# Energy justice in the transition to low carbon energy systems:

# Exploring key themes in interdisciplinary research

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With the dual challenges of reducing emissions from fossil fuels and providing access to clean and affordable energy, there is an imperative for a transition to a low carbon energy system. The transition must take into consideration questions of energy justice to ensure that policies, plans and programmes guarantee fair and equitable access to resources and technologies. An energy justice framework is outlined to account for distributional, procedural and recognition inequalities, as well as emerging themes such as cosmopolitan and non-Western understandings justice, in decision-making relating to energy systems. The spectrum of research offers critical perspectives on the energy transition as well as tools for decision-making and policy processes. Quantitative, qualitative and mixed methods all contribute to our understanding of the problems and the success of responses. The studies presented in this special issue illustrate that the field of energy justice is a rapidly growing arena. There is constant innovation taking place in enabling the transition with new structures, processes and metrics being introduced to guide decision-making and a more holistic view of the community emerging where acceptance, mobilisation and empowerment are opening possibilities for a just transition to a low carbon energy system.

Keywords: energy justice; distributional justice; procedural justice; just transition; whole energy systems; low carbon

## 1. Why energy justice?

Energy is of utmost importance to human and economic development and acts as a fundamental building block for the challenges encompassing sustainable development [1]. The twin goals of sustainable low carbon energy systems and enhancing the affordability and equity of new innovations require a nuanced understanding of social justice concerns [2-5]. On the one hand, there is a call to ensure affordable and clean energy access across the world's population and on the other hand, there is an imperative to address climate change through the reduction of fossil fuel use for energy. These two challenges are articulated in the Sustainable Development Goals[1] 7 and 13 respectively and require the consideration of social justice in terms of fairness in access and allocation of resources and technologies. Energy systems are understood broadly as multiple interconnected processes of generation and consumption. These include components related to resource extraction, production, conversion, distribution, delivery, use of energy and the provision of energy services [6]. Social concerns about the energy systems have been addressed in the past, see e.g. Goldemberg [7]; Reddy and Goldemberg [8]; UNDP [9]. Past experiences have shown that realizing energy projects or implementing energy policies across these components is seldom an uncontested process. From confrontations over oil and gas extraction, concerns over the sustainability of biofuels, to resistance against large-scale hydropower, wind energy projects as well as nuclear power, energy questions seem inherently fraught with conflict and sustainability concerns. This ultimately raises the question of energy justice: how can we understand and foster justice when considering past, present and future energy development of all types across the energy life-cycle, and including the key questions

[1] Please see http://www.undp.org/content/undp/en/home/sustainable-development-goals.html

as they relate to energy for *whom* and for *what* at *whose cost*? Considerations such as these have implications for the transition to a low carbon energy future that is inclusive and resource efficient.

The need to transition towards a less carbon intensive, and more just, global energy system is irrefutable. Considering how critical energy is for enhancing human opportunities and capabilities, the provision of clean, safe, affordable, and reliable energy services (e.g. lighting, heating and cooling, etc.) must be greatly expanded [1]. This objective is an unchangeable key component to sustainable approaches in energy policy-making [10]. The old injustices of a fossil fuel driven system will endure for some time yet. We should not deviate away from uncovering instances of distributional inequality, misrecognition or unfair processes as well as looking for effective policy solutions. At the same time, the new injustices of the low carbon energy transition are only emerging, many of which are not yet evident to policymakers or researchers. The energy justice framework is designed to provide normative and empirical assessments on both old and new contexts [11]. Anachronistic, well established, large-scale infrastructures are pitted against small, micro, modern counterparts, leading to the rebalancing of some old injustices whilst creating new logics of inequality. Given the clear impetus for an accelerated or drastic change of the energy landscape in the coming decades and the key challenges faced by many countries in meeting increasing energy needs, this Special Issue brings together a compilation of articles which examine energy justice across different scales, theoretical approaches and countries.

## 2. Energy justice frameworks

Defining or at least conceptualizing energy justice frameworks has been the subject of more than several books and papers [11-14]. Although the idea of energy justice has been articulated by activists in the environmental justice movement for several decades, it is only in the last decade that sophisticated theorizing of energy justice has taken place. In the process, the concept “energy justice” has come to be

used as a theoretical, policy, political and management tool. There are numerous central tenets of justice – distributional, recongition, procedural to which have been added cosmopolitan and restorative justice. These are the dominant forms of justice mentioned in the literature and the core tenets are summarised briefly below as a reminder for the reader to engage with these forms of justice as they read through the Special Issue. There are also a set of new frontiers that occasionally come up in the literature.

*2.1 Distributional Justice*

The global energy system is inherently unequal with regards to where technologies are located and who can access their outputs [15, 16]. Distributional justice entails an assessment of where the key impacts are located. In the US, energy justice has tended to focus on where polluting forms of energy production are situated. Often such instances are found within areas of social deprivation [17]. This has led several researchers to conclude that the location of poisonous energy related infrastructure has a bias to be located within not only areas of poverty but also of ethnic minority representation [18-20]. The identification of where technologies are located is not only about the production of energy. The development of low carbon energy is intimately connected to the dismantling of old fossil fuel infrastructures. Researchers in South America have underlined how extraction industries from the energy sector are extremely active in identifying cheap areas of land to be exploited, similarly in areas of social deprivation or protected indigenous land [21]. Waste management and decommissioning processes, particularly for oil and nuclear energy systems, also lead to the generation of inequalities in a given energy system, epitomised by a case study of Taiwanese nuclear energy [22].

*2.2 Recognition Justice*

The recognition that parts of society will unfairly suffer from the distribution of inequalities from the energy system is an insufficient conclusion. Through identifying where inequalities emerge, energy justice makes us reflect upon who exactly should we focus on when we think of energy victims [23]. This process is referred to as post distributional, or recognition-based justice [12, 24]. It is post-distributional in so far as the analysis of distributional inequalities must include a deep reflection upon where injustice emerges with regards to the impact on parts of society [25]. In our pursuit to identify where injustices emerge, decision-makers can overlook the true impact on neglected sections of society. It is therefore referred to as recognition justice, or rather misrecognition. Fraser [26] identifies three main categories of misrecognition; cultural domination, non-recognition, and disrespect. Cultural domination is highly relevant in many land and resource conflicts around the world, especially concerning the relationship between indigenous populations and extractive industries [27].

Environmental justice literature from the 1970s was designed to bring attention to particular groups such as the socially deprived or ethnic minorities [28]. It is essential that energy justice takes a wider perspective [29]. This does not mean that we should overlook patterns of poverty or racial driven infrastructure developments. It simply means that we should institutionalize a broader perspective on who can be disadvantaged by the logics of energy systems. The fuel poverty movement in the US and the UK has for example focused on elderly people [30, 31]. This movement is a means for raising to the attention of national governments the plight of inequalities generated by heating based domestic energy systems. Recognition justice challenges us to diagnostically reflect on the further potential of such movements. Recent research has highlighted the lack of access to affordable heating for disabled, or less able groups, in our society [32, 33]. Moreover, student populations are frequently overlooked as a section of society worthy of campaign based activity [34].

*2.3 Procedural Justice*

The right to fair process is the third principle in the energy justice framework. It unites distributional and recognition-based justice through a combined demand for both formal and informal forms of involvement in decision-making [35-38]. The identification of where an injustice takes place, or who is impacted upon, is inadequate for the eventual outcome of a more just experience for society with regards to energy systems. The fuel poverty agenda has been heavily focused on bringing to our attention to the plight of various parts of society with regards to heating demands [39]. The energy justice framework reminds us that our focus must also be driven towards policy based solutions that includes a full recognition of those affected – production and consumption – as well as the consideration of alternative locations [40] and practices [41]. Injustice is not only articulated but must also be challenged from location to practice in a meaningful way. Therefore, the right to fair process is not simply a call for inclusion in decision-making. It also involves a demand for involvement in delivering a more equitable outcome.

Formal processes should therefore be respected to achieve such outcomes. The legal system provides a globally recognised form of inclusion for aggrieved individuals or communities. In 2016, Scotland's undertook a lengthy consultation with a range of individuals, communities, policymakers, and other third sector representations on legislation referred to as ensuring environmental justice. The process recognised the fact that aggrieved individuals could not properly access the legal system due to the highly technical nature of environmentally related legal cases against the development of energy infrastructures. A second issue raised in the consultation was also the cost involved in developing a legal case [42]. Nevertheless, such moves to increase access to formal legal processes are examples of some improvements that may help individuals achieve just outcomes. Informal processes are much more difficult. They often involve substantial changes in culture, norms and values which may take some time [43].

*2.4 Cosmopolitan justice*

Cosmopolitan justice suggests that principles—such as those from distributive and procedural justice—must apply universally to all human beings in all nations. Cosmopolitan justice acknowledges that all ethnic groups belong to a single community based on a collective morality. Moellendorf [44] writes that cosmopolitanism implies that "duties of justice are global in scope, and these duties require adherence to general principles including respect for civil and democratic rights and substantial socioeconomic egalitarianism." Put another way, cosmopolitan justice accepts that all human beings have equal moral worth and that our responsibilities to others do not stop at borders.

When applied as a part of energy justice theory, cosmopolitanism holds that ethical responsibilities apply everywhere and to all moral agents capable of understanding and acting on them, not only to members of one community or another [15]. Such principles are espoused by major international statues such as the Universal Declaration of Human Rights adopted by the United Nations in 1948 and the International Covenant on Civil and Political Rights adopted by the United Nations General Assembly in 1966. They imply that transport and mobility (and energy) choices and technologies entail responsibilities global in scope, across the whole system. We see cosmopolitan themes in articles within the Special Issue in relation to negative externalities [45], the discursive strategies and actions of community activists [46, 47], the development of global whole system policy tools such as life cycle analysis [48] or energy justice assessment metrics [49].

*2.5 New frontiers*

Lastly, although less prevalent, a critique levied at the above approaches is that they (1) have mostly been derived by Western, or European and American, thinkers, not those from the Global South, and that (2) they focus on protecting humans, but not other forms of life. New theories and concepts have emerged from within the SI such as exnovation [46], energyscapes [50] or historical institutionalism [51]. While not exhaustive, Sovacool *et al.* [14] attempted to catalogue and summarize "alternative" or "new frontiers" in theory that are beginning to emerge in the literature. Table 1 offers a high-level summary of these theories and applications.

**Table 1: Summary of Non-Western and Non-Anthropocentric Theories and Applications to Energy Justice**

| Concept | Definition | Application to energy |
|---|---|---|
| **Ubuntu** | The act of building community, friendship and oneness with the larger humanity. | Neighbourhoods efforts to promote energy efficiency, decisions about energy resources within a community |
| **Taoism and Confucianism** | The Tao or Dao emphasizes the virtuous path that leads to greater harmony amongst humanity. It assumes a universal nature and the Means to an end is more important than the end itself. | Respecting due process in energy decisions, adhering to human rights protections when implementing energy projects |
| **Hinduism and Dharma** | Dharma carries the notion of righteousness and moral duty and is always intended to achieve order, longevity and collective well-being. It is context specific and doesn't render itself to | Seeking to minimize the extent and distribution of energy externalities, offering affordable |

| Concept | Definition | Application to energy |
|---|---|---|
| | universalization. Gandhi is a prominent example that espoused and practiced Dharma | energy access to help address poverty |
| **Buddhism** | Expounds the notion of selflessness and compassion, the pursuit of individual salvation or nirvana. Often criticized for its inability to deal with real social issues | Respecting present and future generations with energy decisions, minimizing harm to the environment and society |
| **Indigenous Perspectives of the Americas – e.g. Buen Vivir and Sumac Kawsay** | Cultivation of a cultural mindset that recognizes interdependence of all life and enables good living through responsibility and respect for oneself and the natural world, including other people | Energy systems developed cautiously through long-term experience and sovereign cultural protocols, avoiding dramatic transformation of ecosystems, requiring restoration |
| **Animal-centrism** | Difference in degree but not in kind between humans and all other animals. Valuing and recognizing rights of all sentient life | Energy development avoids harm and provides benefits to all sentient animals |
| **Biocentrism** | Valuing all living beings based on a reverence for life that stems from recognition of the will to live and the basic interest to survive and flourish | Energy decisions guiding by consideration of competing claims to a fair share of environmental resources among all living beings, where basic |

| Concept | Definition | Application to energy |
|---|---|---|
| | | welfare interests outweigh non-basic welfare interests |
| **Ecocentrism** | Moral consideration for human and nonhuman communities and the basic functioning and interdependence of the ecological community as a whole | An energy system is right when it tends to preserve the integrity, diversity, resilience, and flourishing of the whole community, involving direct caring relationships and formal rights of nature |

Source: Sovacool *et al.* [52]

## 3. Reflections on methods – research design and case selection

Researching justice involves a wide range of methodological considerations, approaches and reflections over appropriate research designs. Environmental justice was heavily criticised in the 1970s, 80s and 90s for being dominated by quantitative distributional based examinations [18]. More recent scholarship in environment [53, 54], energy [55, 56] and climate justice [57, 58] has become more qualitative and theoretical. Our special issue benefits from quantitative, qualitative and mixed methods research as well as theoretical reflections. A closer examination of the set of papers reveals a relatively even spread from constructivist to realist research traditions, with a modestly stronger presence from the former. A third of these papers involved some level of mixed methods research, normally involving quantitative surveys and qualitative focus groups or interviews.

*Applied Energy* is a journal that specializes in quantitative and engineering focused studies on energy. This special issue aims to complement that tradition by offering a unique insight into leading research on energy systems from a social science perspective, which values both quantitative and qualitative methodologies. The set of papers demonstrates the unwavering commitment of justice scholarship to quantitative (social) research design and application. We find a range of large and small scale survey-based approaches designed to explore the effectiveness of planning processes [59], social acceptability and transactions costs [60] or a comprehensive analysis of energy user experiences [61]. There are also more radical alternative quantitative assessments that examine the full costs associated with renewable and non-renewable energy sources [49, 62]. Indeed, we find that the application of quantitative methodologies in energy justice must develop more comprehensive approaches to incorporating associated frequently overlooked costs and benefits. Distributional justice stresses that potential or actual economic efficiency (via cost-benefit analysis) should not be a necessary or sufficient condition to justify energy policy or energy projects. Several papers [45, 49, 61, 63, 64] underline that greater quantitative treatment must be given to co-benefits or side-effects of low-carbon energy systems.

This Special Issue also recognizes the importance of qualitative research methods in examining questions of energy justice and thus extended the notion of applied energy into the realm of the social sciences. Nine of the papers draw on qualitative methods to bring an in-depth understanding of lived experiences, perceptions and discourses influencing energy justice in the context of low-carbon energy systems or specific technologies. The traditional method of in-depth interviews has been used to obtain expert and laymen inputs across different cultural contexts [50, 64]. In addition, interviews have been combined with other qualitative methods such as field observations and ethnography [65] and as part of participatory action research [66]. Discourses, perceptions, norms and values have also been studied in relation to understanding how people comprehend energy justice using discourse and content analysis [46, 67, 68]. Additional methods such as process tracing [45], historical political analysis [51], and

deliberative dialogue approach [47] highlight how qualitative methods can offer new research approaches to engaging the social, political and economic dimensions of just transitions to a low carbon energy system.

In the spirit of the interdisciplinary nature of the Special Issue, there are not only quantitative and qualitative studies but also four studies that explicitly apply mixed methods, combining both quantitative and qualitative methods in one study. Interviews and ethnographic field work has been combined with quantitative household surveys [69], and social lifecycle assessment draws on qualitative methods as well as quantitative indicators for energy justice [48]. Mixed methods offer a research design that allows different methods to be applied to one or more case studies in order to study an issue from several perspectives [59].

There is also a wide range of case studies and regional coverage on show in the special issue. Justice scholarship originated with a central focus on the US [70]. This Special Issue has a distinct global view of justice cultures, voices and realities is desperately needed if we are to sustainably transition towards a global low carbon future. For example, research is conducted in nation states such as Mozambique [69], Turkey and Colombia [50], Australia [67] and Canada [47] with the remainder focusing on several European contexts. The case selection process among the set of papers also revealed a split between those working on the dismantling of fossil fuel energy carriers (especially coal) and others focused on the justice implications of low carbon energy sources.

## 4. Key themes in the Special Issue

This Special Issue invited supply-side and demand-side researchers to consider explicitly the social justice and ethical questions involved in both the past, present and future development of low-carbon energy systems. Energy justice is a conceptual, analytical and decision-making framework for understanding

when and where ethical questions on energy appear, who should be involved in their resolution and ultimately which solutions must be pursued to achieve a sustainable energy system underpinned by fairness and equity. Interdisciplinary research efforts are thus required to address energy justice in a low carbon energy system. This special issue has attracted insightful contributions of lasting value pertaining to the growing research field of energy justice. The set of papers address a great variety of issues. We initially identified three themes revolving around community, transition and finance. We then developed two critical narratives that emerge throughout all papers on (1) enabling the transition (2) embracing a holistic view of community;

*4.1 Enabling the Transition: Inspiring new structures, processes and metrics*

Pursuing a 'just transition' to a low-carbon economy is proposed as one foundation upon which to build energy justice in a carbon constrained world [2, 3]. The primary contribution of this special issue is to connect work on energy justice with the critical imperative of moving away from fossil fuels towards a low carbon future. This inspired a wide range of empirical case studies throughout the world leading to multiple insights. Goddard and Farrely [67] use a qualitative case study approach to understand how a transition to renewable energy generation could be achieved in a way that secures energy justice for traditional energy production regions like those of Gladstone in the Australian state of Queensland. This study proposes that a just transition management framework must be adopted in Australia if a move away from fossil fuels were to be possible. The central component of this framework creates powerful niche actor networks to counter the narratives and influence of the fossil fuel industries. The transition towards a low carbon future needs to be enabled through new management processes and associated structures.

The way in which we visualise the transition must allow us to consider its fruition more effectively. Castan Broto *et al.* [69] engage energy justice in the postcolonial context of Mozambique by arguing for

the recognition of non-western traditions of thought through a dialogue between postcolonial and energy justice scholars – resulting in a more sustainable long-term transition. In a similar contribution to bridging theoretical frameworks, Sareen and Haarstad [65] outline an analytical approach that pulls together critical aspects of both socio-technical development and energy justice in understanding sustainable transitions by accounting for the co-evolution of institutional change, material change and relational change, with a cross-cutting concern for multiple spatialities and normative implications. Cardoso and Turhan [50] focus on fossil fuel dependency by examining the changing 'energyscapes' of coal operating on different layers (the market, the physical, and the socio-environmental damages) between Colombia and Turkey. McCauley *et al.* [51] reveal through their study of nuclear energy that a full appreciation of path dependency theory and critical junctures is needed if such a transition is to occur quickly.

The transition to low carbon energy systems needs new models of financing and investment. Articles in the Special Issue address the theme of energy financing as central to this transition. Hall *et al.* [64] questions the justice implications of capital mobilisation for energy investments, and what alternatives there are to commercially-oriented finance for low carbon energy systems. This paper uses a comparative analysis of two developed economies to explore how 'alternative' forms of finance operate in each nation's energy investment landscape and suggest 6 principles that are key to 'just' energy finance: affordability, good governance, due process, intra-generational equity, spatial equity, and financial resilience. Evensen *et al.* [60] examines public perceptions in the UK of who should fund programmes designed to ease the transition to a more sustainable and equitable energy system, finding most responsibility assigned to energy companies, and beliefs about procedural justice meaningfully shaping thoughts on who should pay.

Wider assessments of the true cost of fossil fuel sources are also required to make the case for a low carbon transition. Heffron *et al.* [49] develop an energy justice metric that reveals a more holistic approach to comparing the relative cost of fossil fuel and low carbon energy sources. By embracing the

principles of energy justice, an empirical quantitative study shows that fossil fuels are more expensive when all environmental, economic and social costs are incorporated. Chapman *et al.* [62] put forward an alternative assessment technique, incorporating various indicators of social equity to assess the priority of power plant replacement in Australia that would lead to the greatest improvement in benefits, while placing the burden of system changes away from the most vulnerable. Fortier [48] develops a social life cycle assessment that reveals a more comprehensive picture of impacts of smart grid systems through comparing evidence from the Netherlands and the United Kingdom.

### *4.2 Embracing A Holistic View of the Community: Acceptance, mobilisation, and empowerment*

The dominant view of the community in the energy sector revolves around how best to achieve a sufficient level of acceptability for energy infrastructure projects to take place. The justice question is often reduced to the extent to which developers have successfully imposed or convinced a local community to accept both the positives and negatives of a given project. Roddis *et al.* [59] analyse the effect that community acceptance has had on planning applications for onshore wind and solar farms in Great Britain between 1990-2017 by compiling a set of indicators for community acceptance. They investigate the relative importance of 12 statistically significant variables finding that the visual impact of low carbon infrastructure projects is of course important. We must, however, be cognisant that other variables such as the installed capacity, the social deprivation of an area and the year of the planning application are equally if not more important in many instances. Building on this critique of overly simplified views of public acceptability, often dominated in the low carbon sector by visual impacts, Evensen *et al.* [60] question whether sufficient time and effort is allocated to considering who should pay for the implications of planning and engagement processes. They propose amounts and types of environmental and social levies that could be tied to public acceptance.

The energy justice framework applied to the low carbon energy sector must include reflections on public acceptability, but equally challenges scholars to reflect further on the role of community. Acceptability positions the community in a rather passive role vis-a-vis governments or developers. The community is an active player, crucial to proactively shaping a low carbon energy future. Communities also actively frame and reframe planning processes. Mundaca *et al.* [45] demonstrate in their study of low carbon energy systems in Samsø (Denmark) and Feldheim (Germany) that the perceived fairness of procedures was a critical pre-condition for the perceived legitimacy of outcomes. This is even though some groups were perceived to also benefit from the transition. In addition to this cognitive function that community groups play in planning processes, Dolter and Boucher [47] present an application of deliberative dialogue between developers and community in the design of solar energy programs and offers an example of due process in the program design stage of energy planning. The use of deliberation dialogue in Saskatchewan, Canada suggests that centering due process as a core element of the energy justice decision-making tool can help to achieve energy justice.

The mobilisation of the community to engage both cognitively and physically in planning processes must be considered alongside processes of resistance. Focusing on an indigenous community, Hulbert and Rayner [71] use the trivalent energy justice approach in analyzing the case of the Chippewas First Nation, a Canadian Indigenous group opposing a pipeline expansion and explore what the Chippewas' consider recognition justice and how it intersects with distributive and procedural justice. Using the example of Germany, a setting of deep fossil fuel incumbency, David [46] compares two organizations aiming to achieve energy justice via exnovation (the removal of carbon intensive energy structures) by offering a perspective on the repertoires of contention used as strategies for energy justice. Mobilisation of community groups within the context of energy justice involves both a desire to meaningfully participate in engagement processes as well as to inspire resistance where procedural and distributional injustices occur.

The low carbon energy transition involves processes of acceptance, mobilisation and also empowerment. Lacey-Barnacle and Bird [66] examine the critical influence of intermediary organisations, in the 'civic energy sector' and shows how intermediaries act as a critical bridge between local low-carbon energy initiatives and deprived communities; raise awareness of funding opportunities to otherwise excluded community groups, and, where possible, seek to localise the emerging economic benefits of low-carbon transitions. Such organisations are both empowered in this low carbon transition, as well as crucial instruments for empowering communities. Empowerment in this transition involves an examination of both who is empowered, but also who is disempowered. Bartiaux *et al.* [61] draw on an analysis of energy access of all households in Belgium to discuss the implications of the revealed deprivation of capabilities to imagine otherwise transitions to low-carbon energy systems. Willand and Horne [63] combines the capability and practice approaches to analyse a retrofit intervention trial to reveal recognised and hidden vulnerabilities and practiced distributive and procedural energy fairness in the lived experiences of low-income older and/or frail householders near Melbourne, Australia. Milchram, Hillerbrand [69] broaden conceptualizations of energy justice for smart grids by developing a deeper understanding of the social and moral values underlying the Dutch and British public debate on these systems. Values as reflected in newspaper articles show both as advantages and challenges of smart grids. Their analysis reveals that distributive and procedural justice aspects are perceived to be at the core of many benefits and drawbacks of smart grids. Smart grids have the power to contribute to a more equitable access to electricity systems. However, this access might be restricted to more affluent parts of a population and reinforce monetary injustices faced by economically vulnerable citizens.

## 5. Conclusion

This Special Issue is built upon a foundation that addressing the transition towards sustainable low carbon energy systems means recognizing and addressing energy justice. The collection of articles that has been brought together reflects the broad scope and implications of energy justice. Questions of distribution, recognition and process, as highlighted in the energy justice framework, can be framed and applied across all components of the energy system and in relation to varied actors and policies. Given the lessons from the broad geographical and cultural scope of the articles in the Special Issue, it is apparent that this framework is also expanding to recognise different worldviews, experiences and voices through embracing a holistic view of community whilst acknowledging the need for cosmopolitan justice. Pluralism also exists in the range of methods that are being applied to address energy justice. Traditionally social and natural sciences are being brought together in interdisciplinary research using quantitative and qualitative mixed-methods in single studies. There is also theoretical and conceptual complimentarity developing in enabling the transition. The energy justice framework itself is being extended to combine with other theoretical frameworks such as transition management, postcolonial theory and the capabilities approach for more nuanced analyses and the development of tools to support decision-making and policy-related processes.

The advances in concepts, methods and theory have been applied in the Special Issue across a wide spectrum of contexts, policies and components of the energy system. It is clear in the research presented that in engaging justice in a transition to a low carbon energy system we must respond to both fossil fuel legacies and new technologies. In both circumstances, the research suggests that policies and procedures must give greater agency to community as important energy actors.

As an emerging area of research in an evolving and dynamic energy system, there are still many areas that need to be further explored and researched. We propose that further research is needed on the expansion of non-Western approaches to energy access and justice; more quantitative and empirical testing of the integration of the energy justice framework with other analytical frameworks; and

additional research on bottom-up community led initiatives for energy democracy and energy sovereignty.

This special issue provides a valuable foundation for further research on justice in the transition to a low carbon energy system and we hope the readers of *Applied Energy* are inspired by the articles to contribute new knowledge in the field of energy justice.

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