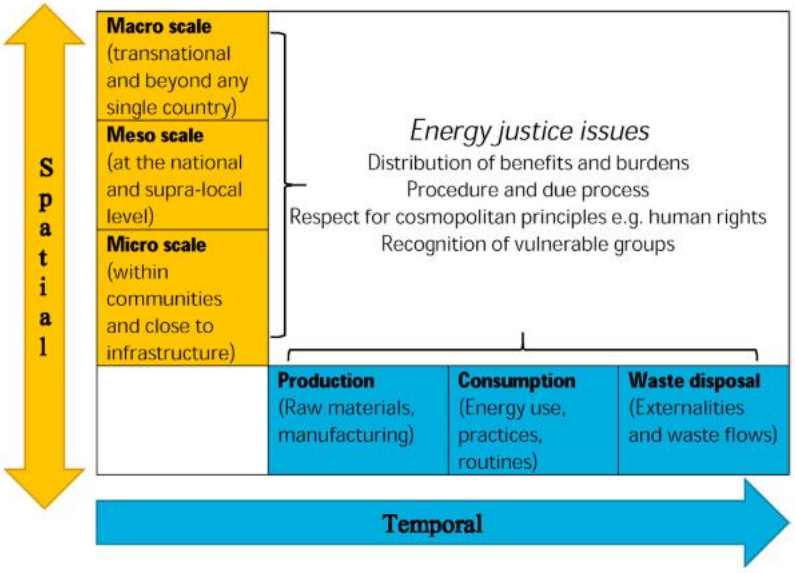

Figure 4: Whole systems/energy justice conceptual framework. Source (Sovacool et al. 2019a, p.3)

communities and close to infrastructure) (Sovacool *et al.* 2019a). Notably, they conclude that energy injustices do not solely apply to fossil fuels or large-scale systems. Potential low-carbon heroes of the low-carbon energy transition, such as solar energy, smart meters, and electric vehicles, can erode existing justice principles or produce their own injustices. In their research, they ask how transitions result in injustices that extend beyond the geographic location of the transition. Therefore, the framework grapples with this inquiry specifically in the context of the whole energy system of a given technology or transition (See Figure 2.2).

My research question related to scale (What role does scale play in renewable energy transformation and how does it affect energy justice?) will use these scalar delineations within the context of this case. Whereas Sovacool *et al.* (2019a) seek to identify all injustices in a system or transition, my research question is designed so as to use scale to better understand energy justice in relation to a specific and established injustice: energy poverty. Since scalar analysis is a budding lens in the field, I will adhere to these scalar delineations in my own analysis for consistency with this formative research paper. In this way, the three scales of analysis for this case will be macro (transnational and beyond the borders of Portugal), meso (at the Portuguese national and supra-local scale), micro (sub-national, community or individual level engagement with energy production and distribution). The definitions used in this study remain the same as those of the authors but shift slightly at the micro scale to better suit the case.

2.3 Energy Justice

This section will review energy justice literature and then discuss spatial justice within energy justice as a theoretical framework that brings together my interests in this study and provides a focused lens to interpret fieldwork data.

2.3.1 Background

What generally constitutes justice has been theoretically debated for millennia but the discussion below will focus on contemporary literature within the last 10-15 years that sheds light on justice concepts within the research context. One definition recognizes justice as that which ensures and recognizes the basic equal worth of all human beings and is committed to an equal distribution of good and bad societal effects (McCauley *et al.* 2013). Another approaches justice in a more procedural way by thinking of it as “parity of participation” (Fraser 2009). Justice concerns permeate every aspect of society and has thematic branches to guide and focus

the discussion. One such branch, energy justice, examines the justice implications of energy systems and is the focus of this study. Energy justice describes a global energy system that distributes equitably both benefits and burdens of energy services and is more representative and inclusive of all people in the decision-making process (Sovacool *et al.* 2019a).

Energy justice is rooted in environmental justice, which emerged in the early 1980s and points to how environmental effects of climate and pollution are unevenly, and thereby unjustly, distributed. For example, some studies estimate that people in rich countries, as a result of their nations historical emissions, impose 200-300 times more health damage on others than they experience themselves (Sovacool *et al.* 2016). However, it has been argued that the continued inability of environmental justice (and related climate justice) to address environmental failures suggests that environmental justice lacks suitable influence on decision-making (Jenkins 2018). This emphasizes a need for current, focused justice models, such as energy justice, which has had growing success. Jenkins identifies three distinguishing aspects that set energy justice apart. First, it has increased potential for policy uptake due to its more targeted systems focus. Second, energy justice developed primarily as an academic concept and it did not come out of the anti-establishment social movements as environmental and climate justice did. Lacking an activist past gives it more potential for mainstream policymaking. Third, the conceptual framework shows capacity for academic and policy applications since it is backed by a strong methodological tradition (ibid).

Addressing the climate crisis in a just manner presents complex challenges and requires thoughtful, holistic solutions. For example, access to modern energy benefits its users immensely as it reduces household environmental risks and improves quality of life. However, this increased wealth and subsequent consumption increases global risks of climate change and environmental pollution. This outlines a central paradox that frequently exists in the search for energy poverty solutions: to achieve a healthier home environment, those experiencing energy poverty often need to increase their consumption, but global environmental justice relies on decreased energy consumption. Such a conflict shows the need for a framework that can systemically account for a variety of needs in energy systems and transitions.

Fraser's (2009) seminal three-dimensional theory of justice offers a useful launch-point for understanding energy justice. As mentioned above, she describes justice as "parity of participation" and goes on to outline a triad approach that examines distribution, recognition, and political structures that may be impeding this participation. This established approach gives justice a uniquely geographical angle which has further developed theoretical approaches to

energy poverty within energy transitions. A contemporary development on Fraser's work divides energy justice into four distinct sections: distributive justice (costs and benefits), procedural justice (due process), cosmopolitan justice (global externalities), and recognition justice (vulnerable groups) (Sovacool *et al.* 2019b).

Bouzarovski and Simcock's (2017) conceptualization of spatial justice in energy poverty stems from the premise that geographic disparities are an important component of energy justice. This framework builds off the earlier geographies of energy transition by applying those elements to energy poverty. Four mechanisms of spatial justice have been defined as "landscapes of material deprivation, geographic underpinnings of energy affordability, vicious cycles of vulnerability, and spaces of misrecognition – operating at a multiplicity of scales" (Bouzarovski and Simcock 2017, p.641). Attempting to specify and then applying these mechanisms to the case study of Portugal may help in grasping some tangible and meaningful elements within this highly complex theme.

2.3.2 Distributive Justice

Distributive justice deals with how social benefits and disadvantages are allotted across society (McCauley 2018; Sovacool *et al.* 2019b). Sovacool et al.'s study on energy justice revealed that the majority of the energy transition injustices across four countries were of a distributive nature. As the nature of distribution is inherently spatial, these results show how geographers are well-positioned for energy justice and transition studies. Accordingly, I hypothesized that distributive justice will occupy a majority of this case study analysis. To help with a more complete understanding of distributive effects in energy justice, I turn to the theoretical lens of spatial justice.

In their paper "Spatializing Energy Justice," Bouzarovski and Simcock (2017) argue that the understanding and recognition of geographic disparities in energy vulnerability are key components of energy justice. They seek to contribute to a wider understanding of energy justice theory "by disturbing the artificial vs. production binary that characterizes much energy poverty research" (Bouzarovski and Simcock 2017, p.640). They identify four mechanisms that contribute to the rise in energy injustices that happen on a multiplicity of scales: landscapes of material deprivation, geographic underpinnings of energy affordability, vicious cycles of vulnerability, and spaces of misrecognition.

Landscapes of material deprivation

The presence of energy poverty is spatially uneven both at the scale of the EU (Bouzarovski and Herrero 2017) and uneven across Portugal itself (Gouveia *et al.* 2017). Research strongly suggests that the environmental features of a place shape and contribute to factors that leave households vulnerable to energy poverty, a distributive phenomenon that Bouzarovski and Simcock (2017) call *landscapes of material deprivation*. Landscape describes the varied material elements that make up the environmental features of a place and the interaction of climate conditions with the built environment are also components of this landscape (ibid).

In Portugal, an uneven material landscape is apparent in the quality of the housing stock and the energy consumers' usage patterns. Gouveia *et al.* (2017) give a good outline of this phenomenon: The country has an aging building stock of poor construction which significantly impacts energy demand. About 50% of these buildings need extensive renovation to keep up with healthy thermal comfort requirements. On top of this, most households do not have central HVAC systems which causes people to use inefficient decentralized alternatives. These various issues with the building stock coincide with a per capita residential energy consumption which is 28% below average for the then-EU28, even when compared with countries of similar climate conditions. This is likely due to the high cost of energy in Portugal, which is approximately 13% higher than the then-EU28 average, and results in people choosing to not use energy even when they really need it. The energy efficiency of homes, heating systems and appliances, as well as the flexibility of heating systems and infrastructures all make up the built environment and play a significant role in vulnerability to energy poverty.

The geographic underpinnings of energy affordability

Portugal has been identified as among the least seven egalitarian countries in the European Union (Bartiaux *et al.* 2016). Although I have previously pointed out that energy poverty is not directly tied to income, it should still be noted that income does play a part as the ability to purchase energy is out of reach for some. Massey argues that capitalism, as well as governance, naturally results in territorially uneven development and gives the example of the spatial division of labor in urban spaces through a conceptualization of cores and peripheries (Massey 1994). A cases study in India outlines the importance of procedural justice in the installation of large solar parks (Yenneti and Day 2015). In Lisbon, gentrification is changing how and where people live as an increase in tourism, and expatriates settling in the city, has driven up housing prices (Lestegás 2019; Sequera and Nofre 2019). The rollout of solar PV brings up geographical questions of placement, scale, distribution, and ownership. The flexibility of solar PV allows

consumers to own solar panels and produce their own energy, which in turn reduces their energy bill. Consumers can own their energy on a scale that suits them or their communities which in turn gives them more ownership over what they pay for energy. However, there is an upfront cost to obtaining individual or community level solar which may be exclusionary to those most vulnerable to energy poverty.

Vicious cycles of vulnerability: The spatial distribution of energy needs

This angle of the spatial justice lens reveals underlying distributional patterns of energy vulnerability. These patterns can be wider material and economic inequalities that contribute indirectly to energy distribution and consumption. For example, research shows that people with a disability or medical issue are often at increased risk of experiencing energy poverty and the consequences for them are more severe (Bouzarovski and Simcock 2017). This can be because of a need for a warmer than normal home environment, increased laundry and cleaning needs, and/or energy intensive medical equipment. In many excess winter mortality cases, those with a pre-existing condition do not have the means to maintain a healthy level of thermal comfort in their homes. This can lead to a deterioration of health conditions that would have otherwise been under control (Healy 2003). It is also well documented that problems arising from energy poverty, such as low temperatures and mold in the home, have detrimental effects on mental health as well as physical health (Bouzarovski and Simcock 2017). An unhealthy home environment can perpetuate a vicious cycle as one needs their physical health, and functioning mental faculties, to address and ideally transcend the challenges of poverty. Another vicious cycle can arise when, due to arrears or people opting to underutilize their energy services, the energy provider is unable to invest in energy efficiency measures.

A spatial distribution of health has been observed with geographic concentrations of those in poor and good health. Graham notes that "inequalities in people's health are intimately and inextricably connected to inequalities in their material and social circumstances" (Graham 2007, p.xi). As these examples illustrate, vulnerability to energy poverty often has a distributional pattern similar to other vicious cycles of vulnerability. Recognition of these patterns might inform more effective policy decisions and a better use and distribution of resources in targeting and helping those who are most at risk of the ill effects of energy poverty.

2.3.3 Procedural Justice

Procedural justice in energy transitions is concerned with fairness in the way in which the transition is implemented (Yenneti and Day 2015). It is a useful lens for examining who is

participating in energy transitions and whether there is democracy in the decision-making process. According to Sovacool *et al.* (2019b), "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" (Sovacool *et al.* 2019b, p.582).

Institutions

The presence or absence of justice is usually a direct result of the policies of a given nation-state. Therefore, to understand justice, it is important to recognize the institutions within the case. The institution that is most universal in any case dealing with justice is the government. However, institutions can be more than just governmental bodies.

I employ Lund's definition of institutions in order to streamline defining each institution involved in this case study:

"The state is always in the making" (Lund 2016, p.1199). By recognizing the state as an unfinished entity, Lund argues we can better understand it. Governments and authority form around the control of resources, be it energy, knowledge, trade routes, etc. The state exercises its authority to empower or disenfranchise. This ability is what constitutes state power. Lund goes on to say that any organized body with the capability to govern, other than formal, statutory government, should also be recognized as an institution. Therefore, state effects can come from other institutions than purely government ones. "Claims to rights are therefore ways to invoke public authority and governing capacity in different institutions, be they statutory or not" (Lund 2016, p.1202). In other words, a claim to authority may be made indirectly by categorizing or controlling property or resources, in this case energy.

For the purposes of this study, institutions are organizational bodies that form control over central resources and have the ability to disenfranchise or empower. In Portugal, I see this in several different institutional actors in terms of energy as a resource. For example, Energias de Portugal (EDP), Portugal's largest energy supplier is a private entity, but they exercise a substantial influence over how the low-carbon energy transition progresses in Portugal, giving them certain state effects. In response, collectives, such as the renewable energy cooperative in Lisbon, have formed to exercise their own authority over energy operations. I discuss these institutions and others, along with their role in solar PV, in Chapter 5.

Stakeholders and Social Imaginaries

Solar energy uptake has a variety of stakeholders, institutions and non-institutions, with different motivations, incentives, and visions of possible energy futures. Identifying these stakeholders and understanding their agency will be important for interpreting the research results. One such stakeholder is the above-mentioned institution, EDP. Beyond that, a stakeholder in solar energy uptake is any person or group actively involved in the promotion, production, or regulation of solar. Additionally, stakeholders are people who benefit from solar either through consumption or financial returns.

The production and distribution of energy historically happens at the scale of nation-states resulting in a limited group of stakeholders. Utilizing the resources of these stakeholders in low-carbon energy transition will help initiate decarbonization at the scale necessary to meet the climate challenge. However, these stakeholders often reduce the impacts of energy transitions to narrow configurations of decarbonization and environmental concerns (Szolucha 2019). Such perspective ignores how the way energy is produced, distributed, and consumed shapes culture, politics, and people's imaginaries of possible futures.

Solar stakeholders can have contesting sociotechnical imaginaries about possible energy futures. Sociotechnical imaginaries are "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). Large scale energy projects frequently are elite led, centrally controlled, and can often rely on neoliberal approaches to resource management. This unequal social arrangement of energy facilitates an oppositional, often grassroots-based, response from non-traditional actors such as individuals and collective institutions (ibid). These are a new type of energy stakeholder who view a sustainable energy transition as one that integrates aspects of justice as well as decarbonization efforts. These stakeholders are individuals, collectives, non-profits, and other groups not typically associated with large-scale energy operations with social imaginaries that contest traditional large-scale approaches to energy transition. Solar PV is a technology that allows realization of these new social imaginaries about possible energy futures through its modularity and affordability. I address stakeholders in more detail in chapter 5.

2.3.4 Cosmopolitan Justice

Cosmopolitan justice is a globalized approach that recognizes that all human beings, in all nations, have equal worth and are bound and protected by certain moral principles (McCauley

et al. 2019). It also recognizes that all people have a collective morality that extends beyond borders and does this by maintaining a justice lens that looks beyond nations and communities to include all humans (Sovacool *et al.* 2019a).

There is a climate crisis that depends on vast transitions to renewable energy sources, increased energy efficiency, and a decrease in consumption. As stated earlier, energy poverty sometimes results in under-consumption meaning that certain populations may need to consume more energy for optimal health and quality-of-life. However, energy poverty will not be solved in a sustainable way if, for example, it was given for free to the energy poor. Here lies a delicate balancing act because energy certainly needs to be more accessible for those vulnerable populations but cannot be free. If energy is free for this group, they may use it irresponsibly and create a cosmopolitan justice issue where the burden of this inefficient over-consumption may be distributed elsewhere. In this hypothetical scenario, there could be an issue of mis-framing where those situated just outside of the poverty line, or whichever distinguishing boundary defines who gets the free energy, are most burdened with the cost to pay for the free energy. Also, conservation and efficiency are important for any country to meet decarbonization goals and a country may not find the capacity to move away from polluting energy sources if usage were to be increased to unsustainable levels. This would present another justice issue of mis-framing as any country's ineffectiveness at moving away from high-carbon-emitting energy sources can continue to contribute to the global climate crisis.

2.3.5 Justice as Recognition

This branch of energy justice focuses on identifying vulnerable people whose vulnerability may be worsened 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 additional representation or special treatment to protect them from further harm (ibid). Energy poverty is a form of energy injustice (Sovacool *et al.* 2016). This idea has gained mainstream, broad recognition in Europe and globally, which is evidenced by both the EU and the UN defining access to affordable and stable energy from clean sources as a human right (European Union 2012; United Nations 2018). This is a broad definition and this study would benefit from a more specific understanding. Spatial justice theory offers a focused approach for identifying injustices of recognition through the idea of *spaces of misrecognition.*

Spaces of misrecognition

Bouzarovski and Simcock (2017) discuss the geographical dimensions of justice as recognition. Injustices in recognition happen when the needs of certain identities are overlooked within social, cultural, and political spaces. Spaces of misrecognition also manifest through stigmatization of certain groups of people in public discourses and cultural representations. The inability to adequately or comfortably use energy services can carry a stigma of someone who is poor or incapable. This stigmatization is geographically dependent and can be stronger in places that carry a public discourse which suggests the poor are responsible for their own poverty (ibid).

This spatial recognition lens also suggests that area-based schemes of energy efficiency improvements may mark out those experiencing energy vulnerabilities in a way that stigmatizes them. As much as it is important to recognize and efficiently use resources on people caught in the vicious cycle of vulnerability, policymakers should consider how a group may be maligned through the identification meant to help them. Such a recognition may help policymakers roll out an action plan that results in better compliance and is more suited and sensitive to the needs of a specific population.

2.4 Summary

This chapter has summarized the term and conceptual frameworks that provide a foundation for this research project. First, a discussion on energy transitions, energy poverty, and scale was defined to provided cohesiveness to the study. Then, a review of academic work on energy justice supplied the main framework to interpret the results of this study. Within that framework, a discussion on spatial justice explicated a nuanced, geographical understanding of the research results. This was essential in order to specify and operationalize an otherwise quite broad, and conceptually oriented, energy justice framework.

3 Context

In this chapter, I will give a comprehensive overview of the field area and topic by situating my research in the context of solar PV in Lisbon.

3.1 Lisbon, Portugal

Figure 5: View of Lisbon looking southeast from the historical Alfama district. Photo taken by author. 5 June 2019.

Lisbon is the capital of Portugal and the largest city with a resident population of 506,088 that increases to 925,959 when the commuting population is included (Lisbon's Energy and Environmental Agency 2019). It is the country's political, economic, and cultural center where decisions happen on environmental governance and energy transitions. Portugal is a parliamentary republic, covers 92,212 square kilometers and is home to 10.39 million people (United Nations 2019). It is situated on the Iberian Peninsula in the southwest of Europe.

Lisbon has become a leading city in the EU for sustainability and earned the title as the European Green Capital 2020. "Lisbon thus asserts itself as a promising European and world "ambassador", promoting reflection and action on the most pressing contemporary

environmental issues, while also stimulating the creation of participatory and virtuous synergies with the most varied sectors and entities (public and private) of the Capital and the country, which will last, we are sure, beyond 2020!" (Lisboa E-Nova 2020).

History

Portugal is a relatively new democracy. On 25 April 1974, the Carnation Revolution took place to eschew the Estado Nuovo authoritarian regime and usher in democracy. Portugal joined the EU in 1986 and the European Monetary Union in 1999. Economic difficulties resulted in an exodus of 586,000 mainly young and highly qualified people between 2011 and 2016 (Lloyd-Jones 2020). The rate of outward migration has slowed since 2016 due to some economic improvements and a tax incentive from the Portuguese government.

Economic revitalization in Lisbon was characterized by the infusion of large sums of money into new hotels and tourist facilities. The Portuguese government meant this as a way to create much-needed jobs but these jobs were mostly low-paid and seasonal and resulted in what the Organisation for Economic Cooperation and Development (OECD) identified as "the country's legacy of a low-skilled labor force" (Lloyd-Jones 2020). These factors have gentrified Lisbon significantly which has caused housing to become prohibitively expensive amidst low incomes.

Climate

The climate in Lisbon is quite mild. The yearly mean temperature is 17˚C with an average low of 11˚C and an average high of 23.2˚C. Lisbon residents experience 315 days of sun a year on average. The city receives about 47.2mm of precipitation annually (Lisbon's Energy and Environmental Agency 2019).

3.2 Political Economy

The global financial crisis of 2008 caused a severe recession necessitating Portugal to take assistance from the EU and IMF. They were able to exit this program in 2014 and have since displayed significant reform progress (OECD/IEA 2016). However, public and private debt remain high and unemployment is still too high despite a reduction overall. This is a contributing factor to inequality and poverty.

In the energy sector, policies created in 2005 have led to Portugal becoming a top renewable power producer, relatively speaking (Miguel *et al.* 2018). With no fossil fuel production, nearly half of Portugal's energy came from renewable energy in 2014 and is growing (OECD/IEA

2016). In March 2018, Portugal made the news by exceeding its own energy needs and produced 103.6% energy from renewables (Bellini 2018c).

Portugal is a Southern-European coastal nation and will likely experience the effects of climate change more forcefully than a more land-locked Northern-European nation. The climate and location are conducive to solar and new solar technology has become cost-effective enough to be competitive on the market. As a result, there has been a huge influx in solar energy uptake which has resulted in lower energy prices (ibid).

Bartiaux *et al.* (2016) determined Portugal to be among the least egalitarian societies in Europe by analyzing Eurostat data. This context is important to assess the political economy and determine the best energy policy for Portugal's solar transitions. Additionally, energy and climate policies can increase energy poverty, according to some environmental justice studies, which is further evidence that energy policy is vital to the community in which it is implemented (ibid). Bouzarovski and Simcock (2017) determined that where a person lives is as important as the socio-economic group that they belong to in order to assert that location-based policy is most practical for energy poverty alleviation. Bartiaux *et al.* (2016) came to a similar conclusion when they determined that policy needs to fit the social structure of a place and argued for a solar transition model that plays to Portugal's socio-economic makeup. The authors apply the social concepts of vertical diffusion and horizontal diffusion to energy transitions and determined that each concept in practice had the potential to decrease or increase inequalities depending on the location implemented. Currently, the energy tariffs for energy efficiency tend to only benefit the upper class as that is where most energy retrofits happen (ibid).

In addition to policy, compliance can be a key factor in effective energy transitions. In a key study, Delicado *et al.* (2016) argued the importance of gathering community perceptions of solar energy projects from start to finish. The authors note that, in their location of study within Portugal, residents were dismayed with the fate of unused materials, waste, and animal welfare. The authors also write how decommissioning, waste management and contamination of hazards are often overlooked in current policy. If the affected group of people is not on board, compliance and acceptance of low-carbon energy transitions may be missing and/or misunderstandings can happen resulting in an unsuccessful transition.

Energy policy is decided in and decreed from Lisbon. Prior to 2018, the energy portfolio came under the ministry of the economy. Then, in October 2018, the Ministry of Environment and Energy Transition (MATE) was created, representing a shift in priorities for the administration.

3.3 Portuguese energy market

In Portugal, the electricity sector is almost fully liberalized and privatized, meaning generation and supply activities are not strictly regulated. These activities can be developed by any company that goes through the licensing, registration and proper procedures (Pacheco and Mendes 2019).

EDP formed in 1976 from the merger of 13 freshly nationalized companies, making it Portugal's only energy producer at the time. In 1994, the company restructured, a process that created the EDP Group and the National Energy Network (REN). By 1997, EDP began to privatize and sold off 30% of its capital and became completely privatized by 2013 (Silva and Pereira 2019).

Portugal, like most European countries, relies on imports to meet its energy needs. In 2015, Portugal had the seventh highest energy dependence in the EU (Miguel *et al.* 2018). Portugal's former Minister of Environment and the Energy Transition, João Pedro Matos Fernandes, said in 2018 that "Our energy dependence from abroad is now 75%. In 2030 it will be 65% and in 2050 17%" (Bellini 2018a).

In Iberia, Portugal and Spain each pay more for renewables through, for example, a feed-in tariff but rate-payers get a reduction from lower spot prices induced by wind energy produced across the border (Prata *et al.* 2018). However, this dynamic is changing as renewable energy sources are dropping in price. For example, solar PV reached grid parity recently. In January of 2018, the first private solar power purchase agreement (PPA) was signed which means it will not be developed with direct public incentives. For large scale solar developers, the private PPA market is increasingly becoming a great option. The government has indicated that these types of projects would be "based on market prices, and without subsidies paid by consumers, through the national electric system" (Bellini 2018b).

Capital, especially private credit from banks, has been shown to bolster transitions from fossil fuels to renewable energy sources (Shahbaz *et al.* 2017). Portugal is also experiencing a high rate of investment from China's Foreign Direct Investment in Europe. Pareja-Alcaraz calls China's acquisitions in Portugal impressive and that Lisbon "should see China's penetration in their markets as a mixed bag of opportunities and challenges that demands better informed analysis" (Pareja-Alcaraz 2017, p.700).

4 Methodology and Methods

In this chapter I discuss the research methodology. First, I discuss the research design and then I discuss the methods. This study is based on eight weeks of fieldwork in Lisbon over the course of two visits. The first visit took place 24 November 2018 to 7 December 2018. The second field visit occurred 27 May 2019 to 4 July 2019. During this time, I conducted 24 interviews with 20 different informants, attended two relevant events, and recorded field observations. My informants consisted of academic researchers, energy community professionals or proponents, energy cooperative members, two government officials, and an interview with a renewable energy investment firm. I used these semi-structured interviews to gain understanding of the role of scale in justice aspects. These interviews give value into the actions of key actors in solar energy uptake, but it is a limited sample and therefore not generalizable on its own. For this reason, post-field work includes desk work and document analysis. The interviews provided insight and served as a guide for which document analysis to conduct. Some insights from the interviews gain generalizability when appropriately paired with grey and academic literature.

4.1 Research design

To begin the research design, I had to choose how to approach the case study. The case study is an intensive study of a single case (or a small set of cases) with the goal of being able to generalize across a larger set of thematically similar cases (Gerring 2007). To study a single case with the intent of shedding light on generalizations that can transcend that case, brings with it some ambiguities. For example, the case usually begins with a certain idea or focus that changes as the researcher processes the details of the study. Also, despite the best efforts of the researcher, the boundaries are sometimes open-ended (ibid). The case study is most useful when "an empirical inquiry must examine a contemporary phenomenon in its real-life context" and when the boundaries between the phenomenon and its context are difficult to distinguish (Yin 1981, p.98).

I began by reviewing news, articles, journals and reports related to energy poverty, energy justice, energy transformation, solar PV, and the Portuguese context. I had the opportunity to visit Lisbon early on to explore my central research theme. It was a two-week short-term scientific mission, made possible by the European Cooperation in Science and Technology (COST), that served to bolster my research design and as first round fieldwork. During this scoping visit, I investigated the same research question (*What is the potential of solar to*

alleviate energy poverty?) as with the later, six-week spring visit that served as the primary fieldwork for this project.

Through this preliminary site visit and the preparatory literature review, I noticed a great deal of ambiguity in how to identify and address energy poverty. I also noticed a disconnect between proposed solutions for energy poverty and the discourse surrounding small-scale solar rollout. Namely that solar has big potential, through its hypersizability, to increase affordability and accessibility to clean energy, yet it appears that only a limited group of people are getting solar. If justice is parity of participation, then the existence of accessibility barriers to small-scale solar uptake (possibly due to the scale of upfront cost and time to recuperate those costs) points to an inequity of opportunity in this technology. Still, solar PV offers potential as an affordable way to utilize this plentiful source of energy in a sunny place like Portugal. Furthermore, the modularity of solar PV raises questions around how scale of deployment affects participation and other energy justice properties.

The interviews from this preliminary visit quickly revealed the ambiguity and importance of scale in low-carbon energy transitions and energy justice through the dueling ideas about scalar deployment of solar PV that I received from informants. After that site visit, scale took a central role in this case study, which led me to add a supporting research question (*What role does scale play in low-carbon energy transformation and how does it affect energy justice*?). Furthermore, solar PV had only recently become competitively priced in the market and was increasingly affordable, accessible, and flexible; this raised further questions about scalar deployment and uncertain energy futures. At the same time, energy policy and institutions are in a state of adaptation; another ambiguity that affects the rollout of solar PV. For example, in 2018, there was an administrative cabinet change and the Portuguese government created a new Ministry of Environment and Energy Transition (MATE). Prior to this change, the energy portfolio was placed under the ministry of economy. The administration's combined energy and environment portfolios in a single ministry is significant and suggests evolving priorities on the part of the Portuguese government. This action is bound to have (and has had) an effect on how the low-carbon transition unfolds.

For the research design and field work, I began with a post-structuralist lens, which is concerned with looking beyond structuralist explanations of society and often challenges binary categories. It understands meaning as relational and focuses on the ways in which meanings and identities are produced and resisted (Couper 2015). Our relationship with energy is as a resource that is essential to our way of life. Yet for environmental governance and corporate

interests, energy can be a means to tax money and profits which can greatly influence how energy systems distribute this vital resource. These institutional interests can frequently be at odds with the public's wants and needs.

Take the yellow vest case in France which unfolded, coincidentally, while I was in Lisbon investigating energy-related injustices in November 2018. At that time, the French government instituted an environmental policy strategy that imposed a green tax on fuel. This action set off massive country-wide protests characterized by moments of violent civil unrest. Socio-economic inequalities had produced a spatial gap in which many people cannot afford to live in the cities resulting in them living in rural areas and driving long distances to urban centers for work; a phenomenon that Massey (1994) discusses through a conceptualization of territorial divisions of labor into cores and peripheries which are a by-product of capitalism and governance actions. The people who had been consigned to these periphery spaces claimed they could not afford this new tax and demanded its repeal. The French government, which was gaining criticism as being for the rich, attempted a decarbonization move but had structured it in a way that was antithetical to many people's reality. The burden of cost was unfairly placed on the individuals whose means of work and survival depended on affordable fuel. In one weekend and one city alone, Paris sustained an estimated € 3.1 million in damages and the violence escalated to have severe and sometimes fatal consequences (Cigainero 2018). It is probably fair to say that the damages and loss of life are a net negative against any gains of the green tax. This shows that how an energy transition happens matters and it is important that energy policy look beyond traditional structures of distribution and economy to account for existing socio-economic realities. Although decarbonization efforts address a critical need for the future, people will not be able to get on board if they are currently experiencing intense hardships. This challenges the notion that simply changing the source on energy infrastructure equates to sustainability. How the cost and benefits of energy transition is distributed is critical for successful solutions to the pressing climate crisis.

In Portugal, the energy-related socio-economic structures have parallels to the yellow vest case. As discussed in the first three chapters, low-carbon energy transitions can amplify or disadvantage already vulnerable populations. In Portugal, this can be seen through the extremely high cost of energy for consumers. This cost hike is, in large part, due to the renewable energy tariffs used to promote wind, hydro, and solar; the cost of which fell on the end consumers. In an already inegalitarian society, this is a significant hardship on those vulnerable to socio-economic adversity and poverty. At the same time, Portugal has an already

impressive track record of renewable energy uptake giving it a reputation as a European leader in renewable energy. As Portugal forges ahead, experiencing gains in economic activity and notoriety, it is clear that a significant portion of the public is left out of these gains. Around the world, I see examples of similar injustices that work against decarbonization efforts as climate-denying, far-right governments are voted into power. Portugal's current government administration is enabling and supportive of decarbonization efforts and they are beginning to acknowledge, and attempting to address, energy injustices. Examples, such as the United States, France, and Hungary, serve as an indication that not addressing underlying structural inequalities can actively work against climate change mitigation strategies. In other words, addressing the socio-economic structures that disadvantage people is not only a good and just thing to do, it is imperative for a successful energy transition. Portugal is in a pivotal moment to do just that and makes for a great case study to explore energy justice within low-carbon energy transitions.

According to Gerring (2007, p.19), a "case connotes a spatially delimited phenomenon (a unit) observed at a single point in time or over some period of time." The events currently unfolding in Portugal make this an exciting point in time to investigate. As a member of the EU, Portugal is part of a globally bold, climate change mitigation strategy. Solar is slated to play a large role in the EU-mandated goal of reaching carbon neutral by 2050. The newness of solar PV and the clear intent of European institutions and Portuguese policymakers to address energy poverty also make this a timely project. A review of the state-of-the-art reveals that energy poverty is context specific and can have a multi-faceted array of causes (Bouzarovski 2018). Solar PV as an individual or community source of energy is still a new phenomenon and due to its novelty, data on who is adopting solar, how they are using it, and the effect of very recent energy policies is sparse or non-existent. In other words, observable data points are few and energy poverty indicators are notoriously difficult to track. For these reasons, I chose a qualitative approach to this case study as I determined descriptive, interpreting, and contextualizing analysis to be most suited for understanding this case at this point in time.

In order to design effective field work, I needed to choose an approach for this case study. The success of a case study requires that it "follow an explicit design" (Yin 1981, p.103). Having conducted initial research with the literature review and first site visit, I saw the importance of recognizing the various realities of socio-economic adversity and poverty. Poststructuralism assumes that the production of reality happens through various sets of relations and, according to Cresswell (2013, p.208), "it is more of a horizontal model rather than a vertical one."

Following this philosophy of science, I planned my research to explain, rather than interpret or predict (Sorrell 2018), as attempts to make universal claims are often misguided (Lund 2014).

After my first visit to Lisbon, it became apparent that spatial characteristics of scale and distribution played a central role for energy justice in energy transitions. For example, my informants from this first visit would consistently suggest a solution related to size and scale when asked "What is the best way to address energy poverty?" After this discovery, I reviewed further literature on scalar analysis of low-carbon energy transitions. I also saw the importance of including a scalar analysis in this study since there appeared to be a relationship between scale and just energy outcomes (or at least the social imaginaries of such outcomes). For these reasons, I chose an energy justice framework as the theoretical lens which is explained at length in Chapter 2. This framework allows for a post-structuralist, multi-dimensional, multi-scalar analysis and interpretation of systemic justices and injustices within energy systems. This makes it well-suited to this case study. It is a useful tool for looking past traditional vertical, structural perceptions of energy transitions to better understand the impact of energy systems' spatial configuration and the various solar stakeholders' relationship to that spatiality.

Applying an epistemological lens to the design led me to consider my role in the research and nature of the knowledge produced. As a case cannot be separated from its context, neither can a researcher be separated from her/his point of view. Therefore, it is important to consider my positionality or my perspective as it is shaped by a unique mix of my class, race, nationality, gender, culture, and other identifiers (Mullings 1999). As an American living in Norway and conducting research in Portugal, such a consideration helps to assess and bring awareness to how the cross-cultural nature of the study affects the results and knowledge produced. Additionally, I am an early career social scientist and during these interviews, I was clearly in the role as a student. On top of that, I am a woman and I look quite young. These characteristics both influence how I regard the case and how my informants will respond to me in both positive and negative ways.

As an outsider, misunderstandings can happen because I am unable to speak Portuguese. I conducted every interview in my native language which was the informant's secondary language and can certainly impact the information gathered. To avoid mistakes and misunderstandings, I recorded the interviews whenever possible. In the moment of interviewing, there are social and research dynamics that I am consciously and unconsciously managing, such as wanting to appear professional and well-prepared and conducting the interview in a manner that will yield the best results. In retrospect, I found these dynamics to at

times distract me from fully absorbing what my informant said. Reviewing the recordings showed me that I had occasionally missed a key point or not understood fully so this proved to be a good tool for increasing accuracy. Another tactic I used to avoid misunderstanding was to often repeat back to the informant what I understood them to be saying and I found this to also be important for accuracy. In most cases, informants affirmed that I indeed understood their point but there were a few key moments that the informants stopped me and corrected me.

Being an outsider can also have its advantages. For example, I can view this research case through a perspective situated outside the Portuguese context which may bolster the transferability of the results to other cases. This dichotomy of outsider advantage and disadvantage also played out at the state meeting to outline a roadmap for achieving EU mandated carbon neutral goals by 2050. At the time of the meeting, I had been in Lisbon for 10 days during my first visit to the city. Two of my informants were in attendance, which was helpful since the event was conducted in Portuguese. As an outsider, the inability to understand was a disadvantage as I missed out on everything that was not spoken directly to me by someone I knew or accompanied by a revealing presentation slide. However, this position as an outsider provided a chance for a different form of observation as my attention was directed at the dynamics of the room and who was in attendance. For example, the Portuguese Secretary of Energy and the Secretary of the Environment were in attendance along with other relevant government officials. Executives from EDP, Portugal's largest energy supplier, were also present. One of my informants commented that I was very lucky to be in Lisbon at this time because this event was a veritable "Who's who" of the Portuguese energy sector.

In my position as a female student who looks quite young, I experience at times a credibility issue. In past experiences where I have occupied a technical or advisory role, I found that people sometimes did not take me seriously. To counter this possibility in my interviews, I prepared for fieldwork thoroughly by learning the technical details of energy systems and researching my informants and reading their published works, if applicable. Energy geographies research sits at a nexus between social, qualitative theory and technical understandings of energy systems which requires researchers to often branch out into new arenas of knowledge. I came into this study with a strong interest in the energy sector, but I lacked the knowledge necessary for this case study. Therefore, another preparatory measure involved hours of discussion with my project supervisor who has a deep understanding of the energy sector. These discussions grounded me in a complicated subject and guided me to find the literature and information necessary to become suitably informed in my research focus.

Although there may occasionally be a credibility issue, I also find my role as a young-looking female student to be a great social advantage. People generally feel comfortable talking to me and will "open up" accordingly. Furthermore, as an early-career, unknown social scientist, I do not have name recognition or title next to my name. In this study, I had difficulty securing interviews with certain informants, such as government officials; a difficulty that perhaps will lessen with more name recognition, accomplishments, titles, etc. And finally, I would be remiss to not acknowledge that these are my own perceptions of my position in the world and are based on anecdotal experiences and may or may not have bearing in reality or on the production of knowledge in this study. Nevertheless, I went in understanding that complete objectivity is not possible and the intention to maintain awareness of the coproduction of knowledge that can happen in research: both in the way I perceive the case and the way my position affects the information I receive. "Research is primarily an enterprise of knowledge construction" and the researcher, along with the participants, are engaged in producing this knowledge (Guillemin and Gillam 2004, p.274). Therefore, research is an active process that requires reflection, scrutiny, and investigation into the researcher, the participants, the data, and the situated context (ibid). According to Mullings (1999), calling out uncertainties is a critical step to increase the quality of the research and minimize the influence of the author. This suggests that an additional component of research design is continuous self-reflection and a section in the discussion of results (Section 6.3) covers reflexivity.

To strengthen the validity of the results, I planned to employ methods other than interviews, as having more than one method allows one to triangulate data and look for cohesiveness across the data types (Jick 1979). From the first round of interviews, and reviewing research methodology literature, I anticipated that some challenges may arise. For example, a study can risk becoming a phenomenological examination of the people and their opinions rather than an examination of the case (Bonham and Bacchi 2017). My informants are a diverse group of solar stakeholders. For interviews with cooperative members and other non-expert informants, it makes sense to gather experiential-focused data.

Although participant observation is a method used in this case, the interviews were not part of that method. I attempted to structure and conduct the interviews in a way to avoid this portion of the study inadvertently becoming a participant observation. If the interviewer has never been involved in a particular group before, one risks being categorized in some manner, which may influence the study (e.g. rookie, outsider, etc.). Clifford (2010) cautions researchers to avoid becoming the "phenomenon." I addressed this, as much as possible, through careful preparation

for each meeting. Most informants were professionals and focused on the subject matter. If, in a few instances, the conversation wandered away from the central focus, I made effort to bring the conversation back to the topic at hand quickly.

4.1.1 Semi-Structured Interviews

The complexity of the case, and the context it is situated in, calls for qualitative data collection because it raises specific issues that are inadequately addressed through quantitative datasets: energy poverty, energy justice, and the relationship of scale to these themes. As discussed in Section 1.1.1, energy poverty is difficult to detect with quantitative measurements and was most pronounced using empirical data. The newness of these themes means I have little idea what to expect as a researcher and therefore an exploratory approach is most suited to the study. Also, looking at issues of energy poverty and energy justice require analysis and understanding of human meaning, which is a challenge to do in aggregate data. Hunt (2014) writes "qualitative methods are used to answer questions about experience, meaning and perspective, most often from the standpoint of the participant." As discussed in Chapter 2, a key tenet of energy justice is participation and accounting for who is participating, who is not, and their perspectives through qualitative methods offers a prudent path forward for energy justice research.

The nature of this case is broad and quickly evolving, so it is important to remain flexible to allow for new directions in the research. For this reason, I chose semi-structured interviews as the primary data collection. A semi-structured interview follows a predetermined structure but gives the flexibility to follow an interesting thread that may surface during the conversation (Clifford 2010). In case studies, opening questions are often just a first step and a slightly different line of questioning will emerge while carrying out the study (Lund 2014).

I decided to speak with experts, professionals, and citizens taking part in solar PV and not people vulnerable to energy poverty. In addition to the challenge of identifying energy poor households (an industry-wide challenge which I discuss in Section 1.1.1), I assumed there may be great difficulty in securing interviews with the energy poor. Additionally, the possible stress I might inflict by seeking out people specifically because they are in a vulnerable position caused me to decide against this path. In other words, this way of finding informants runs the risk of stigmatization and causing a space of misrecognition (Bouzarovski and Simcock 2017), a form of recognition energy injustice which I outlined in Chapter 2. Furthermore, the scalar focus of my study warranted speaking to informants with backgrounds and experience in different types of solar deployment. These informants were much easier to find and contact

which strengthened the case. By speaking to decision makers, small- and large-scale solar PV actors, and relevant institutions, I developed context for who is participating and who is missing in the energy transition in Lisbon. Participation is a key indicator for procedural justice.

To find informants for this study, I used non-probability, snowball sampling. My supervisor facilitated introductions to two relevant informants for the first trip to Lisbon which helped initiate the snowball and best utilize my limited time on location. In Lisbon, my first point of contact was a sociologist at the University of Lisbon who hosted me on my first visit to Lisbon. Her work centers on energy poverty and energy justice and she referred me to three good contacts, who then gave me leads to several more contacts. During that first visit, I interviewed eight informants and met with several of them again upon returning. To plan for the second visit, I scheduled, when possible, interviews with them for my first three days in Lisbon to allow time for following any new leads they gave me. At the end of every interview, I asked for recommendations of other possible informants. Often, they had people to suggest and were kind enough to let me use their name when contacting their recommended informant. For the other people that I wished to talk to, I looked them up online and contacted them by their publicly listed contact information (which, in many cases, was usually the contact details for the institution they belonged to.) I began with an email requesting an in-person interview with an official letter attached. If I did not receive an answer within five to seven days, I called their institution to make my request again. If the phone call was unsuccessful, I visited their office in person to request an interview. I acquired two key informants only after a physical visit to their office. This method of gaining informants without a lead was significantly less successful and the majority of my contacts came from snowball sampling.

In certain cases, the unsolicited contact approach had no success. For example, my varied attempts to speak with someone at EDP were unsuccessful. I emailed several EDP departments whose contact information I found online. Then I tried phone calls about a week later. Finally, I made the trek across town to visit their office. I walked into their cavernous lobby soaking wet because there had just been a downpour of rain. Hoping that my efforts to be there despite the foul weather would garner some support, I spoke with the front desk, explained my case, and gave them a letter I had prepared. In one last attempt, I contacted an executive from EDP who spoke at the Carbon Neutral Roadmap 2050 meeting. I found her profile via LinkedIn and sent a message explaining that I saw her speak at the meeting, briefly explained my case, and asked for an interview. In the end, I never received a response from EDP.

Table 1: A list of interviewed informants categorized by type and the date(s) interviewed.

	Respondents	Type	Interview date (STSM trip)	Interview date (Fieldwork trip)
1	Representative of Coopérnico 1	Community energy/networks	26-Nov-18	14-Jun-19
2	Representative of Coopérnico 2 (by phone)	Community energy/networks	13-Dec-18	07-Jun-19
3	Representative of GoParity	Community energy/networks		25-Jun-19
4	Representative of PROSEU	Academia		17-Jun-19
5	Researcher 1	Academia	27-Nov-18	28-May-19
6	Researcher 2	Academia	05-Dec-18	18-Jun-19
7	Researcher 3	Academia		28-Jun-19
8	Researcher 4	Academia	06-Dec-18	
9	Researcher 5	Academia		18-Jun-19
10	Researcher 6	Academia		19-Jun-19
11	Researcher 7 (by phone)	Academia		05-Sep-19
12	Researcher 8	Academia		18-Jun-19
13	Coopérnico Member 1	Coop participant		26-Jun-19
14	Coopérnico Member 2	Coop participant		29-Jun-19
15	Coopérnico Member 3	Coop participant		26-Jun-19
16	Coopérnico Member 4	Coop Participant		25-Jun-19
17	Coopérnico Member 5	Coop participant		17-Jun-19
18	Representatives of Hyperion	RES investment firm	03-Dec-18	
19	Representative of APREN	RES civil society	03-Dec-18	
20	Representative of DGEG	Regulatory institution		26-Jun-19

In total, I spoke with 20 informants with 18 of them acquired through snowball sampling. This sample should not be considered representative of the Portuguese population as "non-probability sampling can only be adequate if the researcher does not aim at generalizing his or her findings beyond the sample" (Gobo 2011). In other words, attempting to generalize this case compromises the quality of the research. Rather, the intention is to explain or characterize the general social, political, and economic patterns at play. Observed patterns, if they have resonance with structures in other case studies, may then have some valid generalizability.

When creating interview guides, I divided the informants into two main categories: institutional actors which included expert interviews from government officials and professionals in the field, and citizen solar actors. The interviews for both categories had a similar base structure, but I tailored each interview to the informant ahead of time. When interviewing experts or researchers with vast knowledge of the field, I allotted time to brief myself fully on the

informant's knowledge and background ahead of the interview. I did this by locating and reading sufficient academic writing pertaining to the topic. If it was an expert interview, there was often a list of published works on their online biography and I located and read all their work that was relevant to my research. If I did not find a list of published works, I searched by author on the Web of Science, ORIA, or Google Scholar in addition to searching any additional information I suspected might come up in the interview. I read all informants' Curriculum Vitae (CV) and/or online biographies when available, and researched relevant initiatives, organizations, or institutions. The interview questions I created for the institutional and expert interviews tended to be more technical in nature and asked about my project subject matter directly, such as asking about their perspective on solutions to energy poverty. When interviewing citizen participants, the questions I created tended to be more phenomenological in nature steering towards perceptions, experiences, and personal motivations. Unless I received an indication that one of these informants had special or technical knowledge on a concept in my project, I fit the questions to that person's interests and experiences. Example interview guides can be found in Appendix A and Appendix B.

My informant sample is well saturated with people working in, interested in, or investing in community focused and small-scale solar PV projects and initiatives. To an extent, this skew is appropriate and telling. These informants are community focused people. Some of them expressed, unsolicited, approval of my research subject matter and were therefore eager and willing to help with my project. With medium to larger institutions, or governmental institutions, it took some time to get a response to an initial query requesting a formal interview over email or phone from anyone, if at all. I unpack the implications of this in Chapter 6 of this thesis and discuss how it likely affects the study.

As mentioned above, my informants spoke Portuguese as their native language, but I conducted the interviews in English. To increase comfort and convenience, I gave informants choice of location and whether to be recorded. In many cases, the subject matter was not sensitive information for the informant, so most were comfortable being recorded. In the remaining interviews, informants did not grant permission for recording or I decided it was inappropriate for reasons including a loud environment or I suspected that it would make the informant uncomfortable or self-conscious. The choice of location given to the informant appeared to serve mainly as a convenience to them and a means to get a positive response for a request to meet.

Figure 6: Map of informants and locations of interviews conducted in Lisbon. Google Maps. 24 May 2020.

4.1.2 Direct and Participant Observations

Although I have attempted to separate participant observation from the interviews for the sake of structured thesis sections and interview integrity, these methods are inherently linked (Jackson 1983), as a researcher participates in interviews as well as facilitating them. Furthermore, my attendance at two events, which served as a big part of my participant observation, was a direct result of the interviews because the event invitations stemmed from two informants. Participant observation also extends beyond the interviews which allowed me to include various experiences and observations that add value to the case study. Participant observation is firmly rooted in ethnography, which is the study of people in their natural environment and context and seeks to capture social meanings and details of ordinary activities (Jackson 2006). The primary goal of ethnography is to develop a deeper understanding of a certain group in a specific moment in time (ibid). The term participant observation has been called oxy-moronic as 'participant' implies direct and invested involvement whereas 'observation' implies an outside, distant perspective (Tedlock 1991). Jackson (1983, p.39)

provides a discussion to define the term, calling it a "conscious and systemic sharing…of life-activities." The author moves on to a broader description of 'participant observation' as shorthand for a set of methods that includes interviews and the details learned in the participation and observations that happen in addition to interviews (ibid). Using participant observation in Lisbon, in addition to and beyond the interviews, allowed me to gain a more in-depth understanding of solar energy sector stakeholders and their context.

This method also provided greater context to solar energy deployment and persistent household energy deprivation in Portugal. For example, I met and conversed with new people, during the two events I attended, with interests and work experience that were in line or parallel to the subject of this study. This led to a few additional interviews with or recommendations of people to talk to, or a specific report that may be useful to review. Participating and speaking with these individuals also served to confirm parts of the preparation and research design thus far as several times, a respondent recommended that I speak with an individual I was already in contact with or read a paper with which I was familiar.

The first event was the Portugal Roadmap to Carbon Neutral 2050 meeting which took place on 4 December 2018. The purpose of this event was to present a plan to meet the roadmap's ambitious decarbonization goals and facilitate expert panel discussions. During the Spring 2019 visit to Lisbon, my informant from PROSEU invited me to a prosumerism business model workshop. This workshop was held at the University of Lisbon on the 12th of June 2019. It was facilitated by small-scale solar researchers who had done previous research in the UK and Germany on business prosumerism models and now sought community input to create business models for different forms of prosumerism that could be viable in Portugal. The workshop held relevance to the study since it was exploring small-scale solar PV models and the event flyer described prosumerism in a way that fits the research focus: "Prosumers may be the key players in a distributed and increasingly democratized energy future. The growth of renewable energy sources prosumerism all over Europe challenges current energy market structures and institutions."

In attendance were people from various backgrounds related to energy. I met and spoke with a mechanical engineer, a representative from Coopérnico, an employee of EDP, a PhD candidate in electrical engineering, and various researchers. The facilitators assigned us to groups and gave each group a prosumerism scenario to model. This entailed different types of community scale solar PV models in which, in most cases, the community owned and operated a solar PV system and sold excess energy to the grid. Each model had varying degrees of connection and

dependence to the central grid and large-scale energy suppliers. The models required an advanced level of technical knowledge well beyond anything I knew or needed to know so I was mostly an observer for my group's model building.

Participant observation featured in my daily life in Lisbon as well. During the winter visit, my first happenstance observation incident happened in the way that I found myself constantly feeling cold. This surprised me as Portugal's weather report predicted mild and sunny conditions. Indeed, those were the conditions, but there was an icy chill in the air, especially when I found myself in the shadow of a building. Inside the buildings, there was almost no relief. Lisbon is full of old buildings built without insulation or central heating, which is central to the issue of energy poverty. Although I had read about this phenomenon, the reality of this was much more impactful from this experience. Direct experience of the research context is at the core of ethnographical approaches and served as a way to connect with informants (Tedlock 1991). For example, before interviews officially started during my winter visit to Lisbon, I figuratively "warmed up" the room with my experience of being cold the entire trip, which all informants found amusing and quickly commiserated with.

Daily life in Lisbon also gave me insight into the socio-economic conditions. The city is changing and gentrifying through an increase in the presence of expatriates and tourists (Lestegás 2019). The cost of living has therefore increased; an additional burden for those who are unable to afford, or simply do not want to pay, an expensive energy bill. The right to housing versus the impact of tourist-related urban renewal was a central focus during the local elections in October 2017 amidst a backdrop of surging housing prices, escalating rents, and resident displacement (ibid). The local community and institutions have responded to these factors in some interesting ways. One example is that of public transportation. The cost of a trip on the metro is €1.50 with a small savings if one uses a prepaid metro card. There is a monthly pass available for €30. This would have saved a lot of money, as I needed to use the metro several times a day, most days. However, there are frictions put in place to keep tourists, or those staying in Lisbon temporarily, paying more. To get the pass, one needs to order it online and have it sent to a physical mailing address. Then it will come, at the soonest, 14 business days later. The other possible way to get a pass was to visit one of two Lisbon metro offices. When I visited one of these offices, there was a long line in which I counted 38 people ahead of me. I waited for 20-30 minutes to see if the line, perhaps, would move quickly. In that time, the desk served only two people, so I left because I had an appointment and resigned to using the preloaded card. I paid at least triple the cost of the €30 monthly pass during my time there.

Later, I was told by an expatriate who lives in Lisbon that the inconvenience is by design to keep tourists and temporary visitors paying more. This effectively subsidizes the cost of transportation for the locals. This is not a new phenomenon. A European urban regional transportation study examining the effects of tourism on public transportation found that tourists play an important role in the economic development of a nation, and urban planners see tourism as an effective way to subsidize public transportation services. This study also found that the tourists' need for intensive mobility, and the fact that they cannot usually take advantage of the discount packages designed for local users, means their additional demand pressure also helps funding, especially during off-peak periods (Albalate and Bel 2010, p.432)." Here I must acknowledge my own likely role in ongoing urban gentrification as the "studentification" of Lisbon has been called out for its gentrifying role in academic texts (Malet Calvo 2018; Sequera and Nofre 2019). I visited Lisbon from one of the wealthiest nations in Europe and both of my visits were generously funded by research grants. Therefore, I had no issue with paying extra for public transportation and the experience did provide a first-hand perspective on urban socio-economic dynamics in Lisbon.

In addition to the above-mentioned participant observation, I kept a journal of daily observations during my time in Portugal. This helped me keep track of thoughts and ideas from the day. It also helped me be better prepared by giving me space to take note of which interview questions worked well and which questions were unproductive or elicited confusion from informants. After fieldwork, the journal refreshed my memory of my time in Lisbon and therefore added value to my data analysis and thesis writing.

4.1.3 Text Analysis

In human geography studies, textual and discourse analysis serves to investigate the "situatedness of knowledge, the contextuality of discourses, and the active role which spatial images play in political life (DeLyser 2010, p.2)." Ahead of fieldwork, I read, broadly, various academic texts and reports related to this case to establish a foundation of key concepts, theories, and appropriate technical knowledge. In addition, I subscribed to news alerts and monitored relevant twitter accounts, such as those of the Portuguese secretary of energy. The topic of research is very current and evolving as I prepared for field work and even now as I write.

Through interviewing a varied sampling of people in Portugal, I amassed a wide range of data. First, I transcribed the audio recordings to text. Then I sorted the text through qualitative coding

using NVivo software. I first created categories based on the general themes that I mentally noted during transcription and the themes from my notes. Once I began coding, these categories naturally evolved, and I added and deleted as needed. The categories I established are "energy justice," "energy communities," "energy/environmental governance," "energy market," "energy poverty," "energy transformation," "Portuguese context," and "solar PV." Some of these categories had sub-categories. For example, under "energy justice," I created "cosmopolitan justice," "distributive justice," "procedural justice," and "justice of recognition." Under energy/environmental governance, I created subcategories titled "self-consumption," "prosumerism," and "territorial considerations." Under "energy market," I created "energy cost structure," "renewable energy investments," "scale-down/disrupt," and "scale-up/economies of scale."

In addition to using NVivo, I manually went through all my interviews and chose the three most interesting or revelatory quotes from each. I put these quotes together in one document to scan for dominant themes that way as well. This also helped me establish additional coding categories for NVivo and gave me a different point of entry to the text.

4.2 Ethics and Access

The main ethical consideration for this study was to the informants. Guillemin and Gillam (2004) provide a helpful guideline to follow that prepares a researcher to not only consider procedural ethics, but also "ethics in practice." Procedural ethics refer to any ethics related formalities that need to be carried out prior to research, such as submitting an application to the Norwegian Center for Research Data (NSD) if needed. Ethics in practice are the everyday ethical issues that can arise while carrying out research and the authors offer guidance on how to respond to difficult and unexpected situations. I considered formalities such as consent, anonymity and confidentiality. Since I would be speaking to experts, researchers, and institutional actors in a professional capacity about non-sensitive topics and the interviews were non-attribution, I determined that filing an application with the NSD was ultimately not necessary. However, I did file an application with them for good measure and created a consent form. Every participant completed a consent form except for two interviews which happened over the phone. Anonymity and confidentiality were unnecessary in most cases as the subject matter is not sensitive to the informants. Several informants, without prompting, said I could use their quotes and full names and titles in my research results. This suggests that, not only are

they not concerned with anonymity, but would, in fact, like to have their names and quotes known.

In the case of a government representative, there were more considerations. Kezar (2003) acknowledges the challenge of engaging with people in power, or who represent powerful institutions, and outlines some strategies for addressing this. A social scientist examining any issue related to power dynamics generally desires to have a transformational interview, one which encourages self-reflection or examining alternate views of reality, but this often proves difficult when talking with those in positions of power. One strategy outlined by Kezar is to approach the interview with careful regard for respect, mutuality, and trust. This is done through transparent reflexivity in which the researcher contemplates their own assumptions and how they affect the research project. Then they share some of these insights, along with a detailed, but succinct, description of the project, with the person interviewed. To establish a meeting with this government representative, it took six months from the time I first contacted him to when we sat down for the appointment. He requested that I send my questions ahead of the meeting so he could prepare. I obliged and sent a questionnaire along with a description of my goals for the interview. At the meeting, he declined to be recorded and brought in a colleague for the interview as it was the institution's policy to not meet with outside sources one-on-one. Although my primary method was semi-structured interviews, this one became much more structured. It became clear that if I asked a follow up question, or something that was not on my list of prepared questions, it sometimes presented a problem for them. I picked up on this early in the meeting and adapted to give assurances to keep rapport up. For example, I stated that I was grateful for his time and willingness and all questions were, of course, optional to answer. Additionally, I acknowledged one of my assumptions about the challenges his office likely faces in energy governance. In retrospect, I see that I made this acknowledgement because I assumed it likely that he saw me as partial towards community, small-scale solar PV projects since my project has an energy justice focus. Therefore, I made a comment sympathetic to the governance challenges that likely exist for him to illustrate my equal curiosity about all scalar approaches to solar energy systems. If he declined to answer a question, I quickly moved on. Also, I made the sections of my thesis used from the interview available in order to comment if he so desired; however, my email did not receive a response.

Another ethical consideration pertains to the balance of perspectives collected. If I divide the informants by scale; those who are involved in small-scale community-level projects and those who are involved in official institutions, it shows there is an informant bias in my research.

Accessibility to representatives of official institutions, such as the regulatory bodies or the energy companies, was difficult to obtain. Difficulty in access to these types of informants is nothing new for social scientists (Kezar 2003). For this reason, I evaluated press releases, institution websites, and public reports to keep the institutional perspective in my research and maintain a balance of perspectives collected.

5 Findings

In this chapter, I will discuss the results of the fieldwork as they relate to my central research question. The chapter is divided into three subsections which outline the findings. Section 5.1 identifies the procedural aspect of energy justice by recognizing solar stakeholders and their level of participation. The section starts by identifying institutional and non-institutional stakeholders, and who is missing from participation in solar PV uptake. Section 5.2 finds that energy justice approaches have a uniquely spatial quality and speaks to changing scalar distribution of benefits and ills and increased distributed generation through two sub-sections. Section 5.3 finds that networks matter for small-scale solar actors and examines the justice aspects of this.

5.1 Solar stakeholders: Who is participating?

In this section, I will establish who the relevant stakeholders are and what their agency is. It is an important tenet of procedural justice to identify the various actors, observe the distribution of benefits and ills across this group, and recognize who is missing from solar PV.

Scale matters for identifying solar actors. Examination of the multi-scalar layers of solar rollout reveals which actors are participating and/or benefitting and which are absent.

5.1.1 Institutions

In Chapter 2, I defined institutions in line with Lund (2016)'s definition. Accordingly, institutional characteristics include a certain claim to rights and governmental duties which, in this case, would be the control over energy resources. Here, I discuss the various institutional solar actors in terms of their motivations, scale of activity or influence, and community perceptions.

Governmental Actors

The most influential institutional actors in this case are the governmental actors such as MATE, the Directorate of Energy and Geology (DGEG), the Regulatory Entity for Energy Services (ERSE), and Lisboa E-Nova. MATE, ERSE, and DGEG operate at the macro-, meso-, and micro-scales of solar energy transition. They handle transnational operations in Portugal, are responsible for laws, regulations, and taxes that apply to national infrastructure, large-scale utility energy production and distribution, and are most recently becoming enablers of small-

scale, decentralized, community energy models. Lisboa E-Nova operates at the micro scale as an arm of the local municipality. Environmental governance dictates how an energy transition happens and the distribution of that resource.

Policymakers in Portugal have many challenges they must consider. In the past year and a half, the government acknowledged energy poverty with increasing frequency. I witnessed this during the Roadmap to Carbon Neutral 2050 meeting on 4 December 2018, held in Lisbon. To clarify, I attended the meeting that was held in Portuguese, and then Researcher 2 who also attended the meeting informed me afterwards that officials said the term 'energy poverty' three different times. Researcher 2 has done extensive research on energy poverty and knows the state of the art quite well. During our 5 December 2018 interview, he was rather excited about the mentions of energy poverty at this important and influential meeting. At the time, he claimed he had never seen this before in his years of research on this subject.

I met with Researcher 2 again 18 June 2020 and he, like many of my informants, acknowledged the challenges that government actors face in addressing energy poverty within energy transitions, especially in the Portuguese context. In both meetings, he argued that housing renovations are the best way to address energy poverty and recognized the lack of participation from economically vulnerable people. "It's difficult in Portugal, and across the world, but [especially] in Portugal to understand how to go for deep renovation schemes, deep deployment of solar…But also how to integrate the poor and the vulnerable. That's even more difficult. I think it's a struggle because in reality in Portugal was not able to develop energy efficiency mechanisms. That's the reality you see. What's happening in comparison to other countries we are not able to engage people, to engage institutions, to go for energy efficiency measures. We have reduction of energy consumption but (it) was really linked to the economic crisis. People were reducing consumption and reality was not really an improvement on energy efficiency."

Policymakers and regulators are currently embracing community energy projects and gradually adapting energy policy to reflect this, according to the DGEG representative that I spoke with. The most recent example of supporting policy is the new collective self-consumption law which establishes a framework allowing individuals, collectives, and energy communities self-consumption of renewable energy (Diario Da Republica Electronico 2020). A representative of DGEG spoke about the sudden surge in solar PV projects looking to be licensed. "We didn't plan this uptick in solar. The prices suddenly dropped, and everyone is rushing to invest in it." In 2012, there was no demand for solar licensing, then 2013 and beyond, there was a "sudden uptick." This requires thoughtful policy response from government agencies like DGEG and

ERSE. The DGEG representative also added that people who do not have money to invest in this solar for self-consumption, will in theory pay more for their energy because of grid upkeep and upgrade costs. A study examining the impact of fixed charges on the viability of self-consumption solar PV found that net-metering schemes with a volumetric retail rate, like the one in Portugal, can enable PV customers to avoid paying their full share of infrastructure costs. This can lead to higher costs for all other consumers (Solano *et al.* 2018). However, the DGEG representative said this will not be an issue because when self-consumption and prosumerism reaches 1% of installed power, these users/producers will have to pay a cost of general economic interest (CIEG) tax, which he assures will adequately fund infrastructure costs without burdening non-solar PV consumers. The perceptions collected from industry professionals and government actors indicate that stability of supply and cost is a big concern. Certainly, this is a component of distributional justice.

Energias de Portugal (EDP)

EDP is participating in and benefiting from solar PV uptake at the macro, meso, and micro scales. I was not able to secure an interview with EDP which is admittedly a disadvantage. However, EDP has a large online and public presence which allowed me to analyze their actions from a distance and include this scalar perspective. At the macro scale, they are a transnational company based in Portugal with a global presence operating in 14 countries and serving 10 million customers. The company has international shareholders with the largest share belonging to a Chinese state-owned company (21.4%). The name of their parent company is EDP Group and under that they have created EDP Renewables (EDPR). EDPR positions themselves as a forward-thinking company with socially and environmentally responsible business policy. They claim to be the world's fourth largest renewable energy producer and the Dow Jones Sustainability Index included the company for the past 13 years (Energias de Portugal 2020). Corporate social responsibility and sustainability certifications has its own academic theme with a good deal of literature to discuss the merits and accountability issues of these themes. This is outside the scope of this paper so the takeaway here is that EDP positions themselves as a world leader in renewable energy, much in the same fashion that Portugal positions themselves as a leader within energy transitions in Europe.

At the meso scale, EDP is the largest producer, distributor, and supplier of energy in Portugal. According to their webpage, they are "the main investor in Portugal and one of the engines of economic national development" (Energias de Portugal 2017). EDP has a controversial history with the Portuguese public. A case study from the Lisboa School of Economics and Management sums this history up well with the title "Portugal's Main Energy Producer that Everyone Loved to Hate" (Silva and Pereira 2019). From 1976 to 2013 EDP went through a massive restructuring by transitioning from a public company to a fully privatized one. To guarantee the success of privatization and future profits, the Portuguese government gave huge subsidies to EDP. These subsidies provoked public scrutiny and a call to downsize such payments. In 2007, the EDP president at the time was under investigation for having led the negotiations that determined the subsidies. Furthermore, EDP received large subsidies to promote renewable energy production, the cost of which passed on to the end-consumers. The case study asks whether EDP should actively campaign for their good name or just let time pass (ibid). Either way, it is clear the issue left a lasting mark on the public. Congruently, this came up in my interviews in the way many informants spoke about the need to disrupt the energy market and have more distributed generation like decentralized solar. At this scale of

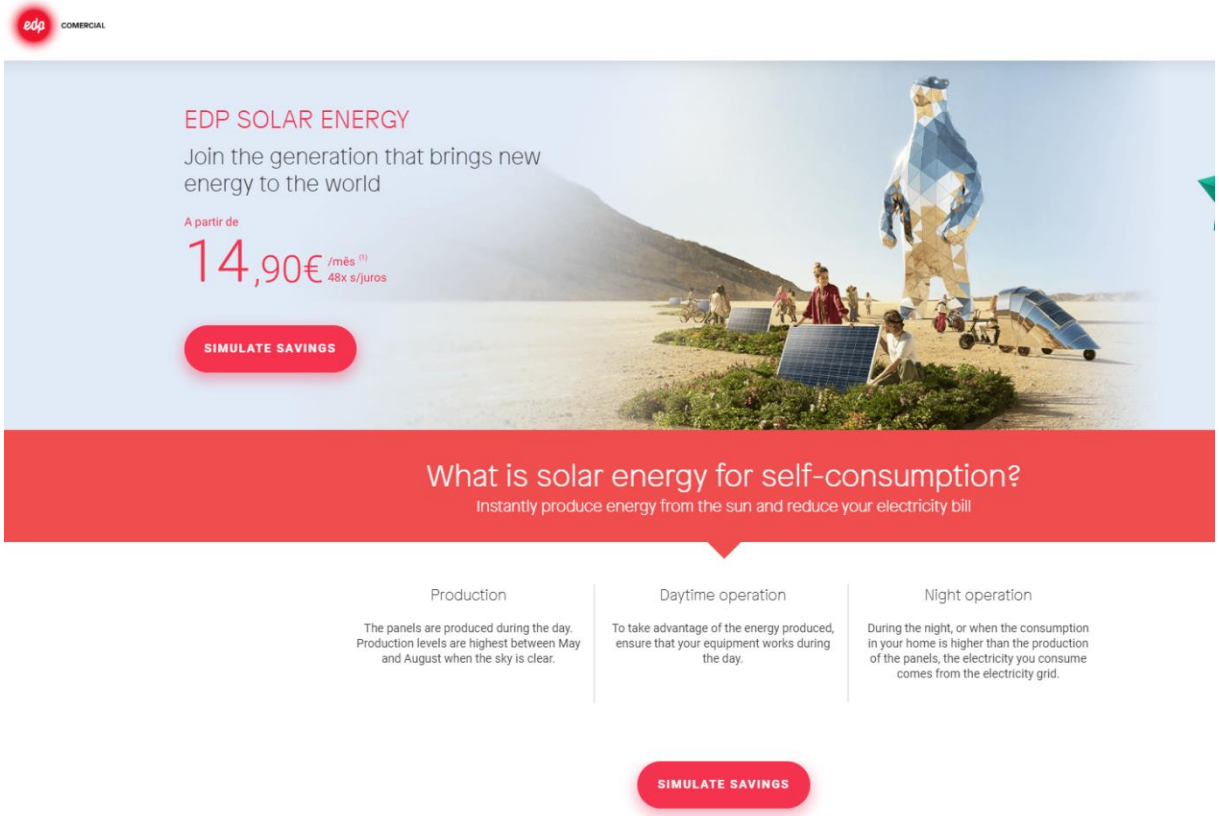

Figure 7: Advetizement from EDP website showing services for solar PV self-consumption (Energias de Portugal 2020). Screengrab 12 March 2020. www.edp.pt/particulares/servicos/energia-solar (English provided by Google Translate.)

production, EDP has the resources to help execute a low-carbon energy transition for better cosmopolitan justice. However, one of the subsidies that EDP received criticism for promoted renewable energy sources, like solar PV. The company profited and passed on this cost to the end user which is a distributional injustice.

On the sub-national, micro-scale level, EDP is offering a program to help people install solar PV panels for individual and collective self-consumption use. This type of energy use is increasing in popularity as seen through the recent push for small-scale solar that changed Portuguese energy policy to allow collective self-consumption. EDP is capitalizing on this by offering a way to acquire panels without many of the usual logistical, financial, and temporal barriers. They offer personalized advice, installation, warranty, interest-free monthly fees, and 100% green energy.

Civil Society

Civil society organizations and institutions are those separate from government and business. These non-governmental organizations and institutions manifest and represent interests and needs of citizens. They are sometimes called the "third sector" and have the power to influence the actions of policymakers and businesses (World Economic Forum 2020).

The National Energy Agency (ADENE) is an association of private law, non-profit, and public utility agencies. They develop actions in energy, efficient use of water and electricity, energy efficient mobility, and other areas of public interest related to the energy transition. They do have some influence on public policy by providing support in the identification and feasibility of energy efficiency measures (ADENE 2020). They also manage certain energy efficiency certifications and, according to their website, are addressing building quality, an important component to increase the viability of solar PV to alleviate energy poverty, through specialized training in the ADENE Academy.

The Portuguese Renewable Energy Association (APREN) is a non-profit association who represents, defends, and coordinates the common interests of its members; renewable energy producers as well as non-producers, that contribute to APREN's purposes through technical, legal, economic, and financial development of electricity production from renewable energy sources (APREN 2020). APREN is an important actor in achieving large-scale, national-level low-carbon energy transitions because they coordinate with the Portuguese government and ministries responsible for energy and the environment to aid in the development of enabling energy policies in Portugal. They also engage with "crucial national stakeholders in the

renewable energy sector" facilitating dialogue between its members to promote deployment of renewable energy sources (ibid).

ADENE did not respond to my requests for interview but I was able to secure an interview with APREN after contact via email, phone, and finally visiting their office in person. It was clear their office is quite busy given Portugal's ambitious goals with renewable energy sources, and I was fortunate that a knowledgeable representative took time to talk with me. He had a broad vision of how the energy transition needed to happen and stated that energy policy requires stability. For example, if developers perceive instability in energy policies, such as not knowing how a new administration will treat the policies of the previous administration, they will be reluctant to invest and develop. When asked about energy poverty, the APREN representative said the most important approach will be enforcing efficiency rules on building construction. He stated that the sector should be stricter on efficiency because "95% of people are cold in the winter. Look at us, we are cold right now!" I certainly cannot confirm the validity of the first part of that statement, but I can confirm that I was indeed cold, sitting indoors in APREN's office with my jacket on the entire interview. My follow up question to this statement asked if APREN's agenda included energy efficiency renovations for existing buildings. He replied no and said they are focused on the energy transition.

The APREN representative went on to say the other important way to address energy poverty is to lower the cost of energy and the entire economy will benefit as a result. He had a scalar approach to achieve this suggesting that Portugal needed to open new interconnections, or infrastructure that allows energy to be traded transnationally, with Africa. "The closest country capital is not Madrid or Rome, it's the capital of Morocco." Portugal has a geographic disadvantage, according to him, of being a periphery country and an interconnection with Morocco would be beneficial for both countries and result in lower costs. This comment hints at a form of location-based distributional injustice that only exists at the macro, trans-national, and trans-continental scale.

APREN is clearly an important stakeholder in enabling the scale of low-carbon energy transition needed to address the climate crisis and for cosmopolitan justice. The APREN representative was well informed about issues of energy deprivation in Portugal and had a scalar approach to this. As will be outlined in the introduction of the following stakeholders, the approach outlined by the APREN representative comes from a social imaginary in contestation with other, community-based imaginaries of possible energy futures.

Coopérnico

Coopérnico is Portugal's first and only renewable energy cooperative and is a solar actor on the meso and micro scales. Their vision is to create an energy model that is socially and environmentally responsible. Their mission is to involve citizens and businesses to create what they call "the new energy paradigm - renewable and decentralized - for the benefit of society and the environment" (Coopérnico 2020). They began operating at the micro scale by gathering environmentally and socially minded investors to fund solar projects on community buildings. These projects work with community centers, such as schools and mental health institutions, by renting their roof-space for solar PV installation, and then selling that energy back to the grid as prosumers. Coopérnico then distributes the profits to the investors, and the institution or collective that own and operate the community center would receive extra income from the rent. At the end of the contract, these community centers keep the equipment.

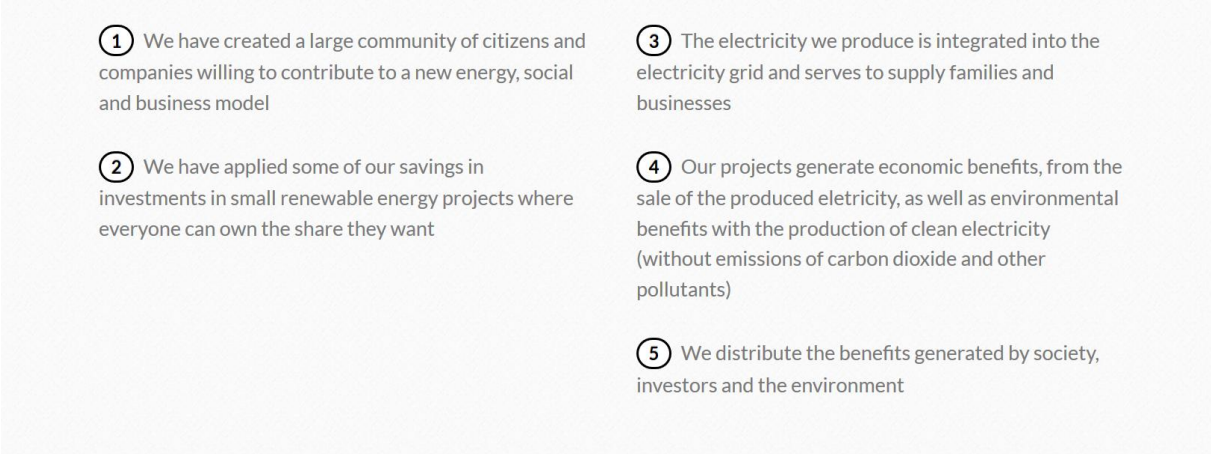

Figure 8: Coopérnico concept from their official website (Coopérnico 2020). Screengrab 12 May 2020. www.coopernico.org

Coopérnico representative 2 spoke about difficulty in working with Portuguese policymakers: "They are afraid of everything that is not centralized and big. We hope the EU will be an important instrument to change their minds." As I stated earlier in this section, the DGEG representative said they are currently embracing community energy and self-consumption approached in renewable energy. This appears to contradict what Coopérnico representative 2 said. This difference in perception may have a temporal cause as the statement from Coopérnico representative 2 was taken 13 December 2018 and the statement from DGEG dates to 26 June 2019 and it is possible the stance from DGEG shifted in that time. Also, both statements likely need additional probing for clarity of context. Regardless, such contestation of energy futures is nothing new (Szolucha 2019) and illustrates the powerful social imaginaries resulting from procedural injustices, real or perceived. Coopérnico is an institution that exists in response to

the way energy has previously been produced and distributed in Portugal. It exists because its founders recognized that low-carbon energy transitions are about more than just decarbonization. They state a vision for "fair and responsible energy models based on renewables" and part of their mission is "the creation of a new energy paradigm" (Coopérnico 2020).

In 2020, Coopérnico because a supplier of energy. They source energy from 100% renewables and the price of their energy is the same or lower than their competitors, according to Coopérnico Representative 1. Coopérnico Member 4 informed me the only reason he is a member of Coopérnico is because they have the best price on energy. This suggests the cooperative has succeeded in providing people with not only a cost-effective source of energy but also providing a choice to have their energy come from 100% renewables without paying more for it. As of 1 April 2020, the cooperative announced that they saved money on the wholesale market and passed on those savings to their consumers (Coopérnico 2020).

GoParity

GoParity is branded as "impact investing" and according to their website, they facilitate investments that are "for good and for everybody" (GoParity 2020). They impose a bottleneck on the projects they fund requiring that it address at least one of the SDGs in addition to being profitable. GoParity projects cover a wide range of sustainable activity but being a Portuguese company, many of the projects are small-scale solar PV installations. As of 3 May 2020, the two featured investments on the "projects" section of their webpage are small-scale solar PV (See Figure 4).

Figure 9: Solar projects available for investing on GoParity's webpage (GoParity 2020). Screengrab 22 April 2020. www.goparity.com/en/projects

Researchers

As members of academia, researchers have legitimacy and academic resources at their disposal. They are often called upon to help policymakers with decisions based on the latest research.

Researchers in the field of energy poverty and solar PV related topics are well-versed in the complexities and possibilities of these phenomena. Furthermore, I see these researchers as valuable connections between large, institutional solar stakeholders and small-scale solar stakeholders.

Researchers interact with the large institutions, such as those introduced above, and the general public. As a result, they hold unique insights into the interaction between institutional and non-institutional stakeholders. For example, Researcher 6 had this to say about EDPs role in small-scale solar: "They [EDP] send to consumers. They send a letter, if you want we can install it. We can do everything. You see, it's a way of giving in this thing, this....a new idea of producing electricity that they know already is going to be approved. So they want to position themselves in a stronger way. And this is clever because if people say yes and I think most part of the people in Portugal [will say yes], as they don't dominate so well the technology, and they are always a little bit afraid of this new technology. But already, they, EDP, they know very well and they know, they will prepare themselves for the change. And they will sell services. As they are doing now with this, you see?" Furthermore, they see the complexity in solutions for energy poverty and are quick to point out when institutions have oversimplified the problem. In response to a question about the energy tariff relief program for energy vulnerable households, Researcher 3 said: "The easiest approach is to always think the best way to tackle energy poverty is to make electricity cheaper."

Researcher 6 has lived in Portugal her whole life and in Lisbon for much of her professional career. Energy, being vital to modern life, is a personal experience for these researchers, as much as a professional one. All interviews with researchers had a personal touch of the Portuguese context so they served both as expert interviews and self-aware, highly educated, citizen interviews. Researcher 6 received this letter from EDP and immediately has a personal and professional reaction to it. She recognized the capitalist play that EDP is making and hypothesizes how the general population will react while simultaneously experiencing her own scepticism. She spoke about contested energy futures with institutions such as EDP where she envisions local, municipal approaches to energy transition, arguing that this increases the communication, participation, and education of the local residents. Referring to large institutions and their relation to municipal scale approaches, she said "they never think about it you know, these technocratic people."

PROSEU is a research institution and is a part of the growing trend of energy communities all over Europe. It is a project funded by the EU and features 11 energy communities across seven

countries. Their aim is to mainstream prosumerism all over Europe. In Portugal, they represent a multi-scalar coalition between the EU, researchers at the University of Lisbon, and an energy community in São Luís. I spoke to a PROSEU researcher at the university. When asked about advantages of different scalar approaches, she stated: "Well, for me this is the way to go, there's no doubt…the nature of renewables, it asks for decentralization in my view. Because, why would you have huge solar parks somewhere where lots of energy is lost in transmission. Where you could have small and efficient in the way of production. Where you are consuming everything that is produced there. So in terms of technology, it should be local. In terms of environmental, also…In general I think small is beautiful." This researcher's role with PROSEU, and her personal views on solar PV modalities, further illustrate the connection that research institutions are creating between differing scalar stakeholders.

5.1.2. Non-institutional actors

Coopérnico Members

Coopérnico members are an example of what Szolucha (2019) refers to as individual practices and collective institutions that arise in a constructive, and sometimes oppositional, response to large-scale, elite-led, centrally controlled energy projects. These are environmentally minded citizens who choose to invest their money in small-scale renewable energy projects even if return on investment might be higher with more traditional investments. I spoke with five Coopérnico members, so this is not a representative sample. However, there were some consistencies across their answers that sheds light on motivations and perspectives of energy cooperative members.

Four out of five of the Coopérnico members resonated with Szolucha's (2019) description of the oppositional response to traditional, large-scale approaches to energy transitions. For example, Coopérnico Member 3 opened our discussion with a quote he attributed to Henry Kissinger, saying "power is built on energy and food" and therefore, "we can't have true democracy without decentralized energy." Coopérnico Member 1 stated that he is a member of Coopérnico because decisions about energy are made by the co-op and not "some big corporation." This member also brought up the high-profile scandal about EDP I outlined in the previous section, saying that the executives there make way too much money. He also taught me the Portuguese colloquialism of labeling these executives as "tacho" which literally translates to "pot." In this context, it refers to a person who has their job because they know people, but they do not do anything useful. In other words, it is about as useful to pay them a

salary as it is to fill a pot with money. Coopérnico Member 2 described the traditional, large-scale energy supplier as a "wolf in sheep's clothing." Coopérnico Member 5 also spoke about the EDP scandal saying "So basically over the last 20 years citizens are paying for that need [to privatize the national energy companies] of the government. They basically increased the revenues of the energy company in order to sell it at a higher price. And this was distributed over the years. So it was not told to people that EDP was going to be sold for 1 billion because people were going to pay higher electricity for 20 years. And that's what is happening now. We are paying the second highest energy in Europe."

Coopérnico members represent aspects of energy democracy because they have a say in where their energy comes from and how this part of the energy transition unfolds. These informants, and their animosity towards EDP and traditional large-scale energy procedures, directly supports Silva and Pereira's (2019) case about "the energy supplier everyone loved to hate." This is a group generally in good socio-economic standing as four out of the five members stated they were willing to pay more for their energy to know it comes from renewable energy sources and they have spare money to invest in solar projects that resonate with their principles. Coopérnico has increased participatory opportunities in energy for consumers but this participation likely does not include poorer individuals. That said, Coopérnico's transition to becoming an energy supplier at a market price indicates at least equal opportunity for anyone who pays an energy bill to have their energy sourced from 100% renewables.

GoParity Members

GoParity members are people who would like to invest in socially and environmentally conscious projects. The projects earn them a profit but is often less profitable than other investments. The representative that I spoke with said that GoParity has a self-imposed bottleneck for their investments. He admits that this loses them profit now but he believes that it will be more profitable in the long run. He said that young people want this kind of investment and, of course, they are the future. The bottleneck imposed today will yield higher returns in the future, according to him.

Members can come from a variety of socio-economic backgrounds since they have a low buy in of 20 euros. GoParity gives members the opportunity to be a part of projects both within the borders of Portugal and abroad.

Cost minded consumers

In my sample, I had one informant who was a Coopérnico member purely because the cost of energy was the best price for his home. He does not invest with Coopérnico because he does not see it as a good investment for his money. Rather, he invests in real estate and has for some years. I took it to be a good sign of Coopérnico's economic success that someone is with them purely because it is the best price. In other words, Coopérnico's model is competitive and does not rely on people who are environmental enthusiasts willing to pay more to know their electricity comes from renewables. Furthermore, it does not require actions or knowledge beyond what consumers are already familiar with. This is important because, as Researcher 2 states, "the inhabitants [consumers] don't know what to do."

5.1.3. Who is missing?

As outlined above, there is a diverse group of institutional and non-institutional stakeholders in the rollout of solar PV. In the last decade, the emergence of collectives like GoParity and Coopérnico have increased participation for interested parties in the low-carbon energy transition through crowd-funded solar PV projects. My findings reveal that although there is a wide array of stakeholders involved in solar PV rollout, those of a lower socio-economic standing were missing. Also, I saw limited involvement of the general population. By this I mean average citizens who are not environmental, renewable energy enthusiasts willing to spend extra money to install solar PV on their homes or invest in crowd-funded solar PV projects.

All informants, except for the representatives from Hyperion and GoParity and four of the Coopérnico members, had awareness of energy poverty and thought it was an important issue that needs attention. Through this analysis of the various solar stakeholders, I see possibility for future participation from energy poor households. For example, the Coopérnico and PROSEU representatives specifically stated ideas and desires of involving energy poor families in future small-scale solar PV projects. Also, EDP's program to bring panels to individuals, without the fiscal and temporal boundaries, and Coopérnico's position as a supplier of 100% renewable energy sources energy at a cost either the same or slightly lower than its competitors offers equal opportunity to participate in the low-carbon energy transition.

Coopérnico and EDP have approaches that potentially engage the general population. Coopérnico's recent transition into becoming an energy supplier has a certain distributive justice to it as they provide energy from 100% renewable energy sources to anyone who pays

an energy bill. Coopérnico Member 4 is a member of the co-op only because they have the best price on energy. He is certainly not a representative sample of the general population (and it might be difficult to achieve such a sample), but he does represent participation in renewable energy sources for motivations other than "saving the environment." When pressed, he does agree that decarbonization of the energy sector needs to happen. However, he is not willing to pay more to know his energy comes from renewable energy sources and he will not invest in Coopérnico projects because the return on investment is low compared to his real-estate investments. By achieving a cost-efficient model of supplying energy, Coopérnico has found a way to entice and include non-environmental enthusiast participants.

A lack of information or knowledge is a barrier to equitable solar uptake or effective energy poverty alleviation policies. Two researchers, who took advantage of the Energy Efficiency Fund (housing renovation) program, stated that the process was quite complicated and even they, with their high level of education including doctoral degrees, had to ask for help from people they knew at the program. In this instance, lack of knowledge, or know-how, is a real barrier for participation in a program that would address energy poverty and increase the viability of solar PV. Knowledge and information, when it is required for participation, should be easily accessible to enable just effects. Several of my informants acknowledged this, which is discussed further in the next section. Moreover, approaches that avoid extra barriers or efforts on the part of the consumers, such as the Coopérnico approach which neatly integrates with the existing supplier/consumer structure, can lessen or remove frictions that may deter participation in solar PV and other renewable energy sources.

5.2. Energy justice approaches have a uniquely spatial quality

The recognition of energy justice is dependent on the scale by which an energy system is produced, distributed, and analyzed.

5.2.1. Changing scalar distribution of energy consumption, taxation, power, infrastructure, and capital

Solar PV actors utilize the modularity of solar to shift the scalar distribution of costs and benefits in energy service. Through the various perspectives collected in this case study, I find that the idea of changing scalar distribution of energy consumption, taxation, power, and capital motivates these solar actors.

Coopérnico is Portugal's first and only energy cooperative and offers a new model to shift the distribution of energy costs and benefits from the traditional meso scale to micro scale through the flexibility of solar PV. Coopérnico Member 5, a leading member both at Coopérnico and GoParity, spoke about longer-standing cooperative models in the Netherlands and Catalonia as examples for Coopérnico, a relatively young cooperative, to follow. These cooperatives have a "virtuous cycle." In this approach, members of the cooperative do not receive monetary distribution. Rather, the benefits disperse as kilowatt hours sidestepping any exchange of money. According to him, the government cannot collect the expensive energy taxes without a monetary exchange. Solutions that avoid bureaucracy were a common thread between several informants, suggesting a sustained wariness of traditional energy institutions and the associated distribution of costs and benefits. As evidence of why energy needs to be separated from traditional, large corporate distribution, Coopérnico Member 5 stated, "Although we have a lot of renewable and hydro power from the fifties…the thing is, it's clear: it [EDP] was a state-owned company, they had to sell it because the state needed to get money. So basically, over the last 20 years, citizens are paying for that need of the government."

A representative of PROSEU spoke about the impressive renewable energy achievements of Portugal. Relative to other European countries, Portugal scores high in terms of renewable energy use, especially in recent years. However, she adds that "this is achieved by large utility companies" and "the people are completely out of this process." In other words, the energy transition thus far is primarily happening at the meso scale and more micro-scale energy systems would increase participation for citizens. PROSEU is a part of the growing trend of energy communities all over Europe. This representative also spoke about shifting the scalar distribution of power in energy systems, saying: "We hopefully want to shift a bit this and start bringing a bit more power to well... empower more local communities as consumers and producers of energy." Indeed, this is a central mission of PROSEU as stated clearly on the website: "PROSEU is applying this inclusive and non-hierarchical approach in its research, by setting up a series of renewable energy Living Labs in nine European countries" (PROSEU 2020). PROSEU is working towards this goal in Portugal through a partnership with Coopérnico in São Luís, an energy community outside of Lisbon. "The cooperative, when they would launch the crowd funding for financing one of these installations, they would open the crowd funding first to those from São Luís, to ensure that local residents would be co-owners of installations." Although this community falls outside the city limits of Lisbon, the new collective consumption law would allow for a similar energy community in Lisbon. By offering

consumers a chance for collective ownership of their own energy, they shift the scalar distribution of power over the fate of their energy supply from the meso scale incumbent corporations to the consumers.

Other informants also spoke about redistribution of power. Researcher 6 had this to say about Portugal's largest energy supplier: "We are living almost in a monopoly. We have EDP and they are very strong." She went on to talk about how plans and strategies to address energy poverty stay at the national (meso) scale and they do not "come into practice." She argued for the importance of bottom-up, "localized" approaches because "when you are working with local municipalities, local power…it's much more easy also to involve stakeholders, to involve people, you know, it's proximity of the people responsible to decide." According to her, it is more productive to work on this micro, municipal scale because people trust the process more when they can get involved.

Redistribution of capital is another theme floated by informants. The flow or stagnation of capital fuels the location, type, and scale of low-carbon energy transitions. Energy as a human right is now a commonly accepted trope and this suggests that energy should not be an engine of profit for large corporations. Coopérnico Member 5 states: "If you can do a system that the objective is not to give profit to big managers to give them big bonuses at the end of the year, but to use those profits to lower the cost of energy for people and for companies, I think that's fair. Because energy, more than a commodity, should be…it's like water, needs to be a right. The right for everyone to have access to energy to produce wealth." GoParity is an investment firm that is essentially putting this idea into practice. Their self-imposed bottleneck limits capital to only projects which advance all the UN SDGs, but the discussion here will focus on their projects related to energy. According to the representative I spoke with, GoParity is changing the flow and distribution of capital: "First of all, we fund NGOs [Non-Governmental Organizations], traditional banks don't fund NGOs because there is not a profit model behind NGOs. If there is not a profit model, they don't have a proper P&L [profit and loss] with profit so the bank...traditional commercial banks don't fund that. We fund that."

GoParity is also changing capital sourcing through, not only crowdsourcing, but also a low entry point to invest in renewables and solar PV. This potentially increases participation at the lower end of the micro scale for a more socio-economically diverse group of citizen investors. Yet as an investment firm with international projects, this micro scale sourced capital has far-reaching impact beyond the borders of Portugal. According to the GoParity representative: "We are giving access to everyone. To [a] community of investors. From 3-7% interest rates.

Investments for everyone. Starting at 20 euros. Think [of] it. We are making [a] social impact just by providing this access as well."

The built environment was an ever-present theme during any discussion of how to alleviate energy poverty in Portugal. The government attempted to address this material deprivation in two different ways. One approach gave tax breaks for efficient housing upgrades. Researcher 6 pointed out the problem with this approach from a distributive justice perspective: "in Portugal, you have the taxes for the houses, the most efficient. The ones [homeowners] that have A and A+. They are the ones who just pay half of the tax...And it's not fair because of course, those are the people who already have the money to have a house A++. So they have to change this…. they are giving the incentives and the privileges to ones who already have money and knowledge to change." The other approach offered financial reimbursement for building renovations that increased the energy efficiency of households. This approach appears to entail a more just approach to distribution of built environment upgrades but the consensus from my informants suggests this program consequently had difficult to clear knowledge and bureaucratic hurdles. I discuss this second approach in the next section along with a call for distributive justice in knowledge.

5.2.2. Increase distributed generation and distributed knowledge

Another repeated theme across several interviews is a call for increased distributed generation and distributed knowledge in low-carbon energy transitions.

Researcher 2 proposed a large-scale, country-wide, decentralized deployment of knowledge in the form of municipal information centers that would assist citizens to renovate their homes, get solar panels, and help with paperwork and other logistics. Hearing this idea, I began to think of this as distributed knowledge or something similar to distributed generation, which is decentralized, on-site energy production performed by a variety of small, grid-connected actors. However, a cursory glance at existing scholarship reveals distributed knowledge is a commonly used term across disciplines. According to Smith (2002, p.19), "a distributed knowledge base is a systemically coherent set of knowledge, maintained across an economically and /or socially integrated set of agents and institutions." Smith conceptualizes knowledge by seeking to map knowledge bases across industries and how it influences the development of those industries. Another approach describes distributed knowledge as information that a group distributes among its member agents (Guzmán *et al.* 2019). For the context of this study, distributed knowledge is easily accessible, enabling, and transparent to all groups, regardless of their

education or socio-economic background. This knowledge is decentralized yet is still connected to a larger knowledge 'grid.' Knowledge distributed as such includes local citizens as "member agents" or member actors regardless of their socio-economic or educational background.

Overly complex knowledge and information can limit transparency and an effective analysis on the impact of an energy policy or energy poverty alleviation measure. For example, the government's actions to address energy poverty, is an energy tariff that targets consumers with an income level below an established poverty line using the state social welfare system. This measure has been successful but fails in other ways. The energy tariff works by taking the family's earnings and dividing it by the number of people and if it is below a certain threshold, the family receives an automatic discount. Researcher 3 has a strong technical background in solar PV deployment at a variety of scales and a keen interest in energy poverty. He evaluated the data from this program to assess the effectiveness of this intervention and said: "it's not very clear, because when you look at the data it's difficult to understand." I list his specific expertise here to illustrate that even with his highly technical understanding of energy systems and data, he found the data from this project difficult to understand.

Researcher 3 went on to say that at best, and to the best of his knowledge given the difficulty of the data, this energy tariff program for energy vulnerable households works as a sort of poverty alleviation, but not energy poverty alleviation. This means that people pay less on their energy bill, but they do not necessarily increase their thermal comfort which is a necessary step for good health. These consumers generally prioritize things like food and medicine above thermal comfort and any monetary savings go to these needs. In other words, a simple reduction in cost will not necessarily address energy poverty. An effective solution needs to focus on ways people can, for example, maintain a healthy level of thermal comfort regardless of their financial means. Another informant, Researcher 2, spoke about more effective distribution of energy efficiency knowledge to address energy poverty. "I think it's [energy poverty alleviation] a struggle because in reality, Portugal was not able to develop energy efficiency mechanisms. That's the reality you see. What's happening in comparison to other countries, we are not able to engage people, to engage institutions, to go for energy efficiency measures. We have reduction of energy consumption but [it] was really linked to the economic crisis. People were reducing consumption and reality was not really an improvement on energy efficiency." A 2019 study documents this phenomenon showing a huge gap between energy consumption and energy demand for healthy standards of thermal comfort (Palma *et al.* 2019).

From here, Researcher 3 discussed how to address energy poverty given this inherent socio-economic context. The normal practice is to give incentives for energy efficiency. The advent of and growing popularity of distributed generation options, such as solar communities, suggests a new paradigm containing a new spatial distribution of energy services. According to him, in an organized collective, people own their own energy to use and the ownership of the consumers gives them awareness and incentives about energy efficiency. As an example, he mentioned Lisboa E-Nova's social housing project that trains people on energy efficiency. In this model, the people live in the same neighborhood community in which they have meetings to discuss energy efficiency practices and behaviors. At this scale, consumers are receiving information and knowledge that allows them to decrease their energy bills and empowers them to request available funding. Researcher 3 then added "I would be very surprised if we could replicate this at larger scales."

Researcher 3 discussed, as an example, a community solar peer-to-peer regulatory scheme in France. Basically, a company set up a model where they would purchase energy from individuals and collectives withing a solar community or set of communities, aggregate it, and sell to those in the same street, for example. This is a distributed generation model, something that is gaining popularity in other Western energy transition contexts. It relies on a system that does not have a monopoly on distribution, something unlike the Portuguese model with its single distribution system operator (DSO). As my informant puts it, "distributed generation means generation...happens in many different places and there is no way of centralizing the generation." The owners of this peer-to-peer system then have the option to keep their energy within their community or sell any unused aggregated energy back to the grid.

As discussed in Chapter 3, around 75% of Portuguese housing stock is in poor condition with no insulation or central HVAC. Policymakers attempted to address this problem with a building renovation measure that earned a reputation as a failure by several of my informants. Although I did not have questions about building quality in my interview guide, the topic came up unprompted in nine interviews which speaks to its importance in discussions of energy justice. Apparently, the assistance program required completion of overly complex paperwork and administration. This became a barrier causing many to not utilize this potentially vital intervention for energy poverty and energy efficiency. In a context like Portugal, equitably distributed knowledge is especially important as illiteracy is a problem among older residents. "Many people in Portugal have a strong rate of illiteracy...you need to do it in a very different way socially speaking…we had many people that are completely illiterate, but they are old

now." With this statement, Researcher 6 illustrates the need for accessible knowledge to a wide range of socio-economic backgrounds because, for example, a significant portion of the older generation is illiterate. This is usually a group more vulnerable to energy poverty as they will often have more pre-existing health complications and require a higher level of heat in winter, for example.

Researcher 7 spoke about the problems with public knowledge: "the public policy instruments in place, they are not tailored for low income persons or families. At all. I am very critical of the programs that are in place because they...the programs in place are very complex to understand to prepare the application. So you should have a high level of literacy to make your application and this is very terrible to do." She went on to talk about her personal experience with this program. Indeed, even as a literate, highly educated academic, Researcher 7 had trouble with her own application to the housing renovation measure. "And I can tell you that even myself I had a couple of questions during the time of the application that I have to ask for clarification, even to me. So imagine a low income family that don't have so much literacy about energy...it's impossible for them to make up the application to get the incentive." She talked about how these housing renovation mechanisms come from "centralized point of view" as they are currently managed and implemented by DGEG in Lisbon. This shrouds the process in so much bureaucracy that many people give up on the process altogether. Even if one succeeds with their application, the waiting period is so long, it presents an additional barrier to this program's ability to help housing quality in an efficient manner.

After many persistent requests and showing up to the office in person, I did finally get an interview with DGEG, the agency that permits solar PV projects. The representative I spoke with stated that they are embracing distributed generation such as self-consumption and energy community projects. As he put it, they, and ERSE, have the responsibility to regulate and permit solar PV projects. When asked about small-scale solar PV projects, he remarked that "We didn't plan this uptick in solar. The prices suddenly dropped, and everyone is rushing to invest in it." He went on to mention how in 2012 there was no demand for solar licensing, then in 2013 there was a sudden uptick. They are "currently embracing self-consumption and energetic communities." To manage the increase in demand for both large solar PV projects and distributed generation, grid improvements need to happen. "DGEG has burden of supporting the grid" and consumers pay for this. With an increase in distributed generation, "people who do not have money to invest in this solar for self-consumption, will in theory pay more." In response, a CIEG tax will apply to all prosumers when self-consumption will reach 1% of

installed power. The DGEG representative also commented on a paradox he noticed about how people want increased renewable energy but do not want to pay for the necessary upgrades to the grid to support this. He said the scheduled solar PV auctions will help with this because a new policy invites investors to invest in the grid. According to this perspective, increased distributed generation and general solar PV activity at the micro scale benefits from large, utility scale solar PV auctions.

5.3 Networks are important for small scale solar actors

The aforementioned distributed generation peer-to-peer model discussed by Researcher 3 relies on the cooperation of a solar community. He also talked about how small-scale solar actors could utilize a third-party institution to give solar communities benefits usually reserved for large, meso-scale operations. A third-party institution could aggregate the excess solar energy from these solar communities allowing them to be competitive in the energy market through their collective strength. This third party might collect and sell all generated kWh which would make the energy model simple for energy communities. This would compensate for any technical barriers that typically hinder the adoption of sola PV for individuals or communities. It would be a simpler, more accessible solar model. In this way, there is no requirement for connection to the national grid, but they still avoid needing expensive batteries or a complicated peer-to-peer system.

The representative of PROSEU also spoke about the potential benefits of a small network of neighbors working together in an energy community setting. In this model, there would be diversity in the socio-economic standing of the neighbors. She explains: “So then if you link this now to energy poverty, or energy justice, it’s interesting because in the last [PROSEU] workshop, there’s one idea. And people are concerned if all families would be included. There was one idea…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. So they are definitely interested in developing a scheme where everyone is included.” The idea is not fully-fledged, but it illustrates how small-scale solar actors envision pathways for energy justice in networks of solar PV users. This representative then spoke about Coopérnico’s plans to become a supplier (she uses the word ‘commercializer’) of energy: “And then Coopérnico wants to become a commercializer. Is also thinking about ways of including people even if they’re not able to install. As a commercializer they have much more flexibility to do this. In Portugal, it’s not difficult to be a producer of small-scale renewables, especially. But it’s

difficult, very difficult to become a commercializer." Coopérnico's mission to become a non-profit supplier will use the advantage of their network of 100% renewable energy producers to distribute clean energy to all at a price that is the same or lower than their traditional, meso-scale competitors.

Gathering informants via snowball sampling reveals another network for small-scale solar actors. The nature of this sampling method is asking for a reference to an informant that they know so it will naturally reveal a known network. The way in which the representative of PROSEU spoke about Coopérnico was a common occurrence in interviews. I began to see how researchers serve as a node between policymakers and small-scale solar actors. For example, when I attended the Roadmap to Carbon Neutral 2050 meeting in Lisbon, researchers who I interviewed, and/or have cited in this thesis, either had a seat onstage next to officials, such as the Portuguese Secretary of Energy and EDP executives, or provided the data and information used in the actual roadmap. These same researchers have a keen interest in energy poverty alleviation strategies and scalar approaches to solar PV deployment. At the same time, they have influence over energy policy as their research is used to make policy decisions. Therefore, they serve as a common point between policymakers and small-scale solar PV.

In the previous section, I discussed my informants' ideas around shifting the scalar distribution of power to municipalities. Two of my informants also discussed the importance of networks to municipalities and their ability to be effective. Researcher 2 articulated this saying: "And municipalities in Portugal. There are two problems. One, most of them are small. So they cannot act alone. That's why all these plans and all this investment on energy efficiency replacement of LEDs [light-emitting diode] on the street lighting, that is done in a bundle. Not small municipalities but by the community we have in Portugal here. The CIMS. Comunidades Intermunicipales or the Intermunicipal Communities. So it's a combination of municipalities by region. So for example, in some regions there is a combination of like 15 municipalities. That's like there is a central office that works with the municipalities, so they go for the programs and plans on energy efficiency together." The collection of these municipalities allows them the territorial independence for effective energy policy implementation, and also allows them to share resources.

5.4 Summary

The following tables summarize the study findings. In the first table, the solar stakeholders are listed along with their scalar participation. The second table states the main findings along with a few clarifying details and two illustrative supporting quotes from informants.

Table 2: Solar Stakeholders, their level of participation in Portugal, and at which scale.

	Scalar participation in solar PV			
	Stakeholders	**Macro-scale participation**	**Meso-scale participation**	**Micro-scale participation**
Institutional	Governmental Actors (DGEG, ERSE, REN, Lisboa E-Nova)	Regulates transnational solar stakeholders within PT, such as the solar auction participants.	Energy policy, renewable energy tariffs.	Lisbon low-income housing project solar community, collective self-consumption law.
	EDP	Transnationally owned and operated. Solar PV in multiple countries.	Portugal's largest energy supplier.	Offering solar panels to individual households.
	Civil Society (APREN, ADENE)	APREN advises interconnection with Morocco trading energy, solar PV.	Important for national transition to RES. Coordinates large-scale public and private interests.	
	Coopérnico		Supplier of 100% RES energy to Portugal.	Crowd owned and funded projects for small-scale, community-oriented projects.
	GoParity	Funds SDG focused projects outside of Portugal which will likely include solar PV.		Crowd funded projects, most of which are small scale and solar PV is a big focus.
	Researchers		Provides actionable knowledge on solar PV rollout to governmental actors.	Growing body of research on municipal- and small-scale solar PV.
Non-institutional	Coopérnico Members			Environmentally focused people with keen interest to invest in community level solar.
	GoParity Members			Environmentally focused people with keen interest to invest in community level solar.

	Average Citizens		Opportunity for inclusion from Coopérnico due to low energy cost. EDP solar panels.	
	Energy Poor		Opportunity for inclusion from Coopérnico due to low energy cost. EDP solar panels.	Limited opportunity for participation via Lisboa E-Nova.

Table 3: Main findings along with clarifying details and selected supporting quotes from the informants of this study.

Finding	Details	Selected Supporting Quotes
Energy justice approaches have a uniquely spatial quality.	Changing scalar distribution of energy consumption, taxation, power, infrastructure, and capital.	"The state needed to get money. So basically, over the last 20 years, citizens are paying for that need of the government." "We hopefully want to (bring) a bit more power to...local communities as consumers and producers of energy."
	Increase distributed generation and distributed knowledge.	"The public policy instruments in place, they are not tailored for low income persons or families. At all." "Distributed generation...happens in many different places and there is no way of centralizing the generation."
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." "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."

6 Discussion

The aim of this chapter is to discuss the findings in relation to the thematic scholarship on the main research questions: What is the potential of solar PV to alleviate energy poverty? What role does scale play in renewable energy transformation and how does it affect energy justice? I address these research questions by reviewing my empirical findings in relation to the theoretical framework of energy justice outlined in chapter two.

6.1 The potential of solar PV to alleviate energy poverty

My findings suggest that the potential of solar PV to alleviate energy poverty relies on increased participation from energy poor households, a more direct and equitable distribution of renewable energy sources benefits, and a minimum standard for the built environment.

6.1.1 Solar PV participation from energy poor households

For solar PV to have potential to alleviate energy poverty, the energy poor must be able to first participate in the rollout of solar PV. Participation is the central tenet behind the procedural justice arm of energy justice because procedures, such as policies or implementation processes, determine who participates and benefits. Röhl and Machura (2018, p.4) write that "at the end of a procedure, one party is the winner, another the loser." As such, identifying solar PV actors within the case study of Lisbon served both as a mode to find potential informants and a way to analyze the procedural justice aspect of solar PV rollout. I found there is a diverse group of stakeholders, institutional and non-institutional, involved in solar PV rollout at different scales. Each type of stakeholder has a social imaginary about what the future of energy ought to look like. Several of these imaginaries adhere to a normative approach which view transition to low-carbon technologies as sufficiently sustainable and prioritize cost reduction as a solution to energy poverty. Cost of energy is an important consideration for energy justice but a narrow focus on cost falls into a production/consumption binary that past studies advise against (Bouzarovski and Petrova 2015; Bouzarovski and Simcock 2017). The energy poor are included as solar PV stakeholders in limited ways. Lisboa E-Nova, a branch of the Lisbon municipal office, facilitates a low-income housing community that includes solar PV and energy efficiency education (Franco 2018). Coopérnico offers consumers an option for 100% renewable energy sources supplied energy to anyone who pays an electricity bill. Other

imaginaries, such as those of Coopérnico and the community energy researchers, put energy poor households in stakeholder positions within future iterations of energy communities.

Solar PV has a wider socio-economic and scalar composition of stakeholders than, for example, fossil fuel energy sources. Large-scale, business-as-usual approaches to energy production, whether fossil fuel or renewable, have historically led to injustices in many cases. The logistics of solar PV give the technology a certain procedural justice not found with previous fossil fuel energy sources because the modularity and affordability allow for wider iterations of ownership and control. In the Lisbon context, new stakeholders have surfaced in the past decade in constructive opposition to the absence or inadequate presence of energy justice in how energy is produced and distributed. Connecting this to wider discussions of energy geographies, I am reminded that "energy democracy" approaches, characterized by large amounts of distributed generation and less capital intensive energy production, are products of the tensions shaping the trajectory of new socio-material assemblages (Calvert 2016). In other words, technological advancements and resource availability do not, alone, explain the evolution of energy systems. In Lisbon, the evolution of energy systems is a product of the tensions created through the 2008 financial crisis and the heavy investment in renewable energy sources and urban renewal that followed. These procedural tensions led to the creation of new stakeholders with limited opportunity for participation from energy poor households.

6.1.2 Equitable distribution of solar PV benefits

My findings indicate a call for a more equitable distribution of not only monetary benefits from RES, including solar PV, but also taxation, capital investment, decision-making, infrastructure, and knowledge. A 2016 study investigated the energy-related inequities across social classes in Portugal and found that the manner in which an energy policy is rolled out matters for energy justice. The authors determined that policies should diffuse horizontally across all social classes at the same time in an inegalitarian society like Portugal (Bartiaux *et al.* 2016). This procedural recommendation would ensure that all social classes participate and experience the equal distribution of benefits.

Two informants, Researcher 2 and Researcher 6, spoke about the problem of expatriates and foreign income in Lisbon unfairly qualifying for the energy tariff relief program even though their income can often be much greater than the average Portuguese salary. The current approach to energy poverty alleviation in Portugal targets low-income households and gives them an automatic discount on energy bills. I discussed the merits and disadvantages of this

policy in Chapter 5 but here, suffice it to say that this form of affirmative action did provide some financial relief to burdened households but most likely served as a form of poverty alleviation, not *energy poverty alleviation*. Researcher 3 implies that energy poverty solutions need to encompass a wider scalar and socio-technical understanding. In addition, the targeting of a specific socio-economic group presents its problems since such targeting can have inaccuracies.

6.1.3 The potential of solar PV relies on the built environment

Housing quality came up often and unprompted as a leading problem in addressing energy poverty. The effectiveness of solar panels diminishes greatly with inefficient housing stock so an inclusion of this theme in this case is relevant. This poor quality of housing stock is a *landscape of material deprivation*, a distributive consequence that makes addressing energy poverty with solar PV challenging due to the built environment's poor interaction with climate effects. It is such a significant issue that I argue the potential of solar PV to alleviate the thermal comfort aspect of energy poverty relies on a minimum standard of building quality. One Portuguese study found that building renovation measures in households at risk of energy poverty have potential to improve energy performance and decrease energy costs whereas energy subsidies for energy poor households do not provide a long term solution as they do not address the root cause of energy poverty (Gouveia *et al.* 2018). The government recognized the building quality problem and started a building renovation measure that allows residents to apply for reimbursement of funds to add energy efficiency enhancing features such as double-glazed windows. This program does not target a specific socio-economic group, which suggests a more procedurally just approach in line with the diffusion recommendations of previous Portuguese studies (Bartiaux *et al.* 2016).

Theoretically, improved building quality would increase the feasibility of solar panels as a promising approach to addressing energy poverty in the context of Portugal. However, my informants revealed the prohibitive complexity of the building renovation program, which has inadvertently made the benefits accessible primarily to those who can acquire extra help and can afford bureaucratic delays for renumeration of building renovation costs. These are well-educated and well-connected people stating they needed to take advantage of their advanced knowledge and administrative connections to complete the paperwork for this building renovation program. Both the procedural and temporal complexities likely present

insurmountable challenges to energy vulnerable households, as confirmed by several informants.

6.2 The role of scale in energy justice

Energy justice is pertinent during energy transitions at different scales in diverse ways. Therefore, scale matters for energy justice. There is a need for multi-scalar approaches to effectively unpack energy justice.

6.2.1 Scale matters for energy justice

As the previous chapters have discussed, community and expert perceptions collected during this study clearly indicate that scale matters for energy justice. The flexibility and affordability of solar, along with the initiatives and projects that have surfaced in Portugal, challenge the traditional model and scale of energy production, ownership, and distribution. When asked why it is important to focus on decentralized forms of energy, a community energy researcher and representative from PROSEU stated "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." This striking claim bears closer examination and, as I argue below, holds true across certain scalar contexts but not necessarily all contexts. Although meso-scale, centralized energy has historically led to energy injustices, it is not clear this is always the case. In other words, energy justice happens in different ways at different scales.

Consider the effects of Portugal's low-carbon energy transition to wind power over the past two decades. Portugal's commitment to decarbonization is substantial as it has decreased its reliance on fossil-fuel power generation "from 64% of total electric power demand in 1994 to 36% in 2014" (Peña *et al.* 2017, p.201). A meso-scale deployment was necessary to accommodate this magnitude of change. This transition was incentivized and fuelled in part by a renewable energy feed-in tariff (FiT) and according to ERSE, these tariffs are always paid by the end user (ERSE 2020). Two studies looking at the effects of FiT for wind power indicate that the large increase in wind power increases the price for end-consumers (Peña *et al.* 2017; Prata *et al.* 2018). Hence this is indeed a case of inequitable distributional effects, a key component of energy injustice. Although this is an example of distributive injustice, it is also an example of cosmopolitan justice because it achieved a large-scale decrease in carbon emissions. This case shows that within the framework of energy justice, it is possible to have both an increase and decrease in

justice effects depending on the scale of recognition. The deployment of meso-scale energy transition recognizes the global need for vast and rapid decarbonization (cosmopolitan justice) but facilitating this through a tariff on end users is recognizable as an injustice (procedural and distributive injustice) at the micro-scale.

Späth and Rohracher (2012) observe that notions of energy regimes characterized by resistance to change suggests these regimes may have too much homogeneity and consistency, putting them in conflict with the unique spatiality of a place. This is not to say that some national and even global level framing of technologies or practices do not have their uses. Rather, these meso-scale framings have their utility for cosmopolitan justice but there needs to be a consideration or allowance of the variation in "regime structures" at the regional/local level (ibid). According to Healy and Barry (2017, p.456), "country-specific strategies must be tailored in order to create coalitions…policy makers in turn need to connect and tailor their policymaking to local contexts, best done by including those communities and citizens in collaborative policymaking." In Lisbon, these types of coalitions are happening in the way that small-scale solar actor networks, such as Coopérnico, GoParity, and solar communities, form to claim their right to energy and exercise their authority over it. In this sense, they collect to become an institution as defined by Lund (2016). Through my interviews, I see the existence of another coalition between these collective institutions, researchers, and policymakers, as discussed in Section 5.3.

Perceptions collected from interviews, as well as a general growing demand for distributed generation (Moss *et al.* 2015; Sturzaker and Nurse 2020) indicate some collective desire for changes to the way that energy markets function. A common thread across the interviews is changes to the scalar distribution of benefits and ills in energy systems are needed for more just outcomes. In an analysis of the distributional costs of Portuguese wind energy under the liberalized Iberian market regime, researchers found that an asymmetric benefit was playing out for ratepayers. The study, conducted by an employee of EDP and two researchers, analyzed the integrated effects of the liberalized market on Portugal and Spain; and found that a rate increase occurred for Portuguese end users and this effect "suggests some kind of welfare transfer that policies should avoid" (Prata *et al.* 2018, p.508). This idea of challenging existing energy market structures is also written on PROSEU's website: "The growth of RE prosumerism all over Europe challenges current energy market structures and institutions" (PROSEU 2020). Here, there is an acknowledgement across several different stakeholders about an inequitable characteristic of the energy market which is an unfair cost burden on the

end user. Coopérnico, GoParity, PROSEU and several of the Coopérnico Members and researchers are promoting or engaging with distributed generation. However, the fact that EDP is now also engaging with distributed generation, through its services to outfit individual homes with solar panels, suggests that scalar changes are already happening to the Portuguese energy market in significant ways.

If energy transitions relegate to one scale, *spaces of misrecognition* can happen. For example, national level energy and the associated distributive injustices identified in Portugal, have resulted in a trending discourse on the merits of small-scale, decentralized, community level energy. This discourse was prominent among the citizen and community focused informants who proffered reasons such as bureaucracy, unfair taxes, and corporate greed as evidence of the ills in centralized, large-scale energy systems. Such systems fail to recognize the spatial and socio-material needs of a place. Projects are surfacing that take advantage of solar flexibility to create new, scalar approaches to energy production and distribution.

However, these small-scale approaches that have great promise rely on some traditional, large-scale characteristics for influence and legitimacy. Coopérnico is an amalgamation of small, community solar energy systems and is in the process of becoming an official energy supplier to increase their market potency. PROSEU draws on eleven renewable energy communities focused on mainstreaming prosumerism in seven different countries and has secured competitive research funds from the European Commission. Its effect on the energy community that partners it in Portugal is empowering a community to realize their goal of a higher level of energy autonomy. This partnership across scales has a characteristic of procedural justice in the way that it gives the community a level of participation, and access to funding, not found in energy transitions at meso scale. In both cases, solar installations that are organized as part of a network to create a larger entity are seen to have greater influence and legitimacy. According to Späth and Rohracher (2012), “local actor networks can mobilize resources specifically accessible to them like organizational capabilities, funding, social capital and institutional adaptation .” Through this increased recognition, these solar actors are increasing salutary justice outcomes through procedural, distributive, and recognition effects.

Scale matters for recognition of injustices. A lens limited to the national boundaries of Portugal will show the effects of a policy on the intended audience. However, if that measure negatively impacts populations residing outside the borders of Portugal, it becomes misrepresentation. For example, EDP is offering a solar panel program that might be one of the best examples of a horizontal rollout of solar PV currently in Portugal. The program removes the technical,

logistical, temporal, and monetary boundaries that typically accompany solar uptake at the individual level. A corporation of the size and scale of EDP can offer financing, insurance, and technical support that an individual would normally have to figure out for themselves. However, there are real justice issues with the supply chain for solar panels (Barnes 2017) and it is unclear where the EDP solar panels come from or which standards they may be held to. Coopérnico, on the other hand, employs a rigorous certification process to ensure the complete lifecycle of the panels used in their projects is sustainable and humane. Looking at this scenario at the macro scale, Coopérnico's approach has cosmopolitan and recognition justice through the extra step they take to acknowledge and ensure that, for example, materials do not come from conflict zones. Yet, at the micro scale, EDPs approach shows procedural justice by making small-scale solar available without typical adoption barriers.

My findings indicate that actors differ at each scale in a socio-spatial pattern, therefore scale matters for procedural justice. The scale at which a solar PV rollout happens has different justice effects.

6.2.2 Energy justice needs multi-scalar approaches

The climate crisis necessitates that energy transformation needs to happen on a large, global scale, a tenet of cosmopolitan justice. Yet the case in Lisbon suggests that a small-scale approach to energy may be better for certain aspects of procedural, distributive, and recognition justice. This proposes that an interdependence between scalar approaches is important for sustainable low-carbon energy transformation. In other words, a just energy policy measure needs to secure even solar rollout to a context-appropriate plurality of scales, as well as the various class and income groups, at the same time for energy justice. In the case of Portugal, a holistic approach to energy transitions might include energy policy that recognizes a multiplicity of scales and acts accordingly. Späth and Rohracher (2012) argue that multi-level governance that integrates and implements socio-technical configurations that differ from traditional, dominant regimes may be advantageous for the long-term success of an energy transition.

My findings show that the modularity of solar PV has shifted some of the power of decision making, production, and distribution to small- and medium-scale individuals and collectives. Through collectives that exercise a claim to right over their energy, energy consumers have gained institutional and state effects. This widens the narrow points of control previously limited within the carbon-only democracy (Mitchell 2009) creating new openings for energy

justice. My findings indicate that some energy collectives, formed in constructive opposition to previous energy injustices, are not only environmentally focused but also socially aware of the energy inequities in their society and wish to integrate approaches that include the energy poor. In this way, they are exercising an additional state effect by attempting to empower a vulnerable socio-economic group with increased rights and access to energy. However, these approaches, at this point, are still conjecture and appear to be a spot treatment rather than a holistic solution. The fact that energy poverty has not been effectively addressed through either micro- or meso-scale solutions suggests that a new scalar approach is needed. One approach, suggested by Researcher 2 and Researcher 6, posits that national governance equips municipalities and tasks them with a horizontal diffusion of energy policy to their constituents thereby allowing for location-specific distribution and greater efficacy. Since the spatiality of municipalities is generally an even coverage over a landscape, it stands to reason, as Researcher 2 does, that giving them more responsibility for the rollout of energy policy may be advantageous for spatial and energy justice. Hiteva and Sovacool (2017) conducted four case studies, across four different scales, investigating how principles of energy justice could be applied to business model frameworks. The authors draw a conclusion supporting the above-mentioned municipal approach: "local authorities and councils should be incentivized and receive support in creating municipal energy companies and/or partnerships, which make use of local energy sources…and improve the efficiency of existing infrastructures" (Hiteva and Sovacool 2017, p.638).

Furthermore, my findings also indicate the essential role that national governments and large institutions play in facilitating substantial decarbonization of energy systems for cosmopolitan justice. An economy built on carbon requires decarbonization efforts of massive proportions on the scale of previous carbon empires. This is critical to have a chance of avoiding the worst effects of cataclysmic climate change and bolster the right of all people to have a healthy world to live in. Additionally, governments need large-scale applications of low-carbon energy transition for a horizontal, and therefore just, diffusion of new energy policies to all members of society across all social classes at the same time. However, it has been argued that the current governance response to climate change is not on the same scale as the climate crisis (Sareen 2019). Although diffusion measures are often the result of government intervention, it does not mean this is always the case (Coutard *et al.* 2005). Furthermore, these large-scale approaches are missing certain democratic effects through issues of misrecognition and misrepresentation which are easier to recognize through more localized perspectives on energy.

Hence my analysis then circles back to merit the capabilities of small-scale applications of energy. My findings show how citizens are taking decisive steps to compensate for perceived shortcomings of energy governance. This quote reflects on the efficacy of people who organize to work for more just and effective energy transitions: “While it is understandable to reject politics, the idea that democratically organized citizens and movements cannot reform, transform and engender societal and energy transitions is to leave oneself exposed to the false lure of the “pragmatic” and the “realistic”— by which we mean to settle for piecemeal and often token gestures in the hope that such small “win–wins” will lead to greater changes” (Healy and Barry 2017, p.456). In Lisbon, people are organizing to create a new sense of what is pragmatic and realistic in low-carbon energy transitions.

Energy geographies research shows that engaging renewable energy actors across scales can be part of a deliberate strategy to pursue interests in energy systems (Calvert 2016). Take, for example, the first solar PV auction that occurred in Portugal in 2018. The auction sold 1.34 GW of new solar development and resulted in a world record low bid (Bellini 2019). However, none of the winners of the auction were from Portugal (ibid). To achieve a large-scale, low-cost, cosmopolitan level of solar PV deployment, the Portuguese authorities opened the auction to domestic and international bidders. Lowering the cost and increasing the uptake of solar PV is important for cosmopolitan justice and greater notions of globalism. A narrow-focused, localist perspective of this auction would miss the huge progression for solar PV viability and greater decarbonization of energy systems that the auction results represent. The disadvantages of localism are known (Späth and Rohracher 2014; Sturzaker and Nurse 2020) and some authors caution against its dangers (Stokke and Mohan 2001). Stokke and Mohan point out how favoring a localist approach can be used for different purposes by various ideological stakeholders, including undermining the role of state or transnational authority. This could potentially be disadvantageous for the critical role energy governance needs to play for an effective and just low-carbon transition. Likewise, a sole focus on large-scale, transnational auctions can result in various spatial injustices since it is typically unable to accommodate local context. A potential strategy to address these shortcomings is to align multi-level energy governance along the specific spatial configurations of a place (Späth and Rohracher 2012) to produce a more effective energy transition. This strategy supports large-scale concerns (cosmopolitan justice) as well as local spatiality concerns (procedural, recognition, and distributive justice) to individual households regardless of socio-economic background.

6.3 Case study reflexivity

Structured, unstructured, and semi-structured interviews can be placed on a continuum (Clifford 2010) so that each semi-structured interview can sway more towards structured or unstructured styles. Except for a couple of interviews with government officials, every interview began to travel that continuum towards an unstructured interview. Often, the interviewees would begin talking from the first question and would not need much prompting from me. In several instances, once I described my research project, the interviewee would begin talking without any question or prompt.

The informant selection is heavy on people working in or investing in community focused and small-scale projects and initiatives. To an extent, this skew is appropriate and telling. These informants are community focused people who were eager and willing to help with my project. With larger institutions, or governmental institutions, it took some time to get a response from anyone, if at all. It could also be said that those working in government or with more official responsibilities, were overloaded with work. In other words, it may be unfair to say they are unequivocally unavailable when one does not know the working conditions of these officials, experts, and executives, and whether their conditions are more intense than those applicable of actors in other institutions. Regardless, there are significant challenges in studying elite groups which are well-known difficulties recognized in academic circles (Kezar 2003). As a student and early career social scientist, my difficulty in reaching these large and established institutions is representative of the socio-economic dynamics I wish to study; a research approach known as ‘studying up’ (Aguiar and Schneider 2016).

Furthermore, my informants had much to say about governmental and large institutional solar stakeholders. I acknowledge here that, not only was I unable to secure a more representative informant sample, I received extensive commentary on governmental and institutional stakeholders from my other informants over time. I further acknowledge that this may unconsciously influence how I represent various stakeholders and it is possible I would portray them in a different light if I had the opportunity to gain their perspective.

7 Conclusion

I began this study through an inquiry into the possibility of solar PV to alleviate energy poverty. From there, I developed a more probing secondary research question to investigate the role of scale in energy justice. Through the procedural and distributive branches of energy justice theory, I found that solar PV needs to have more participation from energy poor households and the benefits of solar PV need to be distributed more equitably. More importantly, the effectiveness of solar PV to alleviate energy poverty is most likely dependent on a minimum standard of building quality. My findings also indicated that energy justice happens at different scales in diverse ways. This suggests that multi-scalar approaches to energy transitions hold potential to result in more just outcomes.

Twentieth century democracy was both created and limited by fossil fuels (Mitchell 2009). In the twenty first century, we are still figuring how renewable energy shapes democracy and what new limits and injustices it creates. Is it the same democracy with the same limits and injustices as the carbon democracy, albeit with different socio-spatial configuration? Are these democratic maladies unavoidable in the renewable energy democracy? The Lisbon case shows us how a particular approach to low-carbon energy transitions can affect various justice outcomes. It shows us how an action or policy can be both just and unjust at the same time and that a complete view of energy transitions needs to include a multi-scalar perspective. It also gives us a glimpse of how an energy transition can be more democratic by showing us how certain approaches 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? Is it more democratic or does the established carbon democracy overpower any potential changes? The Lisbon case shows us that solar PV has many more "points of passage" than fossil fuels making limited central control less automatic. We see the creation of new, 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 exercise this authority.

The renewable energy democracy happens at different scales in different ways. My Lisbon case study shows us how citizens are taking decisive steps to compensate for perceived shortcomings of energy governance. This is a spatially variated response, in which large-scale responses are unable, or unwilling, to holistically accommodate local contextual aspects. This results in 'islands' of increased democratic and sustainable energy effects. In other words, the Lisbon case shows us that without targeted policy, landscapes of material deprivation persist even when cheap and clean energy exists. This is evidenced by the continued presence of energy poverty. Responses that include small-scale solar are creating new landscapes characterized by various justice aspects, such as solar PV and consumer participation.

This case study is exciting and rich in variation because between from the autumn of 2018, when I began this case, to now, Portugal's energy transition and energy regulation have evolved remarkably. Furthermore, Lisbon is a city teeming with renewable energy and sustainability progress, yet it continues to be marked by deep inequalities. My intention was to capture this timely case at a pertinent moment of socio-techno-material shift. This environment generated interesting phenomena to examine such as Coopérnico and record-breaking solar auctions. In this dynamic, and fast-evolving environment, multiple, fascinating research paths emerged but I ultimately decided to limit my examination to themes of energy justice and scale. My study was limited and guided by the informants I was able to secure and the events that unfolded while I was in Lisbon. For example, my study is strongly characterized by the Roadmap to Carbon Neutral 2050 event, Coopérnico's timely transition to becoming a supplier, and the rollout of the collective self-consumption law. Without more participation in my study from large-scale stakeholders, like EDP, it did not make sense to go in depth to the role of the supplier.

Further investigation on these themes could take a few different paths. First, scalar notions of energy justice would benefit from a study that includes more voices from large institutions and governmental agencies. As I have previously pointed out, the interviews in this study are highly concentrated on small-scale solar stakeholders. Without more participation in my study from large-scale stakeholders, like EDP, it did not make sense to closely examine, for example, the role of the supplier in my own study. However, a more in-depth look at this role in solar PV rollout and issues of energy justice would be highly informative for better socio-technical understanding of energy transitions. With further resources and time, I would have been more persistent in my attempts to secure interviews with these valuable stakeholders. Second, scalar research would benefit from more examination of the interaction of multiple scales within the

same case study. In the literature, I see scalar studies on energy justice which utilize a different case for each scale but less studies that incorporate multiple scales in a single case. Third, the Lisbon case highlighted a few instances of practical approaches to energy justice that were spatially limited, such as the Lisboa E-Nova affordable housing renewable energy project. Further research should explore the impact these innovative projects have on energy poor households and how such an approach could be scaled to elicit a more broad-reaching solution.

Next, additional research should examine how energy justice can be better integrated into mainstream activities and policy. Energy justice can be abstract in some literature (Jenkins *et al.* 2017) and "needs to be taken out of the abstract and placed into the realm of the practical" (Hiteva and Sovacool 2017, p.638). Furthermore, building quality is a significant barrier to energy poverty alleviation and solar PV viability for households. Energy poverty research would benefit from additional study on how to better address the problem of building quality in Portugal. Finally, the Lisbon case is an ongoing process with uncertain outcomes. For example, in the final week of writing this thesis, LG Electronics enters the Portuguese solar PV market claiming to be "the only fully integrated energy solution in the world" (Jornal Económico 2020). They offer to incorporate solar panels with other home solutions, such as air-water heat pumps. This new stakeholder will clearly have an impact on solar PV in Lisbon. Large solar stakeholders have the ability to expedite options for consumers that remove technical and maintenance barriers often associated with solar PV. It is probable more actors like these will enter the solar PV market with unknown impacts on small-scale actors and energy justice. Therefore, further research could investigate how this case continues to unfold. A statement by Researcher 3 perfectly encapsulates the complexity and rapidly changing nature of energy poverty within energy transitions while acknowledging the need for more information: "And uh, if we had this conversation in 6 months' time, I would probably say a few different things."

Like the *Energiewende* in Germany (Moss *et al.* 2015), aspects of energy transition in Lisbon are contested. These contestations, and the potential of solar PV, have produced a diverse range of stakeholders with varied socio-technical imaginaries about what possible energy futures will look like. Who gets to realize those futures, and how, is an ongoing energy justice challenge in which scale plays a central role - in communities, in Lisbon, in Portugal, and globally.

Appendix A: Institution Interview Guide

Fieldwork Interview Guide for Institutional Stakeholders (as envisioned for organizations such as Coopérnico and Hyperion)

1. Which solar projects are you currently working on?
2. Which project are you most excited about?
    a. Can you tell me more about that project?
    b. Why are you excited about this one?
3. What determines the size and scale of a project?
    a. Why do you operate at that particular scale?
    b. What are the advantages of that scale/size? What are the disadvantages?
    c. Why is this scale of operation better than another that is smaller/bigger?
    d. Is this the ideal scale of operation for this project? Why or why not?
4. How do you choose the location of your project? What factors determine this?
    a. Can you give me an example?
    b. What are the advantages of this location?
    c. What are the disadvantages?
5. How does the physical landscape of a place impact your project?
6. What are the social considerations, if any, when choosing a location for a project?
7. What risks must you consider when determining the size and location of a project?
    a. How do you address these risks?
8. How does the consumer base influence your project, if at all?
9. Which policies are most conducive to your work?
10. Which policies are most counterproductive to your work?
11. What is the primary motivation behind a solar project? Is there one in particular you could speak about?
12. How does the size and scale of a solar installation affect consumers?
13. What institutions do you work with on these projects? Why?

Appendix B: Non-Institution Interview Guide

Fieldwork Interview Guide for Non-Institutional Stakeholders

1. Are you an investor with Coopérnico? Why or why not?
    a. If yes, do you feel that it is a good investment? Why do you invest here over other investments?
    b. If no, what would motivate you to become an investor?
2. How did you find out about Coopérnico?
    a. How did they market to you?
3. What motivated you to join Coopérnico as a member?
4. How involved are you with Coopérnico?
5. How do you find energy prices to be in Portugal?
6. Do you ever sacrifice comfort in order to save on your energy bill?
7. If the legal framework allows it, are you interested in having your residence or place of work become a renewable energy self-consumption and prosumer site? Why or why not?
8. Do you understand Coopérnico's business model? What do you like about it? What improvements, if any, would you like to see?
9. In general, would you be willing to pay more for your energy needs if that energy comes from renewable energy sources?
10. Do you think it is important to disrupt the current energy market? Why or why not?
11. How do you choose where to invest your time/money?

Appendix C: List of Figures

Appendix D: List of Tables

Appendix E: Abbreviations and acronyms

ADENE: National Energy Agency
APREN: Portuguese Renewable Energy Association
CIEG: Cost of General Economic interest
CIMS: Comunidades Intermunicipales (Intermunicipal Communities)
DGEG: Directorate of Energy and Geology
DSO: Distribution System Operator
EDP: Energias De Portugal
EDPR: Energias De Portugal Renewables
EPOV: European Energy Poverty Observatory
ERSE: Regulatory Entity for Energy Services
EU: European Union
FiT: Feed-In Tariff
GW: Gigawatt
HVAC: Heating, ventilation, and air conditioning
IEA: International Energy Agency
IRENA: International Renewable Energy Agency
IMF: International Monetary Fund
IPCC: Intergovernmental Panel for Climate Change
KW: Kilowatt
LED: light-emitting diode
MATE: The Ministry for Environment and Energy Transition
NGO: Non-Governmental Organization
NSD: Norwegian Center for Research Data
OECD: Organisation for Economic Co-operation and Development
P&L: Profit and Loss
PPA: Power Purchase Agreement
PT: Portugal
PV: Photovoltaics
REN: National Energy Network
RES: Renewable Energy Source(s)
SDG: Sustainable Development Goals
UN: United Nations

References

ADENE (2020) *Agência para Energia*, available: https://www.adene.pt/ [accessed 14 May 2020].

Aguiar, L.L.M. and Schneider, C.J. (2016) *Researching amongst elites : challenges and opportunities in studying up*, Routledge, available.

Aklin, M. (2018) *Escaping the Energy Poverty Trap: When and How Governments Power the Lives of the Poor*, Cambridge: MIT Press.

Albalate, D. and Bel, G. (2010) 'Tourism and urban public transport: Holding demand pressure under supply constraints', *Tourism Management*, 31(3), 425-433, available: http://dx.doi.org/10.1016/j.tourman.2009.04.011.

APREN (2020) *Portuguese Renewable Energy Association (APREN)*, available: https://www.apren.pt/ [accessed 12 May].

Barnes, L.L. (2017) *Environmental Impact of Solar Panel Manufacturing and End-of-Life Management: Technology and Policy Options*, Champaign, IL: Illinois Sustainable Technology Center, available: http://hdl.handle.net/2142/98910 [accessed 17 May 2020].

Bartiaux, F., Schmidt, L., Horta, A. and Correia, A. (2016) 'Social diffusion of energy-related practices and representations: Patterns and policies in Portugal and Belgium', *Energy Policy*, 88, 413-421, available: http://dx.doi.org/10.1016/j.enpol.2015.10.046.

Behrens, P., Rodrigues, J.F.D., Brás, T. and Silva, C. (2016) 'Environmental, economic, and social impacts of feed-in tariffs: A Portuguese perspective 2000–2010', *Applied Energy*, 173(C), 309-319, available: http://dx.doi.org/10.1016/j.apenergy.2016.04.044.

Bellini, E. (2018a) 'Portugal aims for 100% renewables by 2050', *PV Magazine*, available: https://www.pv-magazine.com/2018/12/05/portugal-aims-for-100-renewables-by-2050/ [accessed 13 December 2019].

Bellini, E. (2018b) 'Portugal: 'Unsubsidized' approved large-scale PV projects top 756 MW, first private solar PPA signed', *PV Magazine*, available: https://www.pv-magazine.com/2018/01/12/portugal-unsubsidized-approved-large-scale-pv-projects-top-756-mw-first-solar-private-ppa-signed/ [accessed 25 November 2018].

Bellini, E. (2018c) 'Portugal: Renewables are driving down electricity prices', *PV Magazine*, 12 April 2018 available: https://www.pv-magazine.com/2018/04/12/portugal-renewables-are-driving-down-electricity-prices/ [accessed 28 November 2018].

Bellini, E. (2019) 'Winners, projects, prices of Portugal's record PV auction', *PV Magazine*, 9 August 2019, available: https://www.pv-magazine.com/2019/08/09/winners-projects-prices-of-portugals-record-pv-auction/ [accessed 13 January 2020].

Bellini, E. (2020) 'Covid-19 and dependence on China's PV supply chain', *PV Magazine*, available: https://www.pv-magazine.com/2020/03/30/covid-19-and-dependence-on-chinas-pv-supply-chain/ [accessed 20 May 2020].

Boardman, B. (1991) *Fuel poverty: From cold homes to affordable warmth*, London: Belhaven Press.

Bonham, J. and Bacchi, C. (2017) 'Cycling 'subjects' in ongoing-formation: The politics of interviews and interview analysis', *Journal of Sociology*, 53(3), 687-703, available: http://dx.doi.org/10.1177/1440783317715805.

Bouzarovski, S. (2018) *Energy Poverty*, Palgrave Macmillan.

Bouzarovski, S. and Haarstad, H. (2018) 'Rescaling low-carbon transformations: Towards a relational ontology', *Trans Inst Br Geogr.*, 00:1–14.

Bouzarovski, S. and Herrero, S.T. (2017) 'The energy divide: Integrating energy transitions, regional inequalities and poverty trends in the European Union', *European Urban and Regional Studies*, 24(1), 69-86, available: http://dx.doi.org/10.1177/0969776415596449.

Bouzarovski, S. and Petrova, S. (2015) 'A global perspective on domestic energy deprivation: Overcoming the energy poverty–fuel poverty binary', *Energy Research & Social Science*, 10, 31-40, available: http://dx.doi.org/10.1016/j.erss.2015.06.007.

Bouzarovski, S. and Simcock, N. (2017) 'Spatializing energy justice', *Energy Policy*, 107, 640-648, available: http://dx.doi.org/10.1016/j.enpol.2017.03.064.

Bridge, G., Bouzarovski, S., Bradshaw, M. and Eyre, N. (2013) 'Geographies of energy transition: Space, place and the low-carbon economy', *Energy Policy*, 53(C), 331-340, available: http://dx.doi.org/10.1016/j.enpol.2012.10.066.
Brito, M.C., Redweik, P., Catita, C., Freitas, S. and Santos, M. (2019) '3D Solar Potential in the Urban Environment: A Case Study in Lisbon', *Energies*, 12(18), 3457, available: http://dx.doi.org/10.3390/en12183457.
Calvert, K. (2016) 'From 'energy geography' to 'energy geographies': Perspectives on a fertile academic borderland', *Progress in Human Geography*, 40(1), 105-125, available: http://dx.doi.org/10.1177/0309132514566343.
Campos, I., Guerra, J., Gomes, J.F., Schmidt, L., Alves, F., Vizinho, A. and Lopes, G.P. (2017) 'Understanding climate change policy and action in Portuguese municipalities: A survey', *Land Use Policy*, 62(C), 68-78, available: http://dx.doi.org/10.1016/j.landusepol.2016.12.015.
Campos, I.S., Alves, F.M., Dinis, J., Truninger, M., Vizinho, A. and Penha-Lopes, G. (2016) 'Climate adaptation, transitions, and socially innovative action-research approaches', *Ecology and Society*, 21(1), 13, available: http://dx.doi.org/10.5751/ES-08059-210113.
Cigainero, J. (2018) 'Who Are France's Yellow Vest Protesters, And What Do They Want?', *NPR*, 3 December 2020, available: https://www.npr.org/2018/12/03/672862353/who-are-frances-yellow-vest-protesters-and-what-do-they-want [accessed 7 May 2020].
Clifford, N.F., Shaun; Valentine, Gill (2010) *Key Methods in Geography*, Second ed., London: Sage Publications Ltd.
Coopérnico (2020) *Coopérnico*, available: https://www.coopernico.org/en [accessed 10 April].
Couper, P. (2015) *A student's introduction to geographical thought : theories, philosophies, methodologies*, Los Angeles, Calif: Sage.
Coutard, O., Hanley, R.E. and Zimmerman, R. (2005) *Sustaining urban networks : the social diffusion of large technical systems*, Routledge, available.
Cresswell, T. (2013) *Geographic thought : a critical introduction*, Oxford: Wiley-Blackwell.
Cumbers, A. (2012) *Reclaiming public ownership : making space for economic democracy*, Zed Books, available.
Delicado, A., Figueiredo, E. and Silva, L. (2016) 'Community perceptions of renewable energies in Portugal: Impacts on environment, landscape and local development', *Energy Research & Social Science*, 13, 84-93, available: http://dx.doi.org/10.1016/j.erss.2015.12.007.
DeLyser, D. (2010) *The SAGE handbook of qualitative geography.* , SAGE, available.
Diario Da Republica Electronico (2020) 'Decree Law No. 162/2019', 162/2019, 45 - 62.
Energias de Portugal (2017) *EDP in Portugal*, available: https://portugal.edp.com/en/edp-portugal [accessed 24 April].
Energias de Portugal (2020) *EDP Renewables*, available: https://www.edpr.com/en [accessed 24 April].
ERSE (2020) *Tariffs and prices - electricity*, available: https://www.erse.pt/en/activities/market-regulation/tariffs-and-prices-electricity/ [accessed 10 February 2020].
European Commission (2015) *Study on tariff design for distribution systems. Final report.*: European Commission, available: https://ec.europa.eu/energy/sites/ener/files/documents/20150313%20Tariff%20report%20fina _revREF-E.PDF [accessed 13 January 2020].
European Commission (2019) 'Regulation on the governance of the energy union and climate action ', (EU)2018/1999.
European Energy Poverty Observatory (2018) *Indicators & Data*, available: https://www.energypoverty.eu/indicators-data [accessed
European Union (2012) *Human Rights and Democracy: EU Strategic Framework and EU Action Plan*, Brussels: European Union, available: http://data.consilium.europa.eu/doc/document/ST-11855-2012-INIT/en/pdf [accessed 25 November 2018].
Falk, J., Owen Gaffney, Avit K. Bhowmik,, Carina Borgström-Hansson, C., Pountney, D.L., Erik Pihl, Jens Malmodin,, Jennifer Lenhart, K.J., Mattias Höjer,, Pernilla Bergmark, S.S., Sofia Widforss, and Stefan Henningsson, S.P., Tomer Shalit. (2018) *Exponential Climate Action Roadmap*, Sweden: Future Earth.
Fraas, L.M. (2014) *Low-Cost Solar Electric Power*, 1st ed. 2014. ed., Springer.

Franco, R.N.B. (2018) *Boavista Eco-District: An Integrated Model of Sustainable Innovation*, Lisbon: European Commission, available: https://ec.europa.eu/futurium/en/system/files/ged/2018.04.18_lisbon_new_social_housing_en_mar2018.pdf [accessed 20 May 2020].
Fraser, N. (2009) *Scales of Justice: Reimagining Political Space in a Globalizing World*, New York: Columbia University Press.
Gerring, J. (2007) *Case Study Research: Principles and Practices*, Cambridge: Cambridge University Press.
Gobo, G. (2011) *Qualitative Research Practice; Sampling, Representativeness and Generalizability*, London: Sage Publications Ltd.
GoParity (2020) *GoParity Impact Investing*, available: https://goparity.com/en [accessed 22 April 2020].
Gouveia, J.P., Palma, P., Seixas, J. and Simoes, S. (2017) 'Mapping Residential Thermal Comfort Gap at Very High Resolution Spatial Scale: Implications for Energy Policy Design', *IAEE Energy Forum*, (Singapore Issue 2017), 43-45.
Gouveia, J.P., Seixas, J. and Long, G. (2018) 'Mining households' energy data to disclose fuel poverty: Lessons for Southern Europe', *Journal of Cleaner Production*, 178, 534-550, available: http://dx.doi.org/10.1016/j.jclepro.2018.01.021.
Graham, H. (2007) *Unequal lives : health and socio-economic inequalities*, Maidenhead: Open University Press.
Guillemin, M. and Gillam, L. (2004) 'Ethics, Reflexivity, and "Ethically Important Moments" in Research', *Qualitative Inquiry*, 10(2), 261-280, available: http://dx.doi.org/10.1177/1077800403262360.
Guzmán, M., Knight, S., Quintero, S., Ramírez, S., Rueda, C. and Valencia, F. (2019) 'Reasoning about Distributed Knowledge of Groups with Infinitely Many Agents', in *CONCUR 2019 - 30th International Conference on Concurrency Theory*, Amsterdam. Netherlands, pp.1-29, available: http://dx.doi.org/10.4230/LIPIcs.CONCUR.2019.29 . hal-02172415v2.
Healy, J.D. (2003) 'Excess winter mortality in Europe: a cross country analysis identifying key risk factors', *Journal of Epidemiology and Community Health*, 57(10), 784, available: http://dx.doi.org/10.1136/jech.57.10.784.
Healy, N. and Barry, J. (2017) 'Politicizing energy justice and energy system transitions: Fossil fuel divestment and a "just transition"', *Energy Policy*, 108, 451-459, available: http://dx.doi.org/10.1016/j.enpol.2017.06.014.
Heffron, R.J. and McCauley, D. (2017) 'The concept of energy justice across the disciplines', *Energy Policy*, 105(C), 658-667, available: http://dx.doi.org/10.1016/j.enpol.2017.03.018.
Hesselman, M., Varo, Anaïs, Laakso, Senja (2019) *Policy Brief No. 2, June 2019; The Right to Energy in the European Union*.
Hiteva, R. and Sovacool, B. (2017) 'Harnessing social innovation for energy justice: A business model perspective', *Energy Policy*, 107, 631-639, available: http://dx.doi.org/10.1016/j.enpol.2017.03.056.
Huang, P., Negro, S.O., Hekkert, M.P. and Bi, K. (2016) 'How China became a leader in solar PV: An innovation system analysis', *Renewable and Sustainable Energy Reviews*, 64, 777-789, available: http://dx.doi.org/10.1016/j.rser.2016.06.061.
Hunt, L. (2014) 'In Defense of Qualitative Research', *Journal of Dental Hygiene (Online)*, 88(2), 64-5.
IEA (2019) *World Energy Outlook 2019* Paris: International Energy Agency, available: https://www.iea.org/reports/world-energy-outlook-2019 [accessed 20 May 2020].
IEA (2020) *Photovoltaic Power Systems Programme: Snapshot 2020*: International Energy Agency, available: https://iea-pvps.org/snapshot-reports/snapshot-2020/ [accessed 19 May 2020].
IPCC (2018) *Special Report: Global Warming of 1.5C*: The Intergovernmental Panel on Climate Change, available: https://www.ipcc.ch/sr15/ [accessed 16 May 2020].
IRENA (2020) *10 Years: Progress to Action*: International Renewable Energy Agency, available: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2020/Jan/IRENA_10_years_2020.pdf [accessed 20 May 2020].

Jackson, J. (2006) 'Ethnographic preparation for short-term study and residence in the target culture', *International Journal of Intercultural Relations*, 30(1), 77-98, available: http://dx.doi.org/10.1016/j.ijintrel.2005.07.004.
Jackson, P. (1983) 'Principles and Problems of Participant Observation', *Geografiska Annaler: Series B, Human Geography*, 65(1), 39-46, available: http://dx.doi.org/10.1080/04353684.1983.11879487.
Jasanoff, S. (2015) *Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power*, Chicago, IL: University of Chicago Press.
Jasanoff, S. and Kim, S.-H. (2009) 'Containing the Atom: Sociotechnical Imaginaries and Nuclear Power in the United States and South Korea', *A Review of Science, Learning and Policy*, 47(2), 119-146, available: http://dx.doi.org/10.1007/s11024-009-9124-4.
Jenkins, K. (2018) 'Setting energy justice apart from the crowd: Lessons from environmental and climate justice', *Energy Research & Social Science*, 39, 117-121. http://dx.doi.org/10.1016/j.erss.2017.11.015.
Jenkins, K., McCauley, D. and Forman, A. (2017) 'Energy justice: A policy approach', *Energy Policy*, 105, 631.
Jick, T.D. (1979) 'Mixing Qualitative and Quantitative Methods: Triangulation in Action', *Administrative Science Quarterly*, 24(4), 602-611, available: http://dx.doi.org/10.2307/2392366.
Jornal Económico (2020) *LG enters the solar energy market in Portugal*, available: https://jornaleconomico.sapo.pt/en/news/lg-enters-the-solar-energy-market-in-portugal-588821 [accessed
Kezar, A. (2003) 'Transformational Elite Interviews: Principles and Problems', *Qualitative Inquiry*, 9(3), 395-415, available: http://dx.doi.org/10.1177/1077800403009003005.
Labussière, O. and Nadaï, A. (2018) *Energy Transitions : A Socio-technical Inquiry*, Springer International Publishing : Imprint: Palgrave Macmillan.
Leonel, J.R.N., Catarina, I.R.M., Carlos, J.P.G. and Nuno, M.C.A.R. (2019) 'The Evolution of Climate Changes in Portugal: Determination of Trend Series and Its Impact on Forest Development', *Climate*, 7(6), 78, available: http://dx.doi.org/10.3390/cli7060078.
Lestegás, I. (2019) 'Lisbon After the Crisis: From Credit-fuelled Suburbanization to Tourist-driven Gentrification', *International Journal of Urban and Regional Research*, 43(4), 705-723, available: http://dx.doi.org/10.1111/1468-2427.12826.
Lisboa E-Nova (2020) *Capital Verde 2020*, available: https://lisboaenova.org/catipalverde2020/ [accessed 24 March 2020].
Lisbon's Energy and Environmental Agency (2019) *Lisbon Observatories: Energy and Water*, available: http://observatorios-lisboa.pt/en/cidade.html [accessed 20 May].
Lloyd-Jones, S. (2020) 'History (Portugal)', *Europa World online*.
Lund, C. (2014) 'Of what is this a case?: Analytical movements in qualitative social science research.(Report)(Author abstract)', *Human Organization*, 73(3), 224-234, available: http://dx.doi.org/10.17730/humo.73.3.e35q482014x033l4.
Lund, C. (2016) 'Rule and Rupture: State Formation through the Production of Property and Citizenship', *Development and Change*, 47(6), 1199-1228, available: http://dx.doi.org/10.1111/dech.12274.
Malet Calvo, D. (2018) 'Understanding international students beyond studentification: A new class of transnational urban consumers. The example of Erasmus students in Lisbon (Portugal)', *Urban Studies*, 55(10), 2142-2158, available: http://dx.doi.org/10.1177/0042098017708089.
Martin, D.G. (2011) 'Regional Urbanization, Spatial Justice, and Place', *Urban Geography*, 32(4), 484-487, available: http://dx.doi.org/10.2747/0272-3638.32.4.484.
Massey, D. (1994) *Space, place and gender*, Cambridge: Polity Press.
McCauley, D. (2018) *Energy Justice : Re-Balancing the Trilemma of Security, Poverty and Climate Change*, Springer International Publishing : Imprint: Palgrave Macmillan, available.
McCauley, D., Heffron, R.J., Stephan, H. and Jenkins, K. (2013) 'Advancing Energy Justice: the triumverate of tenets', *International Energy Law Review*.
McCauley, D., Ramasar, V., Heffron, R.J., Sovacool, B.K., Mebratu, D. and Mundaca, L. (2019) 'Energy justice in the transition to low carbon energy systems: Exploring key themes in

interdisciplinary research', *Applied Energy*, 233-234, 916-921, available: http://dx.doi.org/10.1016/j.apenergy.2018.10.005.
Miguel, C.V., Mendez, A. and Madeira, L.M. (2018) *An Overview of the Portuguese Energy Sector and Perspectives for Power-to-Gas Implementation*: MDPI, available: https://www.mdpi.com/1996-1073/11/12/3259/pdf [accessed 29 November 2018].
Mitchell, T. (2009) 'Carbon democracy', *Economy and Society*, 38(3), 399-432, available: http://dx.doi.org/10.1080/03085140903020598.
Mohan, G. and Stokke, K. (2000) 'Participatory development and empowerment: The dangers of localism', *Third World Quarterly*, 21(2), 247-268, available: http://dx.doi.org/10.1080/01436590050004346.
Moss, T., Becker, S. and Naumann, M. (2015) 'Whose energy transition is it, anyway? Organisation and ownership of the Energiewende in villages, cities and regions', *Local Environment*, 20(12), 1547-1563, available: http://dx.doi.org/10.1080/13549839.2014.915799.
Moss, T., Rutherford, J. and Coutard, O. (2014) 'Socio-technical Change and the Politics of Urban Infrastructure: Managing Energy in Berlin between Dictatorship and Democracy', *Urban Studies*, 51(7), 1432-1448, available: http://dx.doi.org/10.1177/0042098013500086.
Mullings, B. (1999) 'Insider or outsider, both or neither: some dilemmas of interviewing in a cross-cultural setting', *Geoforum*, 30, 337-350.
Newig, J. and Moss, T. (2017) 'Scale in environmental governance: moving from concepts and cases to consolidation', *Journal of Environmental Policy & Planning*, 19(5), 473-479, available: http://dx.doi.org/10.1080/1523908X.2017.1390926.
O'Brien, K. (2018) 'Is the 1.5°C target possible? Exploring the three spheres of transformation', *Current Opinion in Environmental Sustainability*, 31, 153-160, available: http://dx.doi.org/10.1016/j.cosust.2018.04.010.
OECD/IEA (2016) *Energy Policies of IEA Countries; Portugal 2016 Review*, Paris, France: OECD/IEA/European Commission, available: https://www.iea.org/publications/freepublications/publication/Energy_Policies_of_IEA_Countries_Portugal_2016_Review.pdf [accessed 29 October 2018].
Pacheco, M.C. and Mendes, J.M. (2019) *Electricity regulation in Portugal: overview*, available: https://uk.practicallaw.thomsonreuters.com/6-564-1565?transitionType=Default&contextData=(sc.Default)&firstPage=true&bhcp=1 [accessed 20 April 2020].
Palma, P., Gouveia, J.P. and Simoes, S.G. (2019) 'Mapping the energy performance gap of dwelling stock at high-resolution scale: Implications for thermal comfort in Portuguese households', *Energy & Buildings*, 190, 246-261, available: http://dx.doi.org/10.1016/j.enbuild.2019.03.002.
Pareja-Alcaraz, P. (2017) 'Chinese investments in Southern Europe's energy sectors: Similarities and divergences in China's strategies in Greece, Italy, Portugal and Spain', *Energy Policy*, 101, 700-710, available: http://dx.doi.org/10.1016/j.enpol.2016.09.034.
Peña, I., L. Azevedo, I. and Marcelino Ferreira, L.A.F. (2017) 'Lessons from wind policy in Portugal', *Energy Policy*, 103, 193-202, available: http://dx.doi.org/10.1016/j.enpol.2016.11.033.
Prata, R., Carvalho, P. and Azevedo, I. (2018) 'Distributional costs of wind energy production in Portugal under the liberalized Iberian market regime', *Energy Policy*, 113, 500.
PROSEU (2020) *PROSEU - Prosumers for the European Union*, available: https://proseu.eu/ [accessed 20 April 2020].
Röhl, K.F. and Machura, S. (2018) *Procedural justice*, Routledge, Taylor & Francis Group, available.
Sareen, S. (2019) *Enabling Sustainable Energy Transitions: Practices of Legitimation and Accountable Governance*, Cham: Palgrave Macmillan UK.
Sareen, S. and Haarstad, H. (2018) 'Bridging socio-technical and justice aspects of sustainable energy transitions', *Applied Energy*, 228, 624-632, available: http://dx.doi.org/10.1016/j.apenergy.2018.06.104.
Sequera, J. and Nofre, J. (2019) 'Touristification, transnational gentrification and urban change in Lisbon: The neighbourhood of Alfama', *Urban Studies*, (Special issue article: Transnational gentrification), 1-21, available: http://dx.doi.org/10.1177/0042098019883734.

Shahbaz, M., Benkraiem, R., Miloudi, A. and Lahiani, A. (2017) 'Production function with electricity consumption and policy implications in Portugal', *Energy Policy*, 110(C), 588-599, available: http://dx.doi.org/10.1016/j.enpol.2017.08.056.
Silva, J.C.M. and Pereira, J.A. (2019) *Portugal's Main Energy Producer that Everyone Loved to Hate*, The CASE Journal: Lisboa School of Economics and Management, available: https://www.emerald.com/insight/content/doi/10.1108/TCJ-05-2019-0050/full/html [accessed.
Smith, K. (2002) 'What is the 'Knowledge Economy'? Knowledge Intensity and Distributed Knowledge Bases', 06.
Solano, J.C., Brito, M.C. and Caamaño-Martín, E. (2018) 'Impact of fixed charges on the viability of self-consumption photovoltaics', *Energy Policy*, 122, 322-331, available: http://dx.doi.org/10.1016/j.enpol.2018.07.059.
Sorrell, S. (2018) 'Explaining sociotechnical transitions: A critical realist perspective', *Research Policy*, 47(7), 1267-1282, available: http://dx.doi.org/10.1016/j.respol.2018.04.008.
Sovacool, B., Burke, M., Baker, L., Kotikalapudib, C. and Wlokas, H. (2017) 'New frontiers and conceptual frameworks for energy justice', *Energy Policy*, 105, 677.
Sovacool, B., Heffron, R.J., Mccauley, D. and Goldthau, A. (2016) 'Energy decisions reframed as justice and ethical concerns', *Nature Energy*, 1(5), available: http://dx.doi.org/10.1038/nenergy.2016.24.
Sovacool, B., Hook, A., Martiskainen, M. and Baker, L. (2019a) 'The whole systems energy injustice of four European low-carbon transitions', *Global Environmental Change*, 58, available: http://dx.doi.org/10.1016/j.gloenvcha.2019.101958.
Sovacool, B., Martiskainen, M., Hook, A. and Baker, L. (2019b) 'Decarbonization and its discontents: a critical energy justice perspective on four low-carbon transitions', *An Interdisciplinary, International Journal Devoted to the Description, Causes and Implications of Climatic Change*, 155(4), 581-619, available: http://dx.doi.org/10.1007/s10584-019-02521-7.
Späth, P. and Rohracher, H. (2012) 'Local Demonstrations for Global Transitions-Dynamics across Governance Levels Fostering Socio-Technical Regime Change Towards Sustainability', *European Planning Studies: Places and Spaces of Sustainability Transitions: Geographical Contributions to an Emerging Research and Policy Field*, 20(3), 461-479, available: http://dx.doi.org/10.1080/09654313.2012.651800.
Späth, P. and Rohracher, H. (2014) 'Beyond Localism: The Spatial Scale and Scaling in Energy Transitions' in, Oxford, UK: Oxford, UK: John Wiley & Sons, Ltd, 106-121.
Stokke, K. and Mohan, G. (2001) 'The Convergence around Local Civil Society and the Dangers of Localism', *Social Scientist*, 29(11/12), 3-24, available: http://dx.doi.org/10.2307/3518224.
Sturzaker, J. and Nurse, A. (2020) *Rescaling urban governance : planning, localism and institutional change*, Policy Press, available.
Szolucha, A. (2019) *Energy, resource extraction and society : impacts and contested futures*, Routledge, Taylor & Francis Group, available.
Tedlock, B. (1991) 'From Participant Observation to the Observation of Participation: The Emergence of Narrative Ethnography', *Journal of Anthropological Research*, 47(1), 69-94, available: http://dx.doi.org/10.1086/jar.47.1.3630581.
United Nations (2018) *Accelerating SDG7 Achievement: Policy Briefs in Support of the First SDG7 Reveiw at the UN High-Level Political Forum 2018.* , available: https://sustainabledevelopment.un.org/content/documents/18041SDG7_Policy_Brief.pdf [accessed 13 November 2018].
United Nations (2019) *United Nation Statistics Division*, available: http://data.un.org/en/iso/pt.html [accessed 19 April 2020].
Walker, G. (2015) 'The Right to Energy: Meaning, Specification and the Politics of Definition', *L'Europe en Formation*, 378(4), 26-38, available: http://dx.doi.org/10.3917/eufor.378.0026.
Walker, G. and Cass, N. (2007) 'Carbon reduction, 'the public' and renewable energy: engaging with socio-technical configurations.(Author abstract)(Report)', *Area*, 39(4), 458.
World Economic Forum (2020) *What is Civil Society?*, available: https://www.weforum.org/agenda/2018/04/what-is-civil-society/ [accessed 14 May].
Yenneti, K. and Day, R. (2015) 'Procedural (in)justice in the implementation of solar energy: The case of Charanaka solar park, Gujarat, India.(Report)', 86, 664-673.

Yin, R.K. (1981) 'The Case Study as a Serious Research Strategy', *Knowledge*, 3(1), 97-114, available: http://dx.doi.org/10.1177/107554708100300106.