Grounding the energy justice lifecycle framework

Grounding the Energy Justice Lifecycle Framework: An exploration of Utility-scale Wind Power in Oaxaca, Mexico

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Abstract
Renewable Energy Technologies (RETs) are often portrayed as inherently just forms of energy production due to their role in climate change mitigation. This paper argues, first and foremost, that this overlooks the contextual struggles associated with renewable energy projects. We do so through critical engagement with an 'Energy Lifecycle Framework' approach to understanding claims of energy (in)justice in Oaxaca, Mexico. This framework for energy justice scholarship promises to enable whole systems interpretations related to the potential synergies and manifestations of injustice, existing at stages from resource extraction to waste, as well as opportunities for achieving more holistic forms of justice. Offering the stages of manufacturing and construction as crucial phases of any systemic approach to RETs and discussing the stage of consultation (an obligatory step in Mexico for energy projects in indigenous territories), the paper challenges and questions our ability to generate abstract interpretations of the relationship between energy lifecycles and their associated, contextually grounded, injustices. To do so, we draw upon extensive ethnographic fieldwork around the development of utility-scale wind power (USWP) projects undertaken in Oaxaca, where a number of regional peasant and indigenous groups have led sustained resistance to USWP on the basis of environmental, political and socio-economic impacts. Demonstrating how pre-existent and embedded cultural and environmental relationships determine the way in which energy justice is understood and constructed, the paper demonstrates tension as it simultaneously corroborates the usefulness of the Energy Lifecycle Framework and urges caution towards universalistic and staged approaches to assessing injustices in energy systems.

Key words
Energy Justice, Renewable Energy Technologies, Mexico, Wind Power, Energy Lifecycle Framework

Highlights
- Empirical evidence is used to corroborate the Energy Lifecycle Framework
- Limitations of the framework are identified and discussed
- The need for contextual understandings of energy justice is illustrated
- The "inherent fairness" of utility-scale wind power is discussed in relation to its social, political, economic, environmental and cultural impacts

1. Introduction

The transition to sustainable energy systems is increasingly backed by global discourses around climate and environmental justice. In this context, Renewable Energy Technologies (RETs) are often portrayed as a more socially just form of energy, and not least because of the emphasis on decarbonisation and a societal transition away from reliance on fossil fuels, which, amongst their many argued "failings", are often located physically and psychologically far away from the communities that ultimately consume the energy they produce [1]. Renewable energy systems are also posited to offer a platform for parts of the world which, in the past, have been exploited for their abundance of natural resources; offering to re-balance the scales by capitalising their equally abundant supply of renewables. Forming the first contribution of this paper, we seek to build upon the literature that challenges these assumptions arguing, first and foremost, that they are overly simplistic.

We give particular attention to a case study of utility-scale wind power (USWP), which, in reflecting upon the long history of energy acceptability within social science research, is considered one of the most contested RET to date [2–4]. As Fortier et al. [5] highlight, while RET may differ from their fossil fuel counterparts, the systems themselves invariably emerge within the same political and cultural economies. In this context, the academic literature on USWP has highlighted its tendency to reproduce unjust distribution patterns, including by frequently burdening vulnerable groups[6–9]. Indeed, Monyei et al. [10] argue that planners around the world need to be cautious, pragmatic and realistic when attempting to decarbonize energy systems given that large scale renewables integration does not necessarily lead to cheaper electricity, the strengthening of energy security *or* the enhancement of economic equity, despite claims to that effect. Yet for USWP, mainstream interpretations of the injustices behind these burdens frequently assume simplistic and reductionist discourses, blaming mainly visual impacts or noise during the power production stage [11–13]. Through a grounded case study of USWP development in Oaxaca, Mexico, our second substantive contribution is therefore to unpack the complexity of energy (in-)justice manifestations with regards to USWP developments. We do so with recognition that the transition from a fossil-fuel based energy systems to low carbon renewable one represents a crucial moment for the identification and addressing of energy injustice.

Conceptually, our paper is informed by a whole systems approach [14] to energy justice, which has more recently been repackaged by Heffron and McCauley (2017) as the 'Energy Lifecycle Framework'. This framework for energy justice scholarship promises to enable whole systems interpretations related to the potential tensions and trade-offs in manifestations of injustice, existing at stages from resource extraction to waste, as well as opportunities for achieving more holistic forms of justice [14,15]. Offering the stages of manufacturing, construction and latterly consultation as crucial phases of any systemic approach to the Lifecycle Framework of renewable energy systems, thispaper challenges and questions our ability to generate universalistic and de-contextualised interpretations of the relationship between energy lifecycles and their associated injustices. It does so mindful of the context that whilst lifecycle approaches to energy justice have been widely theoretically conceptualized, empirical explorations of their manifestation in practice are still comparatively limited.

To develop our arguments, we draw upon ethnographic fieldwork around the development of USWP projects undertaken in Oaxaca, Mexico, between 2017 and 2019, where a number of regional peasant and indigenous groups have led sustained resistance to USWP projects on the basis of their environmental, political and socio-economic impacts. Over the last years a growing literature has been built around the case of USWP in Oaxaca Mexico, including monographs and duographs drawing from ethnographic methods, that focus on the politics and the socio-environmental issues related to this case study [16–18]. The case study has also been analysed recently from a justice perspective, including discussions around the social and environmental justice concerns related to issues of recognition of indigenous and agrarian rights, formal and informal processes for negotiation and the unfair distribution of benefits [19–21]. The relevance of USWP in the Tehuantepec Isthmus as a case study has been increasing in energy justice literature , through papers exploring potential opportunities to develop alternative and inclusive models for indigenous communities renewable power generation in the Isthmus in a post Mexican energy reform context [6], or that analyse the capabilities approach to extend energy justice framework and advance understanding of social acceptance [22].

Demonstrating how pre-existent cultural, political, socio-economic and environmental relationships determine the way in which energy justice is understood and constructed, the paper therefore makes a third, empirically rich contribution to the growing academic literature related to justice and RETs. In order to do so, this paper elaborates injustices identified during the lifecycle stages of manufacturing, construction and latterly consultation, not previously incorporated into the lifecycle framework of Heffron and McCauley [15].

Our paper proceeds as follows. The following section provides an overview of the energy justice literature focusing, in particular, on the move to establish lifecycle-based frameworks for assessing (in)justices. We argue that whilst energy justice lifecycle frameworks take a systemic perspective rooted in solid theoretical foundations, they also open up a series of empirical questions regarding the intersection of the various identified 'stages.' We then progress to a detailed background to wind energy developments in our Mexican case, the Tehuantepec Isthmus in Oaxaca, before the following section offers a methodological elaboration of the research. Here, the paper addresses the call from Jenkins [23] for empirical insights that can critique the theoretical and conceptual frameworks being debated within energy justice scholarship. It does so in reference to ethnographic fieldwork carried out between 2017-2019 where, as part of the main author's doctoral research, 10 different communities in the case study region were visited, spending a significant time within two of these communities (Juchitan and Union Hidalgo). In the subsequent section, empirical data generated through the ethnographic fieldwork was analysed so as to facilitate critical engagement with the Energy Lifecycle Framework. Closing the loop on our empirical and conceptual lenses, the discussion and conclusion then use the empirical evidence presented to critically engage with the Energy Lifecycle Framework and how this – and other research carried out on renewable energy systems in various contexts [24,25] –, serve to challenge siloed or staged interpretations of (in)justice *as well as* the portrayal of RETs, like USWP,as inherently sustainable or just energy systems[26–28].

Our main claim is that pre-existent cultural, political, socio-economic and environmental relationships determine the way in which energy justice is understood and constructed and that such a finding creates tension within energy justice scholarship as it simultaneously corroborates the usefulness

of the energy Lifecycle Framework and urges caution towards universalistic and staged approaches to assessing injustices in energy systems.

2.Energy justice and the energy Lifecycle Framework

Energy systems are traditionally portrayed as a set of technocentric or techno-economic stages, including resource extraction, energy production, energy supply, energy consumption and the disposal of waste products in order to accomplish energy service provision [29]. However, the engagement of social scientific enquiry with existing debates on energy has proliferated in recent years [30]. As a result, substantial recognition is now given to energy production and consumption as a *socio-technical system*, beyond the traditional techno-economic stance [31]. Energy justice's interdisciplinary approach, in particular, recognizes the socio-technical nature of energy systems through its consideration of not only *what* the source of injustice is and how injustices are distributed (distributional justice) but also *who* it affects (justice as recognition) and *how* (i.e. through which processes) (procedural justice) [39], thus integrating the wider complex human-technology interactions into the 'equation' [14,31]. Through this transition, energy justice has emerged as a concept suited to interdisciplinary engagement with energy systems and their social, cultural, and political embeddedness [32].

'Energy justice' is currently undergoing an accelerated uptake as a conceptual tool for analyzing the relationship between society and the production of energy [33]. Building on scholarship in both environmental and climate justice, energy justice has been synthesized in various competing and complementary ways [23]. One important implication of this interface has been an increased attentiveness to the holism of energy systems and their associated (in)justices at various stages of the production-consumption process. One such strand of thinking takes the form of what, in extending the original cosmopolitan justice approach of Sovacool et al. [34], Heffron and McCauley describe as a "cosmopolitan justice across the energy lifecycle" [15:660]. It is important to highlight that by energy lifecycle we refer to the beforementioned stages on an energy system and by cosmopolitan justice we refer specifically to the "Universal" core element of cosmopolitan justice, which claims that "justice concerns apply to everyone equally" [31:2].

Assumptions about the relationship between energy production and consumption, which are often articulated through an emphasis on the responsibility of a national state's infrastructure to provide for citizens, offer a very limited framework for engaging with questions of justice in energy systems. As a result, central to the recent application of justice to the energy sector, has been a shift to expand on existing production-consumption dichotomies and pay more detailed attention to the processes connecting these. Acknowledging the previously overlooked 'in-between' stages, wherein a variety of social and political actors interface with energy networks, opens up more fertile ground for the invocation of advocacy claims to injustice, and subsequent shifts in policy and practice [14]. As Heffron and McCauley describe it, a more "nuanced understanding of social justice concerns within energy systems" is emerging [35:437], which, for Jenkins et al. [39], carries the potential to improve the system overall.

Rather than simply applying a critical lens to inequalities in the provision of energy to consumers, an energy justice approach paves the way for a more truly interdisciplinary engagement with wider energy systems and the way in which various 'parts' of this system are both embedded within, and are themselves

a product of, their social, cultural, and political contexts. In order to provide a framework for assessing energy systems in this way, what was originally labelled a "whole systems" approach by Jenkins et al. [14]and latterly an energy 'lifecycle' approach, has been proposed and subsequently endorsed [5,15,35]. Heffron and McCauley describe the resultant energy lifecycle approach as a valuable framework for "consider[ing] energy justice within an energy system (i.e. the application of energy justice thinking at each stage of the energy lifecycle)" [15:659]. The authors subsequently identify five broad stages within this lifecycle: (1) Extraction, (2) Production, (3) Operation and supply, (4) Consumption and (5) Waste. Also discussed in depth in an earlier piece by Jenkins et al. [33], paying attention to these stages of the energy lifecycle serves to overcome critiques of scalar ambiguity and failures to account for actor diversity within previous literatures, addressing concerns over energy and justice.

Building on previous work recognizing lifecycle effectiveness, and opening up an important dialogue between literature on renewable energy systems and scholarship on energy justice, Fortier et al. [5:211] propose an ambitious move to integrate the energy lifecycle assessment with what they argue to be a 'social lifecycle' assessment framework, already tailored to the 'various lifecycle stages of products and systems'. In carrying this out, the authors present an alternative set of stages more in tune with low carbon transitions and their social embeddedness. These are: (1) Raw material extraction and processing, (2) Manufacturing and construction, (3) Electric power generation, (4) Transportation and distribution and (5) Waste management. Yet despite ongoing iterations of the lifecycle framework, which are situated alongside broader recognition over the contextual embeddedness of respective energy systems, the infancy of energy justice as a critical paradigm means that existing developments have been primarily driven by theoretical conceptualization. This is a critical omission given that assessing the usefulness of these (or any) categories to act as a framework for identifying and/or challenging systemic instances of energy injustice requires substantial empirical corroboration [23]. In partially filling this gap, the research drawn upon in this paper resonates with previous work based in substituting universalizing understandings of energy justice for more contextually attuned ones [24]. Such approaches recognize how different groups of people experience a bottom-up understanding of energy justice [1], influenced by their social, political, economic, environmental and cultural contexts [36]. Indeed, it is in this critical space that the following case study, and its conceptual reflections, are positioned.

3. Background to Case Study

The context of the Mexican region of Oaxaca, where this paper will orientate its empirical focus, offers a particularly powerful context through which to study justice concerns relating to USWP and therefore offer new contributions to the existing literature [28,37,38]. Here, with almost 2.8GW of productive USWP capacity currently installed, the region has faced sustained social resistance from different local indigenous and peasants groups campaigning against the environmental, political and socio-economic impacts of the project [39]. For indigenous resistance groups in the region, USWP projects have come to be included under the umbrella concept of *Proyectos de Muerte* (Death Projects), which are associated with aggressive neoliberal infrastructure developments and extractive resource projects [40].

The Oaxaca Isthmus of Tehuantepec is known by locals as *El Istmo* or the Isthmus. This region, home to 595,433 people, consists of 41 municipalities located in the south-east region of the state of Oaxaca

[41], a state where 158 dialects are spoken [42]. A third of the population speaks an indigenous language and around 61% consider themselves to be indigenous [43]. In the region of the Isthmus the predominant indigenous groups are Zapotecs, Ikoots, Mixes, Chontal and Zoque. However, due to their geographical distribution Zapotecs and Ikoots have been the main indigenous groups engaging with USWP in the region [19]. Zapotecs in the region, known as Binnizá or "people from the clouds", are the predominant indigenous group in the Isthmus (114,633 people) mainly located in the northern area of the region and representing around 7 of each 10 indigenous speakers using the regional variant of Zapotec, the "didxazá" [44]. Nevertheless, the southern part of the Isthmus is home of the Ikoots (as they refer to themselves), also known in didxazá as "Huave" or "those who rot in the moist" [45], with around 24,218 people living near the southern lagoons and the sea [45]. While Zapotec population tends to domain in cities like Juchitan (93,000 inhabitants), Salina Cruz (82,371 inhabitants) and Santo Domingo Tehuantepec (61,872 inhabitants), they are also predominant in towns undergoing a rural-urban transition such as Union Hidalgo (13,970 inhabitants) [46]. On the other hand, Ikoots are mainly concentrated in smaller towns like San Mateo del Mar (5,734 inhabitants), San Dionisio del mar (3.140 inhabitants) or Huamuchil (1,828 inhabitants) [47]. Such demographic and geographic differences between these indigenous groups also manifest through their predominant economic activities. For instance, commerce, services, industry and agriculture are considered the main activities in predominantly Zapotec cities and towns [44], while Ikoots rely on fishering and small scale agriculture [48]. Nevertheless, there are Zapotec communities which also rely heavily on fishing and small agriculture, such as Alvaro Obregon, and for which the relationship with the sea and land played a relevant role on how social acceptance of USWP was framed [49].

Overall, in the region 15% of people over 15 years old are illiterate, 30% of the population experience food poverty, and 4.1% of households do not have access to electricity, which is at least double that of the national average [46]. The Isthmus, therefore, encapsulates the historical condition of social disadvantage frequently experienced by indigenous and rural populations in Mexico [50].

In addition to this socio-economic background, the population has experienced a long and complex relationship with modernizing projects which seek to exploit the region's geo-strategic location by turning it into an industrial and commercial corridor [51]. This political history extends from Hernan Cortez' plans in the XVI century for linking the commercial routes of Europe and Asia, to modern plans to make the Isthmus an alternative to the Panama Canal. Consequently, the history of the Isthmus is littered with tales of indigenous rebellions and a struggle to maintain regional and local self-determination for its populations [52]. Wind energy is now one such source of political strife.

In recent decades, USWP has been strongly promoted as a central pillar in new regional development plans, which aim to increase the industrial and commercial importance of the Isthmus within the broader national context. More specifically, the discourse of USWP development at the national level has set its sights on the dual accomplishment of energy decarbonization *and* socio-economic development for the Isthmus through the attraction of stable jobs based in the different lifecycle stages of USWP [19,53]. Following a first experimental trial involving five 225kW turbines in 1992 [54], guidelines for an accelerated development of USWP in the Isthmus region were set in 2000. Stimulated by six annual colloquiums held in the tourist area of Huatulco, 200 kilometers away from Juchitan - the cultural center of the Isthmus region - both the investment and know-how of transnational USWP companies entered

the region through predominantly techno-economic rationalisations, which focused solely on the commercial feasibility of a regional wind sector. This top-down approach, detached from the contexts in which the projects would eventually be developed, focused on generating policy mechanisms and guidelines to overcome the basic financial and technical barriers for the Mexican wind industry [55]. Since the first utility scale project of 82.3 MW became operational in the Isthmus in 2007, USWP in Mexico has spread rapidly, currently accounting for around 5.5GW, representing 6% of Mexico´s installed power capacity [56]. Meanwhile, the Isthmus region accounts for more than half of such installed capacity alone, with around 2.8GW [57]. Figure 1 shows the case study area and the current concentration of USWP resources.

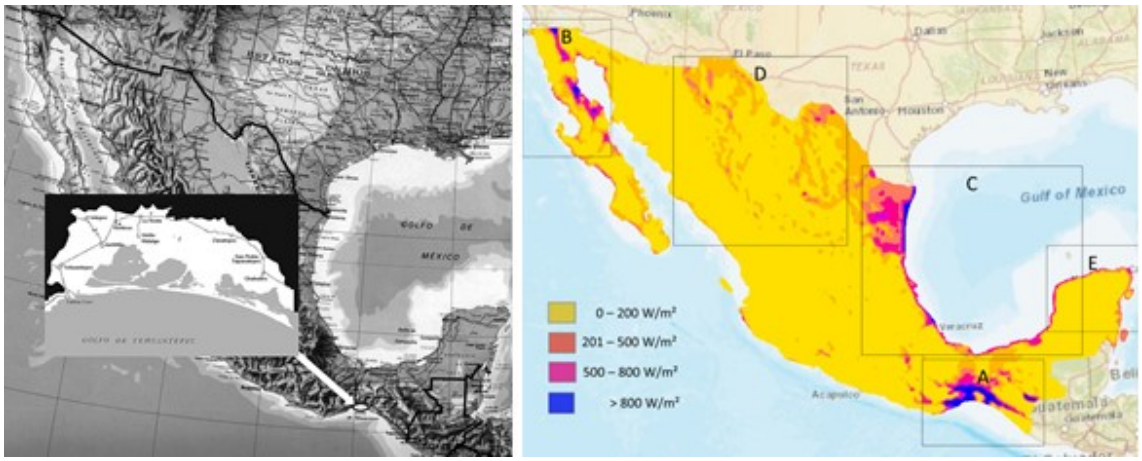

Figure 1. On the left: Location of the Oaxaca's Isthmus region, from Alemán-Nava et. al 2014 [58]. *On the right: Geographic distribution of the existing wind resources in Mexico, from Jaramillo and Borja 2004* [59].

Martínez Mendoza *et al.* [60] highlight that USWP developments in the Isthmus have created only around 300 permanent jobs (mainly accessible to people with higher education), and around 4,700 temporary jobs largely related to the construction stage of wind farms. Moreover, the authors state that these manufacturing facilities remain located outside the Isthmus in urban and industrial hubs in the centre and the north of the country and focus only on manufacturing blades and towers, leaving the main and most expensive components like generators as imported technologies from foreign countries such as Denmark, Germany or the USA. Additionally, the amount of benefits provided by USWP companies under the concept of land lease in the Isthmus is remarkably low in comparison to wind farms in other countries. In Europe, leasing the land for a USWP project would represent around 3.9% of the total project costs, while in Mexico it was reported that the leasing of the land represented only around 0.025% to 1.53% depending on the specific project [61]. Additionally, some authors argue that the tax exemptions for USWP production and the capture of financial benefits by municipal authorities through land-use permits, have also influenced local framings of wind power benefits distribution as advantageous only for private companies and local authorities [26,62]. Such statistics partially illustrate the imbalance perceived by some groups in the Isthmus regarding arguably disadvantageous trade-offs between USWP burdens and benefits [9].

As power generation and sector capacity has increased, so has the network of resistance coordinated by local indigenous groups [63]. Bottom-up resistance movements have sprouted from different communities and manifested into a regional resistance network over time, which later joined the

national network against “Proyectos de muerte”. These resistance movements have taken the strategic move to label USWP– indisputably a renewable energy technology— under the same category of mining, fracking and large-scale hydropower; as large scale-extraction projects with strong impacts on human health, the more-than-human, and the cosmological worlds of different rural communities [40]. It is against the backdrop of this particularly powerful resistance strategy that the paper offers its key contributions.

Partly in response to growing resistance to the USWP developments, the Mexican government undertook policy reforms which sought to recognize and account for the social dimensions of a transition to renewable energy. From 2014, indigenous consultation protocols, based in the International Labour Organization (ILO) 169 Convention, were made obligatory for the development of USWP in the region [64,65]. At the same time, mechanisms including social impacts assessments became obligatory for the development of all energy related infrastructure in the country, including everything from gas stations to utility farm generation plants [66]. These initiatives represented clear attempts by the Federal Government to engage with a previously ignored social dimensions of USWP development in the Isthmus [67].

Yet regardless of this shift in policy, social uncertainty continues to represent a major risk for private investors. Such is the iconic case of the Mareña Renovables project, which after initially being cancelled because of a sustained local resistance from indigenous groups on the basis of a lack of due process, was later renamed and switched to a new area of deployment. After being strongly contested, criticized and even legally stalled by indigenous organizations for several months, it was finally inaugurated in May 2019, becoming the first wind project in Mexico to go through an indigenous consultation process [68]. In this case, USWP developers seemed to be willing to exchange the ideal techno-economic conditions in the Isthmus for lower capacity factors but higher social certainty existent in northern areas of the country. The question remains, however, what are the main sources of injustice driving such a strong local indigenous opposition in Tehuantepec? Early on, the research project developed with the idea that the energy Lifecycle framework could shed some light over how injustices are generated across the stages of a USWP project, or that such an approach could be useful to analyze a complex case study such as the one presented by USWP and the Isthmus. This, in turn, informed the ethnographic methods described in the following section.

4. Methodology

Due to both the context in question and the desire to bring rich, new empirical narratives to bear on theoretical frameworks developed largely within the ‘western’ academy [69] (namely that of the lifecycle approach to energy justice), ethnographic methods were selected. These enabled the immersive day-to-day interactions and experiences required for acquiring a better sensitivity regarding different local understandings of USWP development in the region [70]. In drawing from this methodological approach, this paper aligns with other similar research exercises which utilise ethnographic methods to develop an empirical understanding of the social worlds created around RETs and their interactions with local contexts [1,6,16,24,71–73].

To facilitate the approach described, the lead author (himself a native of Mexico) spent around 22 weeks in the field (during three separate trips) between October 2017 and September 2019. The first

fieldtrip included 16 weeks of ethnographic fieldwork between October 2017 and February 2018. During this first phase, the lead author was involved in volunteering for post-earthquake brigades, established after two 8.2 magnitude earthquakes hit the region on September 7th and 19th 2017. The subsequent fieldwork periods were undertaken in two different visits of three weeks each between July-August 2018, and August-September 2019, allowing the lead author to validate information and collect data for the further stages of his PhD research. This approach allowed him to build a wide network of stakeholders related to the wind power sector, including members of indigenous opposition groups, landowners, private USWP representatives, public servants, human rights organizations and academics. The empirical evidence presented in this paper is principally derived from 58 in-depth interviews that ranged from 30 minutes to 3 hours and provided a total of 69.9 hours of audio recordings. In addition to this, the paper draws on participant observation and participatory action through living in Juchitan and Union Hidalgo and visiting 10 communities in the region where participants were interviewed (Figure 2). The interviews were all conducted in Spanish, as respondents and the lead author were fluid in this language. Whenever an unknown regional term was used by a respondent the lead author asked for clarification to avoid losing subtle meanings. The latter led also to extensive fieldnotes recorded in Spanish.

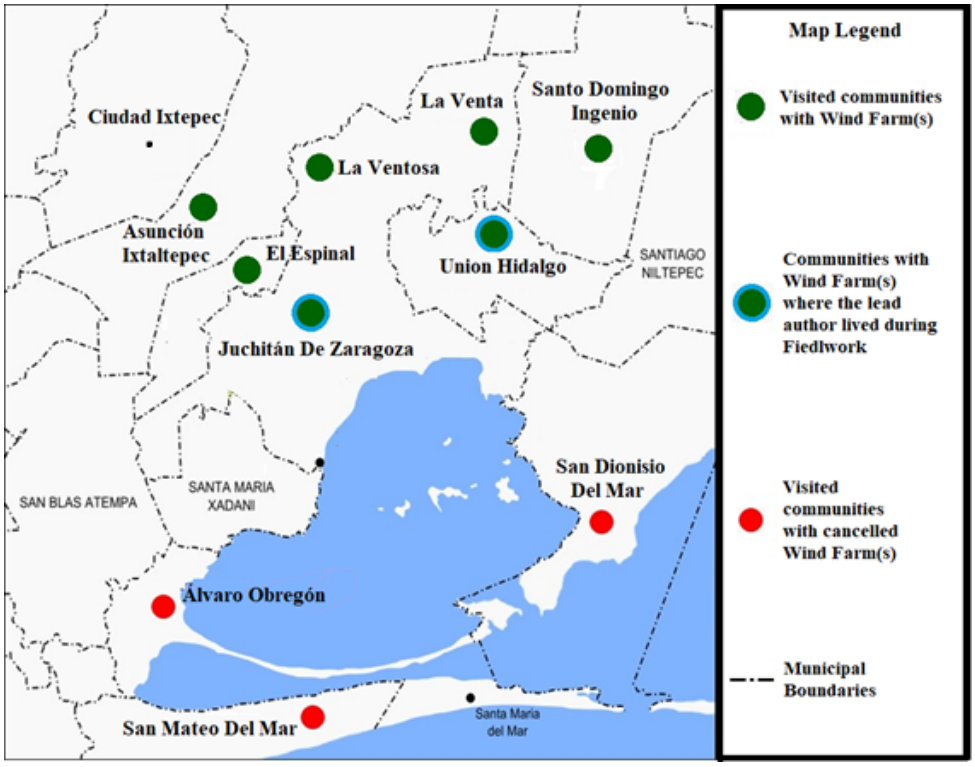

Figure 2.Fieldwork areas with legends in the region of the Tehuantepec Isthmus, Oaxaca, México. Source: Modified from Espejo 5 (2015).

The contextual understandings of justice analysed within this paper come from a wide region in which USWP has been developing over the last two decades. Therefore, the authors acknowledge the complexity of the case study and the fact that empirical evidence emanating from interviews undertaken in

different social, cultural, political, economic and environmental, local contexts in which different USWP projects have emerged, followed a unique narrative. In the words of one participant:

"The problem is that many people mix, as now we were mixing all the wind companies in one bag; they mix all the indigenous communities, treating them as if they were the same... it won't be the same an urban community with 75,000 people like Juchitan, than [in] a fishing community in the shore" **(NGO, Juchitan)**

Nonetheless, the similarities and dissonances arising from a substantial collection of empirical evidence collected over different local contexts and communities in the same region is seen to add empirical richness rather than weaken the article's perspectives.

It is also important to highlight the diverse backgrounds of participants, whose opinions and worldviews provided the data for the subsequent analysis. Therefore, Table 1 provides a demographic breakdown around the participants interviewed for this work including their relationship with USWP, ethnicity, gender, and age.

Table 1. Breakdown of interviewees by type of participant, ethnicity, sex and age.

Type of participant	No. of interviews	Ethnicity	No. of interviews
Opposition	20	Indigenous	50
Landowners	14	Non-Indigenous	8
Locals living near wind turbines	7	**Sex**	
USWP company staff	6	Female	16
Public servants	5	Male	42
NGOs	3	**Age**	
Academics	2	30-40	11
Union Leaders	1	40-50	8
TOTAL	**58**	50-60	14
		More than 60	25

The main author carried out both inductive and deductive coding on all emergent texts (interview transcripts and fieldnotes in Spanish) that included, amongst other categories, the initial stages of energy lifecycle proposed by Heffron and McCauley [15]. This process allowed the emergence of comparable perceptions and discourses found throughout the case study region, as well as claims which were particular to specific communities and USWP projects. To denote the quotations used in this paper with their appropriate context, we specify both the positionality of the respondent (e.g. a landowner renting their land, a member of resistance group, developer, or an NGO member, for instance) and their community of origin and/or reference. Through the process of coding the empirical data using the initial energy life-cycle stages as labels, it became apparent that at least three very relevant stages were missing from this categorization: manufacturing, construction and consultation. These therefore form the backbone to the results to be presented below.

5. Results and Discussion

The existing literature on wind power from a social science perspective is based primarily on studies undertaken in European countries. The not-in-my-backyard (NIMBY) movement referred to in this literature mostly presents claims referring to the negative visual impacts during the power production phase of wind turbines [32,75–78]. However, as will be evident from the discussion that follows, the issues in the case of Oaxaca are arguably more substantive as a result of their geo-historical specificity and the local context [77]. What is more, this is true for injustice claims elaborated across the energy intensive, and potentially disruptive stages of RETs such as mining (related to rare minerals, iron and concrete mining turbines [79]) and construction, with the latter elaborated throughout our empirical evidence.

5.1 Injustices of Manufacturing

Manufacturing is the stage in which extracted raw materials are transformed into USWP components in order to perform specific tasks within the technical integration of energy systems. In the context of our case study, references to the manufacturing phase for wind energy – which takes place mainly in the United States and European countries – were often related to a lack of national industry involvement and therefore a lack of component availability, a prevalence of maintenance issues, and reports of turbine malfunction or even breakdown. Downstream effects such as oil spillages from the gears or bearings operating wind turbines were also linked to these narratives by farmers and palm workers, which frequently transit the road near the turbines to carry out their daily chores. While such stories mirror wider coverage often reported in national media [80], spillages represent visual and tangible evidence that challenge USWP as an ideal, clean alternative in energy production. In this regard, such issues were especially worrying for those with more traditional lifestyles. It was common, for example, to hear farmers, fishers and gatherers worry about the destination of the spilled oil and its unknown impacts on local ecosystems:

"[The] truth is I don't know what happens over there, but I see how oil is spilled. Obviously later the rain comes, and it washes it to the rivers and the sea and… I think in that way that is affecting us, but I don't know how we can stand against these fuckers." **(Palm worker, Union Hidalgo)**

In contrast to the described concerns, USWP in the region was originally promoted as the basis for the development of a thriving local manufacturing industry [81] with the aim, perhaps, to achieve an increased social acceptance from the local population. Indeed, such promotional discourse of job creation as a collateral socio-economic benefit of renewable energy systems is present in outlooks from international organizations and national wind power associations of manufacturing leaders like Denmark [82], and are being used by USWP promoters in Mexico to link the energy transition with regional development and employment creation. This has particularly powerful impacts in terms of raising expectations among a population facing historical socio-economic issues. The way that this message was conveyed, and the powerful impact it had on the attitudes of local populations, is evident through the manner in which a contextually specific narrative of benefit was operationalized:

"They (the wind power companies) laid things out in a very nice way at the beginning: each landowner would have one son working in the wind farm, and they would build a factory for manufacturing blades so they could employ people in the community." **(Landowner, La Ventosa)**

This is a claim frequently expressed by "pro" and "anti" USWP local groups, with the issue around the lack of regionally-based manufacturing also raising questions around the responsibility of stakeholders related to the development of a regional manufacturing industry and local employment. Interviewees working for USWP companies pointed to the state's responsibility for promoting investment to materialize a regional manufacturing industry:

"There has been no one capable to open a blade manufacturing industry…. People claim a lot around this issue- "they told us there would be work". Why? Because manufacturing industries were supposed to come here. This put us (project developers) in a difficult position. But that must be a state policy, the government should be the promoter… our company only sells electricity." **(Developer, Juchitan)**

The early failure to integrate regional manufacturing has had demonstrable effect on subsequent, more recent efforts to introduce manufacturing facilities in the region. For example, a succeeding attempt to build a blade manufacturing facility in Comitancillo, a community two hours away from Juchitan, failed due to local resistance groups which occupied and dismantled the construction site [83]. Interviews with members of indigenous resistance groups revealed how people from Comitancillo joined a regional event for these groups. It was during this event that assistants from Comitancillo were warned about the way in which USWP companies operated, promising only benefits, but hiding information relating to impacts:

"Accepting that manufacturing facility at this moment would be like accepting in advance that many more projects will be installed in the region, and we don't want even one more tower in here." **(Opposition member, Union Hidalgo)**

The case of the Comitancillo manufacturing facility illustrates how perceived injustices around USWP in the region have already been become entrenched. As a result, a historical scar developed through emergent perceptions of injustice has bred a pre-disposition for an "anti" stance towards projects related to USWP. On the other hand, one interviewee from el Espinal explained how pre-existing skills, potentially due to higher education levels, have led to grassroots initiatives attempting to seize the manufacturing niche. One landowner in El Espinal described how local entrepreneurs are providing some small components for the maintenance of wind turbines, manufactured in an artisanal way in local community workshops, for example. This illustrates how manufacturing can be framed both as an attempt to push USWP out of the region, *or* as an opportunity to effectively internalize benefits from the supply chain. Thus, conceptions of manufacturing will depend strongly on the pre-existing local characteristics, including the socio-demographic and economic characteristics of communities.

5.2 Injustices of construction

Impacts coming from the construction of a USWP project are sometimes overlooked in favor of the twenty-five (or more) years of clean and renewable electricity that they ultimately deliver. Similarly, the discourse of USWP technology as a vertical technology is used to minimize the perceived impacts stemming from wind farm siting. Pushing this narrative, some promoters of USWP in Oaxaca argue that land impacts from a small turbine base, its maintenance, and the construction platform and access roads to the site were negligible compared to those from large hydropower or solar farms. In stark contrast, however, this research reveals different claims that frame construction as, in fact, "the most devastating stage" in the lifecycle of a USWP project.

By situating the construction of USWP in the wider, pre-existing regional and local context, it becomes readily apparent that construction impacts go beyond the physical space for the wind turbine base or the operations platform. For instance, the construction process for a USWP project often requires the construction of new roads to provide access routes for heavy vehicles and goods. This involves the clearance of vegetation, which, in the views of interviewees from El Espinal, Juchitan and Union Hidalgo, contradicts the "clean" and "environmental" logic within which wind projects are promoted, whilst also adding a more-than-human component to energy justice claims:

"That was a green common area deforested by wind companies when they open their own way, damaging and killing thousands and thousands of palm trees." **(Palm worker, Union Hidalgo)**

We acknowledge that the claims coming from interviewees are very diverse in regard to this particular issue. However, one particularly powerful narrative emerged that illustrates the importance of the social, economic, cultural and environmental systems; that of herbal medicine.

The value that herbal medicine has in Mexico and its connection to indigenous communities and practices has been regarded as a precious bio-cultural good. Such practices are a crucial part of the identity of local people and herbal medicine is commonly used to treat some of the most common afflictions in the region in an accessible and reliable way [84]. Certain species of trees are also valued beyond their use as food supply or alternative medicines due their local cultural significance and links to the region history and local landscape. In this regard, the clearance of vegetation and invasion of natural areas in the region has deeper social and cultural effects for local populations:

"They came opening paths, clearing trees, which have a long history and are praised here like the "guanacaste", fruit trees which feed people and are sold in the market, like mango… My wife works with traditional medicine and the plants she used came from the very areas they cleared, they are very hard to get now." **(Opposition member, Juchitan)**

In a similar vein, three interviewees from Union Hidalgo, Juchitan and San Dionisio expressed very specific concerns for the impacts to fauna during the construction stage of a wind project. One of the interviews focused on USWP impacts over bird population, specifically to "Zanates", a local bird depicted in Fig.3. Claims around impacts to bird population are mostly related to mortality and collisions with blades during the operation stage, which are already widely studied and reported by the academic literature [38,62].

However, this interviewee elaborated that the construction of a USWP project comes to disrupt a complex interconnected system integrated by regional flora, fauna and traditional economic activities in a very particular way:

"When the wind companies enter there and take the trees out, they also push "zanates" away, which are local birds who eat some plagues that affect the crops." **(Opposition member, Union Hidalgo)**

This underlying connection between birds as natural plague controllers (or "Laborers of Nature") that enhance crops yield has been studied extensively [85–87]. This claim is representative of a systemic rationale which illustrates the difficulty of constricting unsupportive USWP impacts into narrow categories, such as "bird mortality during the production or operation stage".

Thinking systemically about the environmental impacts of USWP construction also raised the question of the relationship between wind turbine erection and underground water systems. The construction process for turbine bases involves deep excavation of the ground to later build the supporting iron structure for the turbine. Through these processes, underground streams have been damaged and altered, blocked or diverted, with devastating downstream effects on local populations:

"It affected the underground water supply. There were places where they dug and they hit the veins of such underground bodies of water. There was not water in the wells and that never happened before... We were not able to water the land for the cattle to have grass and many died." **(Landowner, La Ventosa)**

The dependence on and closeness of some people's traditional activities with nature might facilitate a greater awareness of or sensitivity to potential disruptions to the balance between the non-human and human world. Indeed, interviewees also linked wind turbine development to other traditional economic activities like fishing, hunting and gathering fruit, palm for crafting utensils, or wood. One interviewee reflected upon the disruptive significance that the construction of a USWP project holds for "a communitarian way of life", for instance. Such way of life, as described by the interviewee, represents a harmonic equilibrium between the non-human world (represented in this case mother earth and the sea) and the human world (represented by the local population):

"Construction is the most devastating phase… We want a technology which we can use without disrupting the communitarian way of life, but that strengthens it. Because it is harmonic with mother earth and with the sea, there is a cosmovision of kindness and respect for life, for earth, for the sea… Many say I cannot sell my mother, the earth, she feeds me and nourishes me, and so does the sea, that is not mine, it is the opposite, I am theirs." **(Opposition member, Juchitan)**

This clearly expresses the participant's systemic framing of local and regional ecosystems and the way they understand the holistic and embedded impacts of USWP generation. As illustrated in the last quote, it also provides "nature" with an almost human and sympathetic character, invoking a very different

systemic model to a techno-centric and staged one that could emerge if a standalone energy justice lifecycle model is not well grounded in local contexts.

Figure 3. On the left: A mural partly commissioned by the Bií-Hioxo Wind Farm in Juchitan, representing a Zanate posing on a child´s hand. The phrase, in Spanish, is from Uruguay´s ex-president Jose Mujica and writes: "The ones fighting for the environment, fight also for human happiness". On the right:A painting in San Dionisio del Mar where local assemblies are celebrated. The painting represents"the communitarian way of life".

Extending such discussions, the construction of USWP projects was been labelled by opposition groups as a contributor to a progressive extinction of the traditional economic activities in the region. On the same note, this perceived loss of traditional jobs has come to strengthen claims around a promised, but absent, manufacturing industry. Therefore, in the eyes of one interviewee from San Dionisio, USWP projects would impact traditional economic activities, without contributing with long term employment:

*"People here don't die of hunger, because here, we grab our nets and the sea provides… But if they build that (*USWP *project), all the shore will become an industrial area... Including all wind farms, workers from our region, from the different communities, there is no more than a thousand. Then who is that going to benefit? The construction takes only one year, and then it's over, work is over."* **(Opposition member, San Dionisio)**

5.3 Negotiating Justice

It is difficult to argue for consultation to be considered as a definitive stage in the energy lifecycle, worthy of unique consideration. However, in the context of Mexico´s Energy Policy, and through the enactment of the ILO 169 [65] covenant for indigenous people, this is precisely how it is framed: a compulsory stage in the lifecycle of an energy project. With this in mind, the somewhat paradoxical approach of this penultimate section of the paper is to illustrate how, while manufacturing injustices manifest themselves principally through what they lack and construction injustices manifest through the disturbances that they bring, consultation, when thought of as rigid phases in the energy lifecycle, lacks the ability to capture the complex calls for justice associated with the various parts of this supposedly systemic process. Such issues are directly related to notions of procedural justice that are manifested over the stage of consultation.

In Mexico, the legal obligations for energy projects engaging with indigenous communities state the need to "obtain consent for the construction and operation of a wind park, as well as the aspects related to a just and equal participation related to distribution of socioeconomic and cultural benefits coming from the project" [47:14]. This approach, however, has been widely criticized by local resistance groups and some academics [88,89]. Indeed, placing the consultation process as a specific stage of a USWP project lifecycle has produced issues relating to the conception of Free, Prior and Informed Consent guidelines that must be followed from the ILO 169. Interviewees from Juchitan and Union Hidalgo believed that the consultation processes were not genuine because the Mexican Energy Ministry had already provided prior clearance to the projects submitted at the consultation processes, for instance.

Moreover, conceptualizing consultation as a stage rather than a dynamic and engaging process along a project's lifecycle generates several injustices related to the social, cultural and political context of the Isthmus, according to interviewees. Interviewees taking part in the consultation process acknowledged that negotiating agreements for a 25-years project is challenging, because of the predominantly organic way in which a community life develops and changes through time:

"It will be difficult to know what we expect from the project and the company in the next years. We now know that we don't have public lighting or drain system and we are negotiating for that. But who could know what happens in the next 25 years? People taking decisions now might not even be alive by then!"

(Public Servant, Union Hidalgo)

Taking this a step further, some interviewees who participated in consultations in Juchitan or Union Hidalgo considered them to be a simulation process that far from redressing the existent injustices embedded in USWP, have turned into spaces to legitimize them. One such example would be the integration of participatory planning processes to determine the location of USWP infrastructure. Participatory planning has been highlighted by the USWP literature as a useful mechanism for including local knowledge in project planning [2,90–92] and could, theoretically, prevent environmental impacts like the ones described in the construction section. However, interviews with project developers in Juchitan revealed how, from their perspective, involving community members into a participative planning process would prove to be difficult and probably even counterproductive. This is mainly because the placement of USWP infrastructure corresponds with who receives the economic benefits coming from land leasing. Developers believe that alongside failures to aiding the avoidance of environmental impacts, such an approach could strengthen intracommunity conflicts and heighten the elite stronghold on project benefits due to the pre-existing difference of economic and politic influence among local stakeholders in the region. In this context, members of opposition groups believed that the ability to exert political influence was one of the main flaws in a staged consultation approach. Interviewees also argued that these pre-existent power imbalances transformed an allegedly democratic consultation into a well-defined political opportunity for already powerful stakeholders to push and legitimize decisions which benefit them.

While addressing these deep and historical imbalances in the region is probably far beyond the possibilities of incoming USWP projects, improved mechanisms looking to address such imbalances in the context of consultation seems more feasible. Conversely, if such persistent imbalances are not considered

and addressed during the consultation processes, even the potential benefits from USWP projects can be translated into social conflicts.

Empirical evidence describing the power dynamics between landowner committees, working unions and members of resistance reflect how pre-existing contexts play a strong role in the perception of injustices around USWP:

"The most complicated stage of a wind power project is construction, because unions and landowners which have nothing to do with the project try to get in the middle." **(Developer, Juchitan)**

Indeed, given that there is an almost absent manufacturing industry in the region (as described in previous sections), the local internalization of economic benefits is mainly received by either leasing the land or through short term (approximately one year) construction jobs, material retail and construction services**.** Here, the construction stage becomes a complex political struggle where USWP companies are left to assume the role of mediators and to distribute construction benefits among unions, landowners and the general population:

"In that sense we work on the understanding that landowners are first. If there are no relatives from a landowner who can occupy a job vacancy, that's fine, then we go to the community job bank, because we will create one… Who is leasing the land? Landowners. Then who should get the benefits? Well, landowners. If I don't own land, well, from the bottom of my heart I am very sorry, my brother."
(Landowner, Union Hidalgo)

With landowners having substantially stronger political leverage in this context, most members of the wider community remain excluded from the scope of benefits, ending up with small, informal pieces of outstanding construction work. This uneven distribution of benefits produces conflicts, tensions and pockets of resentment among community members, separating the community along lines of winners and losers [93]. As has been a theme throughout this discussion, the implications of this are further amplified by intracommunity conflicts at the macro-level involving regional construction unions. These regional unions are characterized by a strong political influence and their relationship to mafia-style criminal groups:

"Any construction activity here will involve the unions and they are related to the history of this country, based in mafias which control unions… We try to compromise with landowners included in the project that they will be able to recommend one or two people, let's say that we impose those conditions to unions…that's why we have to constantly meet with unions, bringing the terms and conditions which we also discuss with landowners to make a deal" **(Developer, Juchitan)**

The link between these intimidations and mafia-style criminal organisations was mentioned numerous times by different interviewees, including project developers themselves. In this regard, both opposition members and landowners highlighted the role of criminal groups in charge of pushing USWP

projects and dissolving local opposition using intimidation, physical violence and even murder on behalf of construction union interests:

"The company labelled me as a social agitator, they wouldn't invite me to the meetings… I have been threatened to stop pressing the companies, because they played dirty in the beginning, but we are with the project now" **(Landowner, Union Hidalgo)**

Incoming USWP projects in the region are therefore sometimes perceived as a source of violence and degradation of community life. Interviewees who attended the Juchitan and Union Hidalgo Consultation processes claimed that these dynamics, which also existed before consultation was made obligatory, have inhibited the materialization of a truly democratic process. Both landowners and non-landowners signaled the role of groups linked to construction unions in engaging with intimidation techniques**.**

5.4 Lifecycles revisited

The integration of the identified stages of manufacturing, construction and consultation into current conceptions of the energy lifecycle framework permits several observations. First, it becomes apparent that the claims of injustice around the manufacturing stage are mainly related to what it lacks (e.g. the provision of jobs), while in the case of construction, injustices mainly manifest through what is created (e.g. the disruption of eco-systems and livelihoods). Claims of injustice around consultation, on the other hand, spin around its at times simplistic conception and timing and therefore, its inability to account for the complex pre-existing issues of justice in the region. As a result, the empirical evidence related to these stages in this paper illustrate that the systems-based approach provided by the energy lifecycle framework could be of great benefit to underpin and understand injustices embedded in energy systems. However, it also shows that the stages included in the energy lifecycle framework must be diverse enough and flexible enough to adapt to a wide diversity of energy systems.

More specifically, this paper illustrates that the Energy Lifecycle Framework approach used by Heffron and McCauley [15:660] as a tool to identify "where the issue fits within the energy lifecycle (or energy system)" is more complex than can be conceived of in theory. As an example, the claim related to oil spillages in the region links otherwise separate issues across the different stages of manufacturing, production, operation, supply and waste. In this regard, there appears to be merit in the reflection from Jenkins et al. [14:82], that "whilst each stage of the system may present its own unique justice concerns, it is only by conceptualising the system as a whole that its true justice nature and challenges can be understood.". Here then, a whole systems approach recognizes a "silo" approach to justice concerns as a weakness and frames energy systems as part of a wider justice system.

Indeed, it seems on reflection that a whole systems approach using the Energy Lifecycle Framework *can* lead researchers towards a structured and holistic understanding of how injustices arise from the interaction of technical and social elements along the energy lifecycle. However, in order to do so, a whole systems perspective must acknowledge that any given energy system is embedded into a pre-existing social, environmental, economic and cultural context. Such contextual understanding of energy

systems are therefore necessary to understand the production and manifestation of injustices, and it follows, to comprehend strategies for further remediation. Indeed, as has been discussed in this paper, RETs such as utility-scale wind have a distributed nature linking them to a specific geographical location [94,95]. This also intricately binds them into complex social, cultural, economic and historic background between a local stakeholder network [96–99]. Moreover, through the empirical evidence provided by this research, we have further demonstrated how these pre-existing contexts have a fundamental role in not only the underpinning and assessment of justices or injustices derived from the arrival of USWP projects, but in their later expression.

The case study drawn upon here also illustrates how impacts acquire culturally embedded understandings through the eyes of the inhabitants of the Isthmus. As an example, the quotations in this paper describe impacts to underground water resources, conceived as the veins of as a human circulatory system that are being blocked by the wind turbine bases, or as disruptions to the equilibrium of mother earth. Such more-than-human conceptions of injustices must be framed and understood within the indigenous context of the Isthmus and in relation to the existing bond between their inhabitants, the land and the sea. At the same time, the general feeling of distrust and resentment stemming from the lack of a promised manufacturing industry cannot be understood fully without considering the historical context of socio-economic deprivation, the lack of jobs, disappearance of traditional activities and trends of migration in the region.It was estimated that from June 2005 to June 2010 around 60,045 people migrated from the state of Oaxaca, with around 97% of them migrating to the United States of America [46]. Such contextual understandings of justice perceptions provide an explanation as to why, in this case study, the visual impacts were one of the most *infrequently* heard claims as opposed to case studies based in other contexts.

Therefore, the empirical evidence presented in this paper illustrates how the holistic framing provided by a Whole Systems approach to energy justice might be more practical when it comes to understanding contextual constructs of energy (in-)justice. However, an arguably more holistic whole systems approach might become problematic to operationalize through policy tools like quantitative and comparative Energy Justice metrics [100]. Even if both contributions emanate from the same call "to address justice-based concerns within energy systems, from production to consumption" [31:1] they might be better attuned for different and even complementary purposes.

Altogether then, we caution against attempts to provide universalized understandings of energy justice in support of more contextualised ones [24] that recognize how different groups experience complex geo-historically conditioned injustices in the provision of energy [1]. Put differently, the energy lifecycle framework is supposed to bridge the social and natural sciences accounts of energy systems, providing a technical structure or layout through which cosmopolitan principles of energy justice can be applied and operated [15]. However, this paper illustrates how this can only happen if we consider the surrounding local contexts in which energy systems are embedded. Futhermore, this paper illustrates how a lack of contextual understandings of justice while attempting to advance cosmopolitan justice through energy transitions, can actually result in the strengthening or legitimization of pre-existent injustices or the generation of new ones.

6. Conclusion

You did not install your wind farm in a lagoon, you installed it in an inhabited place, where people live, where this social dimension matters" **(NGO, Juchitan)**

The research demonstrates the usefulness of the energy Lifecycle framework [15] as a general technical layout through which injustices can be underpinned and understood, in this case, as they relate to USWP impacts over its different lifecycle stages. Such common understanding of energy systems lifecycle stages facilitate the exchange of knowledge related to globally inter-connected energy systems and energy technology supply chains using a whole systems perspective. Therefore, this framework opens opportunities to articulate improved discussions over embedded injustices across RETs lifecycle stages. As an example, the energy Lifecycle Framework could facilitate comparative studies between spatial injustices during the construction and operation of utility solar projects in India [71] and here, the USWP projects in the Isthmus over the same lifecycle stages.

Nevertheless, the ethnographic evidence in this paper also illustrates the limitations of the framework to assess injustices within an energy system, with implications for both this case study and others beyond it. The first limitation highlights the missing stages of construction, manufacturing and consultation from the energy lifecycle framework initially proposed by Heffron and McCauley [15]. This initial lack of stages affects the framework's ability to identify and account for injustices embedded in energy systems. Moreover, a lack of relevant stages hinders the framework flexibility to fairly adapt and represent the different lifecycle stages of any given energy system. This would restrict the usefulness of the framework as a general technical layout through which embedded injustices can be accurately underpinned, compared and discussed.

Secondly, awareness is raised regarding the potential misuse of the energy Lifecycle framework in assessing energy systems injustices through a disconnected, staged approach. This risks the framing of injustices as staged, atomized claims or issues isolated from previous processes in the lifecycle, all of which are required for holistic understandings and assessments. Therefore, analysing energy (in)justices using a siloed and staged approach would be in fact detrimental for a whole systems understanding and assessment of (in)justices in energy systems [14]. Thus, the addition of the generic stages of construction, manufacturing and consultation complement and strengthen this systemic view, which the conceptual framework intends to achieve.

In the same vein, this paper recognizes the limitations of the energy Lifecycle Framework as a universal standalone framework for assessing energy justice. In line with the existing literature, this paper acknowledges that "energy justice is an inherently spatial concept" [14:2], therefore it can only be analysed within its specific history, time, context and location" [1:608], and we might also add energy production technology. This resonates with ideas of socially produced space [101] and compels the realization that understandings of justice in energy systems will be influenced by site specific social, political, economic, environmental landscapes.

This research also illustrates how a whole systems perspective must acknowledge that any given energy system is embedded into a pre-existing social, environmental, economic and cultural context. Therefore, this paper promotes contextual understandings of justice [24] as absolutely necessary for the

successful assessment of energy systems [in]justices through the energy lifecycle. A lack of contextual understandings of justice while attempting to advance cosmopolitan justice through energy transitions can result in the strengthening or legitimization of pre-existent injustices or the generation of new ones. Here, the location of this research case study contributes new empirical evidence to the theoretical and conceptual debates on energy justice. Therefore, we believe that arguments presented in this paper make a wider-reaching contribution to scholarship on energy justice and renewable energy system more broadly.

That being said, this research also provides us with clear evidence against the notion that RETs, such as USWP, are inherently good or sustainable, illustrating how these technologies are not universally accepted in local communities. Awareness must be raised for a just implementation of such projects which takes into accounts the existing challenges posed by the combination of different RETs and a pre-existing context existing within the different communities who are acting as local vessels for a global energy transition.

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