Applied Energy 228 (2018) 645–655

Contents lists available at ScienceDirect

Applied Energy

journal homepage: www.elsevier.com/locate/apenergy

Energy justice and sustainability transitions in Mozambique

Vanesa Castán Broto[a,*], Idalina Baptista[b], Joshua Kirshner[c], Shaun Smith[a], Susana Neves Alves[d]

[a] Urban Institute, University of Sheffield, United Kingdom
[b] Department for Continuing Education, University of Oxford, United Kingdom
[c] Environment Department, University of York, United Kingdom
[d] The Bartlett Development Planning Unit, University College London, United Kingdom

HIGHLIGHTS

- New methodologies and concepts are required to deliver energy justice in the global south.
- The postcolonial critique helps develop current theory of energy justice.
- Energy sovereignty emphasises self-determination and autonomy as a condition for justice.
- Energy transitions in Mozambique are fraught with contradictions.

ARTICLE INFO

Keywords:
Energy transitions
Energy justice
Energy sovereignty
Mozambique
Energy access
Postcolonialism

ABSTRACT

This paper advances the debate on energy justice by opening up a dialogue with postcolonial critiques of development. There is an imperative to develop energy justice theory fit to address the complex demands of a global energy transitions in poorer countries of the Global South. Delivering transformative change in contexts where energy systems are underdeveloped requires assessing energy justice principles from multiple situated perspectives, adjusted to the conditions that shape the possibilities for action. However, current theorizations of energy justice tend to build upon universalist notions of justice within a western tradition of thought which may not be entirely appropriate to deliver policy in postcolonial contexts.

This paper offers a situated, particularistic analysis of energy transitions in Mozambique - a country which faces massive energy access challenges - to open a dialogue between theories of energy justice and postcolonial critiques. The paper focuses on three aspects of the energy transition occurring in Mozambique: the logics and impacts of off-grid innovation, the situated transformations occurring in the electricity network, and how transitions in energy fuels shape household experiences of energy access. The conclusion proposes two recommendations as key agendas for future research. The first is a methodological need for research methods to examine energy justice challenges from within specific, situated understandings of energy delivery. The second entails a call for emancipatory notions of energy justice that integrate concepts such as energy sovereignty at their core to emphasise the dimension of self-determination as a complementary aspect of energy justice.

1. Introduction

In June 2017, Mozambique received the news of the construction of a 40.5 MW photovoltaic power extension in the Mocuba district, in Zambezia. Zambezia is one of the provinces with the lowest rates of electricity access in the country, around 10% against a national average of 22% [1]. The solar power plant could make an enormous difference to provide sustainable electricity access. An agreement between Mozambique's national electricity company (Electricidade de Moçambique, E.P., or simply EDM) and the Norwegian energy producer Scatec Solar has made it possible the investment of US$76 million of which 55 million will come from the International Finance Corporation (ICF) and the rest from EDM [2]. Mocuba's solar plant demonstrates the rising importance of energy transitions in Mozambique. First, renewable technologies have become a means to harness the development opportunities of the green economy, attracting international investors to Mozambique - from Norway and Dubai to China. Second, renewable technologies have the potential to address massive energy access challenges in Mozambique.

Addressing the Sustainable Development Goal 7, the energy goal, requires understanding the trade-offs and synergies between the opportunities for sustainability transitions and the energy access

* Corresponding author at: Vanesa Castan Broto, ICOSS, University of Sheffield, 219 Portobello, S14PD Sheffield, United Kingdom.
E-mail address: v.castanbroto@sheffield.ac.uk (V. Castán Broto).

https://doi.org/10.1016/j.apenergy.2018.06.057
Received 1 December 2017; Received in revised form 4 June 2018; Accepted 8 June 2018

challenges [3], particularly in countries that present the largest gaps in electrification and fuel access rates, such as the case in Mozambique. The low carbon transition offers opportunities for rethinking how to deliver universal energy access, because increased renewable energy consumption has a positive impact on economic development and poverty reduction [4]. However, the low carbon transition depends on the political economy of energy and makes manifest the inherent inequalities in current energy systems [5–8]. Questions of justice pertain to both low carbon and energy access agendas [9,10].

There is a need to mobilize the conceptual workbook of energy justice in practical ways that make a meaningful contribution to people's lives. However, this conceptual workbook emerges from within a western-based tradition of thought. Transition possibilities in countries with large deficits in energy access are shaped by post-colonial legacies and the hegemonic dominance of the West in shaping economic and political agendas [11]. Western traditions of knowledge are suspect in postcolonial contexts because they advance strategies of domination and overlook non-western traditions of thought. In this paper, we argue for a dialogue between postcolonial and energy justice scholars about the social construction of energy justice truths in a post-colonial context, and the extent to which universalist conceptions of justice may overlook particularities that determine the eventual outcomes of an intervention seeking to deliver energy justice (see also [12]).

Mozambique is a unique case that shows the importance of post-colonial thinking in countries with massive gaps in energy access. Section 2 explores the rise of discourses of energy justice and Section 3 situates those debates in the context of a global energy transition. Section 4 presents the case study of the energy transition in Mozambique and the methodology. Section 5 reviews the empirical results attending at three areas of analysis: the impacts of off-grid innovation, the transformations taking place in the energy grid, and how the transition shapes household experiences of energy access. The paper concludes with two recommendations. The first is methodological, regarding the need for research methods that look at energy problems from within specific locations. The second is conceptual, calling for a synthesis of emancipatory notions of energy justice and energy sovereignty.

2. The rise of discourses of energy justice

In less than a decade, energy justice has graduated from an emerging critical concept to a framework for decision-making [13–16]. Ideas of energy justice permeate the discourse of activists, from Navajo communities to high-profile campaigns by Greenpeace. The focus is on energy justice as a practical strategy to redefine business models and established ways of doing things in the energy sector [14,17].

As energy justice theories draw on the experiences of the environmental justice movement [18–20], they reproduce the well-established 'three-legged' framework, which considers justice in terms of distribution, recognition and procedural justice (e.g., [21–23]). This framework, systematized by Schlosberg [24], settled a long-standing debate on the need to consider environmental sustainability alongside social justice concerns [25].

Jenkins et al. [22] have re-articulated the three-legged framework in an evaluative-normative axis. With regards to the 'distribution' dimension, an evaluative approach entails asking 'where are the injustices,' whereas a normative approach entails asking 'how can these injustices be addressed.' With regards to the 'recognition' dimension, an evaluative approach asks whose views are overlooked or ignored, while a normative approach focuses on taking active steps to recognize those views. Finally, with regards to the 'procedural' dimension, there is an evaluative question about the fairness of the process, and a normative one, about the possibility to design and deliver alternative processes that could enhance the overall process of decision-making.

In the field of energy studies, environmental justice raises two challenges. First, scholars have sought to develop frameworks that take into account the particularities of energy systems: the mechanisms whereby energy systems appear to exhibit higher levels of complexity, institutional reciprocity, stakeholder engagement, embeddedness, and path-dependence [9,10]. This means navigating the dichotomy between the global and the local (see also: [26,27]). For example, Sovacool and Dworkin [14] draw on global comparisons to advance energy justice debates in international policymaking. However, their examples demonstrate that international policymaking depends on multi-scalar dynamics, shaped by strategic interests and everyday practices.

Secondly, energy scholars have developed practical frameworks to advance energy justice in energy transitions. In particular, energy justice ideas may pose a challenge to the engineering and economic frames that dominate energy policy [14]. An appropriate conceptualization of energy justice is both an essential guide for any energy transition and a strategy to maximize the social justice impacts of the transition. Energy justice may follow the development of new technologies such as microgrids [18]. However, actions to foster transitions may also reproduce entrenched forms of inequality. For example, studies of wind energy and facility siting suggest that large-scale renewable energy developments can have considerable negative social and environmental impacts [28–32]. Not all transitions are just, and transitions themselves may generate further inequalities [33].

Sovacool and Dworkin [14,15] emphasize the performative character of justice discourses. They argue that discourses of justice can establish a relationship between the individual and society that requires looking beyond individual preferences, focusing instead on collective mechanisms. In doing so, energy justice is above all a tool for better decision-making. The scholarly trend is thus to move towards deliberately simple definitions of justice and easy to grasp justice principles that can appeal to a cosmopolitan audience of ethically-concerned energy practitioners and policy-makers [16]. The energy justice frame supports the development of a moral compass to make decisions about energy [14,15,17]. More recently, scholars have systematised these principles into practical instruments such as environmental justice metrics [13,34].

There are limitations to the adoption of energy justice discourses. Even when the details of action are precise, energy may not translate directly into feasible recommendations. Hoffman's [35] seminal paper on energy justice already lamented the gap between the popularity of energy justice discourses and the lack of adequate regulatory and sanctioning actions. He argued that there is no 'smoking gun' to translate good justice-inspired principles into concrete, affirmative action. This is an old problem that persists. Fuller and McCauley [21] found activists wary of energy justice frames because, they argued, such frames were not conducive to effective action. This paper is concerned with a pervasive problem that has received less attention in the energy justice literature. The articulation of energy justice discourses at a global level may lead to the uncritical translation of a universalist discourse on justice, to the specific context in which western-notions of justice may be wholly inappropriate. This problem becomes visible when examining global energy transitions.

3. Energy justice for global energy transitions

While there has been a rapid increase in the use of renewables worldwide, progress towards universal energy access has been too slow [36]. At the current rate of progress, achieving universal access to electricity will take 53 years, and universal access to clean fuels and cooking will take 92 years [36]. According to the Global Tracking Framework, industrialization and urbanization appear to improve rates of energy access in Asia. However, despite improvements in countries such as Kenya or Ghana, energy access rates in sub-Saharan Africa are stagnant. In countries like the Democratic Republic of the Congo and Angola, rates of access have even worsened. Energy justice debates are particularly relevant in countries with stagnant or decreasing rates of energy access, of which Mozambique is an example.

Table 1
Key aspects of each dimension of energy sovereignty.
Adapted from [52].

Dimensions of energy sovereignty	Key aspects
Connection to socio-ecologically responsible relationships	Resource exploitation discourses and practices (multinational companies, distribution utilities, local producers) Practices of territorial and resource control (e.g. network distribution) Means to implement differentiated and unequal service provision Connections between resource use and livelihoods
Self-determination in relation to business models and technologies	Challenging impositions of top down assumptions about energy access such as 'economies of scale' and 'comparative advantage' Functioning of different business models (e.g. subscription, pre-paid) Functioning of different service provision models (e.g. centralized, off-grid) Discourses for the prioritization of alternatives Circulation of technological alternatives
Participation in decision-making and innovation	Participation of community members in decision-making Recognition of contextual knowledge and local priorities Active challenging of discourses that misrepresent communities' needs and perspectives

In these countries, postcolonial debates pertain the study of development interventions and infrastructure development [37]. Postcolonial perspectives call for a historical reading of energy challenges in light of the diverse colonial experiences of different countries and regions [11]. The postcolonial critique also points towards a global cultural legacy of oppression and exclusion [38]. This perspective highlights that we operate in fundamentally unjust systems of knowledge production, whose logic of operation responds to the values and perspectives of elites in the West and reproduces unequal power relations. Notions of energy justice emerge from within Anglophone philosophical traditions [14], and they are suspect in their intent to modernize. Attempts to decolonize energy knowledge start from questioning the self-evident truths of knowledge, especially its most familiar points of reference that often go unquestioned [39].

The energy justice literature is sensitive towards the dangers of normalizing universal ideals into a single perspective [27]. The principle of recognition, for example, advances pluralist approaches to decision making and rationality [40]. This principle is a celebration of the particular. Schlosberg and Carruthers [41] argue that a pluralistic discourse of justice can integrate a range of demands from indigenous peoples, attending at their collective (rather than individual) experiences of justice. The constitution of decision-making regimes appears as an external imposition that indigenous peoples have to navigate. Recognition is a condition for the incorporation of excluded groups into an otherwise hegemonic regime.

The post-colonial literature is also skeptical towards calls for modernization. Modernity projects may reproduce inequality and injustice, rather than recognizing the myriad ways in which societies flourish and deliver multiple forms of individual and collective wellbeing. A long tradition of scholarship in development studies demonstrates the pitfalls of models of sustainable development generated in the West and parachuted into developing country contexts without giving proper consideration to the context of action [42]. For example, much energy policy focuses on developing universal, best practice models that can be implemented uncritically in any context (e.g. [43]). Tomlinson [44] has argued that expert-driven models of best practice from the north undermine the development of knowledge of people's in the south, and hence, they hinder their autonomy- even when best practice models are often ineffective or unfeasible. For Urpelainen [42], best practice policies require specific conditions to ensure success, conditions which are often absent in postcolonial contexts.

The postcolonial perspective emphasises specific aspects of energy justice. The imposition of hegemonic perspectives on energy development has practical implications for the material experience of energy systems. Empirical evidence on access to cooking fuels questions the idea that there is a universal model of clean fuels. For example, a recent assessment of the transition to 'modern' energy fuels in Sierra Leone reveals how simplified models of transitions to clean fuels may be inadequate to address people's energy needs [45]. The authors argue that international development organizations tend to think of LPG as the 'modern' alternative to traditional cooking fuels such as charcoal. In the standard global narrative, increasing access to LPG is more just. However, when looking at the case in context, increasing access to LPG in Sierra Leone may create further injustices, particularly if accessing modern fuels means for households losing their autonomy and increase their dependence from large multinationals [45].

Energy scholars argue that the energy justice framework can put governments to task by establishing fairer systems for decision-making in energy planning. However, an emphasis on formal decision-making can obscure informal and tacit practices which shape the actual outcomes of the process. For example, Yenneti and Day [46] study of the case of the Charanaka solar park in Gujarat, India provided recommendations for the participation and inclusion of minorities in the government-led '*Jawaharlal Nehru National Solar Mission*' launched in 2010. However, their analysis reveals that, aside from the less-than-virtuous process of decision-making, the complexities and servitudes embedded in the caste system determined the outcomes in the case of Charanaka. In sum, current energy justice frameworks may not be sufficient to challenge existing structural determinants that prevent cultural and social transformations towards just and sustainable futures.

The literature on energy sovereignty connects energy justice and postcolonial debates on energy. Energy sovereignty is, generally, the right of people to access energy resources within ecological limits to have a dignified life [47]. From this starting point, the concept of energy sovereignty builds upon two fields of theory. First, there is an anthropologically-inspired notion of resource sovereignty that contests directly western models of resource management and exploitation [48]. The notion of 'sovereignty' emerges in indigenous struggles as a means to claim the historical injustices embedded in the contemporary use of land and resources [49]. Second, there is a body of research that engages with activist movements to claim indigenous rights over land and resources (e.g., [50]). This movement demonstrates sensitivity towards energy sovereignty (e.g., [47]). Buiding on the work of McMichael [51], Castán Broto [52] has argued for a three-dimensional understanding of energy sovereignty (Table 1).

Energy justice ideas work together with the principles of energy sovereignty presented above. However, the most significant difference between both approaches is that the concept of energy sovereignty focuses on delivering energy as an emancipatory project. By advancing energy sovereignty debates, self-determination becomes the core of energy justice thought. Again, an added difficulty is that ideas of self-

determination and autonomy rely on Western theories of social development [53]. However, an emerging shift of thought towards conceptions of justice starts from a commitment to let people make decisions about their lives. In a post-colonial context this also means learning to recognize how people themselves engage with the making of technologies of everyday life, through hybrid forms of contextually generated innovation and the appropriation of external ideas [54].

In summary, energy sovereignty thought complements energy justice thinking by emphasizing the need to recognize the autonomy and self-determination of people in framing energy decisions that affect them, including the frames applied to evaluate them ([52], see also: [49]). A multi-scalar examination of energy justice challenges in Mozambique, a country with one of the poorest rates of energy access across in the world, provides insights into the avenues for developing a postcolonial perspective on energy justice.

4. Methodology

4.1. Understanding energy dilemmas in Mozambique

Mozambique is a country of almost 29 million people, frequently found at the bottom of the development tables, such as the Human Development Index. In 2015, with a GDP per capita of US$380 per person, life expectancy at birth was 58 years, and 46% of people lived in poverty (down from 70% in the late 1990s).

In Mozambique, the abrupt end of Portuguese colonialism in 1975 left a vacuum of expertise and infrastructure as the country descended into a civil war between the Frelimo-led state and the Renamo opposition guerilla for the next sixteen years (1977–1992). The 1980s were characterized by a decline in population and life expectancy, migration to cities and towns, and economic decline and crisis. The end of the war marked the beginning of an age of relative prosperity and growth for the whole country. However, over the last five years, the economy of the country was affected by a debt scandal, as secret loans of over $2 billion were procured by the government. This occurrence exposed that national elites were able to use global financial capital to make decisions with little accountability to the general population. Further public indebtedness meant that less funds were available for other social sectors [55]. Inflation and withdrawal of donor support have propelled an economic and social crisis.

Mozambique has one of the lowest rates of electricity access in the world. Rates of electrification remain low at 20.1% [36]. This statistic hides a significant divergence between rural areas, where access remains low at 5.7%, and urban areas, where rates of access have grown to 54.5% (Fig. 1). Electrification rates have improved considerably since the end of the war (Fig. 2), but the supply is most often intermittent and unaffordable.

The majority of people in Mozambique still rely on charcoal and biomass to meet their most basic energy needs (Fig. 1). Urban dwellers rely on charcoal, while fuelwood remains the primary fuel in rural areas. CO_2 emissions per capita are low (0.31 metric tones per capita) but the low carbon transition is of great significance for Mozambique,

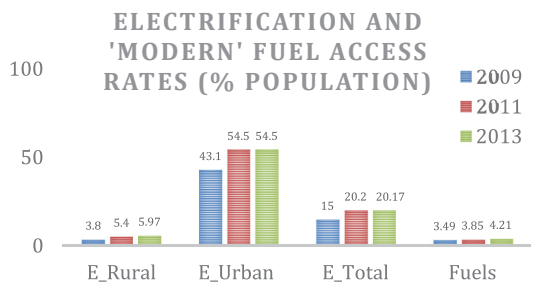

Fig. 1. Energy access in Mozambique (own elaboration from data from the Global Tracking Framework).

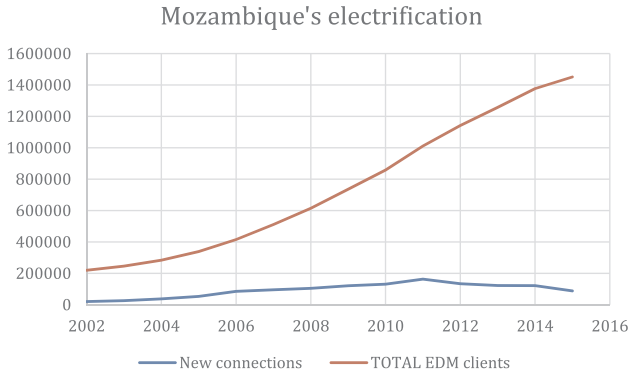

Fig. 2. Mozambique's electrification rate since 2002 (Own elaboration with data provided by Mozambique's public electric utility EDM).

as renewable energy technologies offer hope for rapid electrification of remote rural areas. Mozambique's energy system appears to be in transition: renewable technologies are rapidly changing the expectations of energy access in rural areas and helping imagine alternatives in urban areas. Simultaneously, deforestation affects the supply of charcoal and fuelwood, while there is a political imperative to use the countries' fossil fuel resources (including the newly discovered deposits of natural gas in the northern Rovuma basin) to benefit a broader sector of the population.

4.2. Research methods

The empirical research presented in this paper is a synthesis of insights generated from different research projects undertaken in Mozambique since 2012. This work is synthesized into three main aspects: the territorial deployment of low carbon innovations with a focus on rural areas; examination of the attempts made to deliver the social mandate of universal electricity access; and the contradictions embedded in fuel transitions in urban areas. The methodology of each of these aspects is described in greater detail below.

The section which follows focusses on the issue of low carbon innovation drawing on three phases of multi-site fieldwork conducted in Mozambique in 2013 and 2014. In the first phase, data was gathered through 75 semi-structured interviews with officials at EDM (the state-owned electricity provider), FUNAE (a public agency responsible for rural energy), and several government ministries, including Mineral Resources and Energy, Environmental Management, Foreign Affairs, and Planning and Development, and the Centre for Investment Promotion, which channels foreign investment projects. The interviews focused on institutional histories, energy development priorities, investment strategies, donor engagements and locational characteristics. The second phase, in partnership with the development charity Practical Action, included site visits to six off-grid energy service projects in Manica and Zambezia provinces, and a solar equipment assembly plant outside the capital city, Maputo. The visits explored the configuration of energy resources, technologies, infrastructures and demand in different parts of the country. Return visits in 2015 and 2017 enabled follow-up interviews in Maputo and Beira. The third phase consisted on a systematic review of major low carbon projects funded with international capital in Mozambique up to December 2017. The analysis situates the qualitative insights of previous research within the overall landscape of low carbon innovation in Mozambique.

The second section on the operation of the electricity network draws upon the results of three ethnographic field visits made in 2013, 2015 and 2017. These field visits focused on various aspects of the operations and management practices of Mozambique's national public electricity company, EDM, including electricity distribution (such as implementation of the prepaid systems), the management of blackouts, and workers' practices. This data has been reinterpreted in the light of a

historical analysis of the history of EDM in the political context of Mozambique and a review of EDM's electronic archival records.

The third section reviews household experiences of fuel transitions in the capital, Maputo. Initial research took place to study household experiences of energy access in the low-income Chamanculo C neighborhood of Maputo. Research methods included semi-structured interviews with residents and institutional representatives, a workshop for the participatory mapping of energy infrastructure in July 2014, and a follow-up household survey of energy needs and uses. A particiaptory workshop with local Secretários do Bairro ('Neighborhooud Secretaries') was conducted in July 2017 and an interview survey of 62 respondents across four neigborhoods in Maputo (Polana Caniço A, George Dimitrov, Magoanine C, and Bairro dos Pescadores) took place from July to October 2017. Interviews were conducted among low and lower-middle income residents to understand their experiences of energy access and perceptions of energy transitions.

5. Energy transitions in Mozambique

5.1. Justice and off-grid innovation

In Mozambique, the development of new energy resources, infrastructures, and technologies is shaped by networks operating through and beyond the state, while maintaining the political-economic power imbalances guiding energy system development (cf. [56]). Two strategies for supporting energy transitions are emerging. First, a strategy of grid expansion in which EDM is extending transmission infrastructure to meet growing demand, particularly in urban and peri-urban areas. Second is a strategy of decentralized generation, operating off the main grid, and shaped by a recognition of the limits of grid extension and by donor priorities for addressing energy access and climate agendas. This second strategy is most often associated with low carbon innovation.

Table 2 presents an overview of the key characteristics of salient low carbon projects funded through international climate finance mechanisms such as the Global Environmental Facility or the ACP-EU Energy Facility from 2003 till 2017. The projects have a combined value of over US$170 million. While the sample of projects is still small (13 major projects), the results illustrate the dominant trends in low carbon policy in Mozambique. First, 10 out of 13 projects are for energy generation, with a minor representation of projects oriented towards addressing directly household challenges. Second, low carbon projects prioritize off-grid solar PV and off-grid technologies (see also [57,58]). Third, regarding geographical remit, low carbon innovation is exclusively directed towards rural areas, with a minor interest in peri urban locations, although this interest is circumscribed to a limited number of biomass and fuel access projects.

The qualitative analysis of the interviews illustrates the institutional dynamics that have shaped this landscape of low carbon innovation. FUNAE (Fundo de Energia), the state agency responsible for rural energy services, is responsible for the growing interest on decentralized solar in rural areas. Mozambique's central government established FUNAE in 1997 with Danish assistance, and it initially supplied diesel generators and kerosene in rural communities lacking energy services [58]. By the early 2000s, its focus had shifted to promoting, supplying and financing renewables. While FUNAE has developed some microhydro and pilot wind projects, its main focus is on solar PV.

Table 2
Low carbon innovation in Mozambique.

Type	
Energy generation	10
Household fuels and innovation	3
Dominant technologies	
PV	8
Hydropower	2
Biomass	3
Distribution model	
Off-grid	11
On-grid	1
Mixed	1
Geographical remit	
National programme	2
Rural areas	9
Rural and peri-urban areas	2
Total initiatives	13

From 2000 to 2011, FUNAE installed over 1.2 MW of PV capacity with the support of European and Asian donors. FUNAE [59] calculated that some 1.5 million Mozambicans benefited directly from installed solar PV systems by 2012, representing about 0.8Wp per person.[1] More recently, solar power installed capacity was estimated at 2.2 MW in the country [61]. While the amount of electricity supplied is small, solar PV is seen as making a significant difference in rural areas where access rates are extremely low (e.g. [58]). Moreover, the focus on PV fits within an overall rhetoric of a country rich in energy resources. In 2014, the Mozambican government published the Renewable Energy Atlas of Mozambique, which maps several hundred projects on a technical and economic pre-feasibility level; it estimated renewable generation potential of 23,000 GW, with the vast majority from solar [61].

As our analysis of projects shows, solar PV has facilitated new forms of off-grid rural electrification. Here, distance from the existing electricity grid network influences the uptake of PV in specific contexts: solar PV is prevalent in spaces beyond the coverage of the electricity grid. Access to grid electricity in Mozambique is shaped by the development of resources extraction, transport corridors, ports and urban centers during the colonial period [62,63]. What constitutes off-grid is defined institutionally. By agreement with EDM, FUNAE only works in areas projected to be over 10 km from the grid network within five years. This agreement serves to enact the territorial separation between rural and urban areas.

In these way, off-grid solar PV competes not with the centralized grid, but with disaggregated—and longstanding—systems that enable the supply of fuelwood, kerosene, or charcoal for domestic use. Solar PV was initially installed by FUNAE, using contractors and following global ISO standards, outside the domestic arena to provide a public source of electricity for lighting and refrigeration in schools, clinics, government offices and other rural institutions. Through linking solar PV with rural development, and the provision of lighting for education and refrigeration for health services, the donor community has envisioned solar technology as a mechanism for development. In doing so, they have produced new forms of demand, which a patchwork of existing local energy systems based on kerosene or biomass struggled to meet cost-effectively or securely. The growth of solar PV for public use has proved to be a testing ground for its further development as a means to provide domestic energy services.

The logical conclusion of this process has been the development of models that reimagine low carbon energy within the households and move away from ideas of energy as a collective, public service. Since 2010, FUNAE has initiated projects focused on households, small businesses and villages, which include mini-grids and solar home systems (SHS) installed in homes and shops. Here, FUNAE is involved in the production of solar PV within the rural economy, procuring systems of less than 100 W, which can be bought by households and commercial enterprises through long-term loans underwritten by FUNAE. Solar PV has no direct competitors, as there are limited forms of energy service

[1] In 2012, FUNAE reported that it installed 81 mini-grid and off-grid systems with a total capacity of 274 kW that year [59]. From 1997 to 2014, FUNAE reported it had electrified 260 villages, of which 191 were with solar PV systems (and 69 with diesel generators), 580 schools, 561 health centres, 74 administrative post buildings, 3 fish markets, 19 water pumping systems, along with the distribution of 1500 stoves [60]. It also built 51 fuel filling stations in this period.

that provide the power required for lighting, mobile phone charging, entertainment and other devices that makeup energy demand. However, the use of PV has not replaced charcoal or fuelwood, which are used for cooking and heating even where solar power is available.

As a consequence, while fostering the demand for solar PV, FUNAE has also become responsible for ensuring the supply of solar PV. For example, FUNAE has managed the construction of Mozambique's first solar module assembly plant, supported by a US$13 million concessional loan from India's Exim Bank. The FUNAE plant, which opened in 2013 in Beluluane, just outside of Maputo, aims to produce 5 MW of capacity annually, reducing imports and equipment costs. The majority of the plant's output is used to supply FUNAE's projects (Interview, FUNAE, August 4th, 2014).

FUNAE has also sought to establish favorable contracts to diversify the range of solar PV available. In 2014, it awarded a contract to the German firm Fosera to install pico-solar systems in schools and homes in Manica province, in central Mozambique. The firm has set up a subsidiary in Maputo assembling pico-solar units (from parts manufactured in Thailand), including solar lanterns and solar phone chargers. FUNAE has also managed the installation of PV mini-grids (with 1.3 MW of capacity) in Niassa province,[2] in northern Mozambique, a project financed by the South Korean government. As solar PV has increased in scope and visibility, it has become a status symbol in rural settings, and there is a growing market demand for installation beyond the boundaries of FUNAE programmes.

The British aid agency DFID, private investors such as Vodafone, and other donors are behind the recent "mobile revolution" in African off-grid energy systems. The advent of mobile technology has spurred innovations such as M-Pesa, the mobile banking system widely embraced in Kenya and Tanzania, which enables users to make purchases and send cash transfers via mobile phones. Through its 'Brilho-Energy Africa' campaign, DFID Mozambique is encouraging private-sector investment to expand SHS and larger solar PV systems for productive use. DFID is supporting M-Kopa[3] (a Kenyan solar energy company spin-off of M-Pesa) with seed funding to establish pay-as-you-go mechanisms in Mozambique (Interview, DFID, June 16th, 2017). The idea is that private investors could help fill gaps in access resulting from FUNAE's limitations. The private sector-led approach stresses cost recovery, while companies such as M-Kopa will hold data on individual-level energy usage and credit histories, which could be used to promote new products. Accordingly, it reflects the growing influence of enabling market models in Mozambique's off-grid energy sector, in parallel with experiences in other African states, with programmes directed towards ensuring the constitution of reliable customers in contexts affected by extreme poverty.

The processes of implementing solar PV in Mozambique encompass multiple actors, ranging from Danish and Belgian finance and technical assistance, Indian concessional loans, a Kenyan mobile money transfer company, and do-it-yourself shopkeepers in rural villages and technology developed in Germany, manufactured in Thailand and assembled in government-supported plants in the capital region. These actors foster systems not derived from the 'hard' kinds of regulation that have led to the development of feed-in tariffs and incentives for innovation found elsewhere, but rather are 'soft,' less direct, and multiple in their origins and form. Their opportunities for action depend on the encounter between the changing discourses of intervention and the possibilities offered in the postcolonial setting.

While solar PV as a decentralized system is common in any rural area sufficiently distant from the existing grid, in practice FUNAE's installation process has been highly uneven. The goals of claiming access to electricity in different administrative districts can obscure the uneven means of deployment. Our research found that such projects are rarely sited in the most remote areas of a district, while FUNAE considers households connected if they live within a 20-km radius of connected institutions (Interview, FUNAE Manica Office, August 16th, 2014). The installation process can be costly for customers and often overlooks local energy needs, as the goal is mainly to bring electricity to the district or administrative post seat to appear in government headline metrics of increasing access, which make electrification appear more inclusive than it often is in practice. Given the dispersed settlement patterns and low population densities in rural Mozambique, both on-grid and off-grid provision bypass most rural dwellers.

During fieldwork, we observed that FUNAE often operates (paradoxically) in a centralized manner in installing off-grid renewables, with much of the planning and decision-making based in its Maputo headquarters. Its supply-based model has succeeded in rolling out energy service projects to expand geographic coverage, but often with limited local consultation or commitment to capacity building. For example, in Chinhambuzi, in Manica province, a solar PV mini-grid, supported with Belgian financial and technical assistance, supplies electricity for three hours in the evenings for the local chief's house, schoolteachers' houses and four local shops, but ordinary residents were disconnected. Several residents considered connecting 'spontaneously,' without FUNAE's permission. The system's capacity of 3.6 kWp would not support it, according to the FUNAE provincial director.

In Mavonde, Manica province, many households who live far from the town centre—to be closer to their machambas (cultivated fields)—were unable to repay loans offered by FUNAE for solar home systems (SHS) and had not taken part in the project. Others felt the SHS were costly and created impositions, such as taking up space in their homes. Those who had taken loans for the systems were mainly shopkeepers, who enjoyed new uses of energy such as freezing meat or fish, which otherwise must be dried for storage.

In Majaua-Maia, Zambezia province, an EU-financed 2.5 million Euro mini-hydro project has rehabilitated a hydraulic system used on a maize plantation during the late colonial period. Similarly, there was little participation in decision-making among residents in the delivery of electricity. In particular, the new system, with 767 kW capacity, bypassed a local mill, used by local women to grind corn for xima, a staple food. This was a priority among residents, as women must travel long distances to use a diesel-powered milling facility, located across the Ruo River in Malawi. Residents in Majaua-Maia are expected to pay for electricity service, without much consideration of their ability to do so, or how they will productively use the electricity. Nor was there consideration of the new expectations created, many of which require support, such as maintenance, service, training or affordable lending, while contextual knowledge and value systems were neglected.

A further impediment in FUNAE's projects has been a lack of monitoring and repair of its systems following their installation. There is a prevailing narrative of poor maintenance. Behind this, there appears to be a lack of knowledge exchange in the development of solar PV, an industry with high import content, requiring knowledgeable technicians and access to materials (cf. [57]). The deployment of low carbon technologies can only be understood concerning the mechanisms deployed to extend the electricity grid over the country, as explained in the following section.

5.2. Justice in the electricity grid

Electrification is a concern of both the people and the government of Mozambique. EDM's work follows what they call 'a social mandate' to provide electricity for all. In other words, EDM's mission enshrines a distributive notion of energy justice. In the words of an EDM staff, "the company's client base is largely made up of low-income clients (…) we have to provide them with a connection to the national grid (…) they are citizens of this country [too]" (Interview, April 2014). However, as we explain below, the fulfillment of this mission comes with contradictions particularly about the implications of this mission for other

[2] This project electrified the districts of Mavago, Muembe and Mecula.

[3] 'M' refers to mobile, while 'kopa' is Swahili for 'borrowed' or 'loan'.

aspects of energy justice and the possibilities for a sustainable energy transition.

EDM was created in 1977, two years after Mozambique's independence, as a state company through the integration of some twenty-five separate and geographically dispersed production and distribution units [64]. This fragmented infrastructure produced annually about 600 GWh of electricity, less than 15% of what Mozambique produces today. Fewer than 5% of the 8 million inhabitants had access to an electricity connection at the time. These were largely located in Maputo and other cities and towns, and, more specifically, in the areas occupied by settlers. In the context of postcolonial Mozambique, EDM's mission was defined as providing a public service of electricity generation, transmission, and distribution to support Mozambique's economic development and the welfare of its population. Then, as now, this mission was driven mainly by the Frelimo government's political ambitions to be seen to act in the public interest to correct the distributive injustice of the colonial regime.

This mission remains nominally unchanged until today, although the company's strategies to achieve it have had to navigate changing contexts over time. During the first two decades of its existence, up to 1995, Mozambique's economic and financial woes and the violence and destruction caused by the civil war made it very difficult to deliver on this mission. From 1995 onwards, EDM underwent a substantial process of system integration, technical and administrative professionalization, and a continuing search for its financial sustainability [64]. Simultaneously, it began expanding the national electricity grid with the support of the donor community, regional partners (namely South Africa's Eskom), and foreign direct investment [64]. For the next two decades, EDM's national grid expanded significantly – even if only reaching about 25% of the Mozambican population by 2015 [65] (a small increment from the position in 2013, see Fig. 2). As noted above, this growth mainly centered in extending the grid to cities and towns, with electrification of rural areas taking a back seat. While EDM is slowly working towards improving nominal access to electricity, spatial inequalities between urban and rural areas remain deeply ingrained in the broader energy system since the colonial times.

Key to this grid expansion was the introduction and near-universalization of Credelec, EDM's system of prepaid electricity. Drawing on experiences in neighboring South Africa and support from the donor community, EDM began consistently rolling out this system to all its low-voltage consumers from 2005 onwards [64]. The first tests in the Greater Maputo area took place in 1995/1996. The system was later extended to other cities in the North (Nampula and Nacala) and reached all the district town seats in 2010 [64]. Nowadays, some 88% of EDM clients connect to the grid through a prepaid meter [65]. Since 2013, EDM has also introduced sales of prepaid electricity tokens through digital channels – mobile wallet, phone banking, ATM and online [65]. Fig. 3 provides an overview of the growth of EDM customer base, following the introduction of the Credelec system. Since 2007, the number of Credelec customers is higher than conventional one. Credelec both facilitates the access of customers who previously would have lacked access even being under the grid, and it is actively promoted by EDM to facilitate their operations.

The switch to prepayment and the digitalization of electricity token sales has had several relevant implications for energy justice. First, the adoption of prepayment is partially blind to aspects of recognition of electricity users' needs. In particular, despite the 'social mandate' mission, the introduction of prepayment centers on the interest of EDM as a provider. While there is evidence that Mozambicans welcomed this switch because it gave them more control of energy consumption [67,68], the way prepayment is managed in practice does not acknowledge their various needs in a proactive (positive) fashion. Instead, users' needs are dealt with through preventive (negative) assessments of the problems they can cause to the system. When EDM first deployed prepayment, the objective was to address problems of long-standing client debt, improve its cash flow and reduce a host of conflicts with clients due to internal administrative inefficiencies and (arguably) corrupt practices. Faced with a state-dictated mission to provide a public service of electricity to a mostly low-income population, EDM embedded notions of household poverty and infrastructural deficits in the new socio-technical arrangements of the Credelec system [69,70]. For instance, recognizing that many users by-passed meters to access electricity without payment, EDM switched from basic prepaid meters to split meters, a technology designed to combat meter fraud. However, because split meters seem more sensitive to electric current fluctuations, many users have reported an increase in meter malfunctioning since the switch [70]. This prevents a continuous access to electricity, which is exacerbated by the many shortcomings of EDM's maintenance service. In other words, the switch to prepayment was provider-centered, not user-centered in its concerns with energy access. A concern with energy justice that takes recognition issues seriously would put energy users at the center of decision-making instead.

Second, and in line with this, the prepaid system implies an uneven moral judgment about how electricity users and electricity providers should behave with each other. On the one hand, electricity users must pay before using the service, no matter what their income situation; moreover, people who consume electricity without paying are immorally free-riding the electricity system and must be punished for that (e.g., through fines and disconnections) [70]. On the other hand, the mishaps in electricity provision by EDM – from fluctuations to temporary or complete blackouts – are cast as unfortunate consequences of a cash-strapped company and an obsolete grid [70]. These mishaps have direct consequences on the service, as the average blackout time, for example, increased by 38 min to 68 min per blackout from 2009 to 2013 [61]. Overall, this lack of accountability undermines EDM's social mandate.

Third, it is unclear whether the switch to prepayment will facilitate or hinder a transition to a lower-carbon future in Mozambique. Prepayment technology has the potential to induce energy-saving behaviors among consumers, because it makes consumption more visible on an everyday basis. Fieldwork findings certainly support this insight for lower-income electricity users, who as noted above welcome the disciplining effect that prepaid meters have on their consumption practices [67]. However, this may be the result of income differences rather than actual changes in everyday practices across the board. Fieldwork findings indicate that prepaid meters have less of a disciplining effect on electricity users with higher incomes, who can afford all the energy they wish to consume. Moreover, the increased demand for electricity by a growing number of people in Mozambique has led EDM to tap into unsustainable sources of energy, despite the country's substantive potential for renewable energy production. As of 2015, of the electricity available for consumption in Mozambique, 77% came from renewables (hydro) and 33% from high-carbon sources (gas, coal, diesel); whereas, only five years earlier, in 2010, the sources were respectively 97% and 3% [65]. Whatever gains have been achieved in access to electricity by a broader number of people, these have been on the back of environmental and social injustices associated with the extraction of 'dirty' fuels.

In sum, the expansion of Mozambique's electricity grid is conditioned by a history of fragmented distribution. EDM has yet to address substantive spatial, social and environmental inequalities that are deeply ingrained in the way that EDM operates the electricity grid. For many households, these challenges come hand in hand with the challenges inherent to accessing fuels for cooking, as the following section explains.

5.3. Household experiences of energy access in Maputo

In Maputo now, perhaps more than any other time in the city's existence, residents use diverse and overlapping fuels for cooking and heating. Charcoal's dominance as households' fuel of choice is being challenged by the precarious nature of charcoal production/

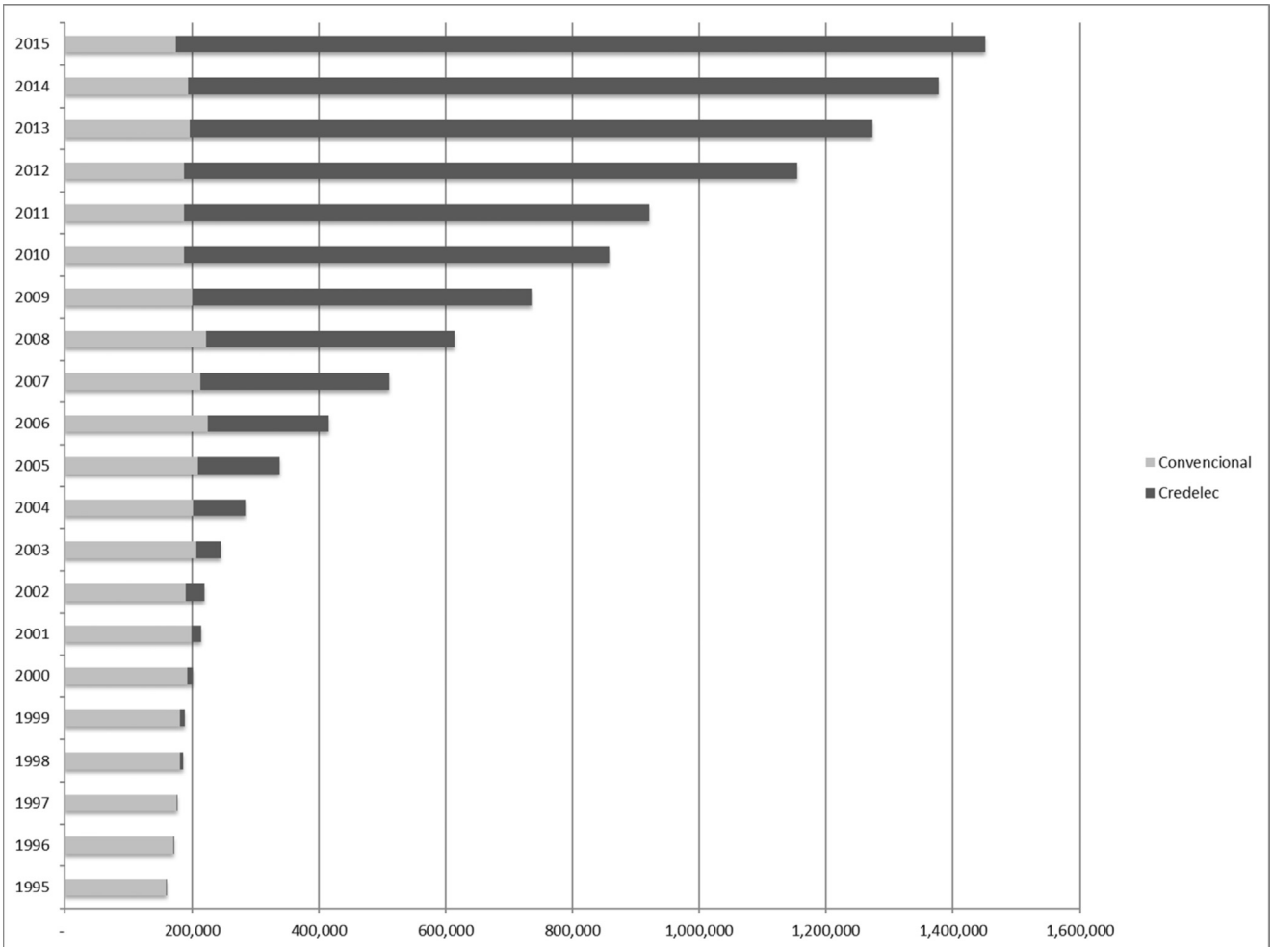

Fig. 3. EDM customers (1995–2015). Own elaboration.
Data sources: [66] (Data for 1995–2011); [65] (Data for 2012–2013); [1] (Data for 2014–2015).

distribution, a growing middle-class with differentiated consumption patterns, and the changing nature of fuel poverty. Evidence from our survey of 62 residents in Maputo suggests that 85% of respondents use more than one fuel concurrently for cooking and heating water. Moreover, whereas 84% of respondents indicated that they used charcoal in some form, only 11% of those respondents used charcoal exclusively.

Research estimates that 80% of urban residents in Mozambique consume charcoal [2013]. The number using exclusively charcoal lowers to 50% in Maputo [71]. In Maputo, this lateral transition has been supported through the increased availability of LPG and electricity. LPG imports have increased in Mozambique from 5000 tons in 1990 to 24,000 tons in 2014 [72]. Moreover, EDM figures suggest that over 91.9% of households are now connected to the electricity grid in Maputo [65].

Nevertheless, charcoal persists in the urban landscape. Like in other countries largely dependent on biomass, households in Maputo resort to fuel stacking, that is, they adopt 'modern' fuels such as electricity and LPG, but these do not replace traditional or subsistence fuels, such as charcoal and fuelwood [73]. For example, when asked which fuels he currently used, one respondent replied: 'It depends, its complicated. We use a charcoal stove mostly, a gas stove … for boiling water or preparing tea when the young ladies go to school, and an electrical stove which is a back-up because it consumes a lot of energy' (Interview 31, Bairro dos Pescadores). Here, the *availability* of modern fuels has not replaced charcoal, but has increased households' energy security by opening multiple, overlapping options for energy provision.

This complex diversification has affected the urban energy landscape and people's perceptions of energy transitions. When one respondent was asked how access to electricity had changed their life, they replied '[Then] there wasn't a big change, but [now] we feel we lose something when we are disconnected from electricity' (Interview 16, George Dimitrov). Here, electricity access has become routinized, and embodied in everyday life. Energy justice has not intrinsically been achieved through increased access to an energy source. Instead, different forms of justice seem to emerge from people's ability to use energy for uses that they can value. This lateral transition of fuel use forces a situated understanding of the interaction between energy sources, livelihoods, and embodied energy use. Both local government and utilities can increase their social accountability by focusing on delivering energy solutions that respond to these concerns.

While the electrification figures for Maputo are higher than for the rest of the country, they conceal many contingencies in the supply and embedded use of electricity. Results from the interview survey suggest that across the four sample sites in Maputo, there exists varying rates of connection. Even in middle-income areas, such as Magoanine C, many households lack connections regardless of how good the network coverage is. In low-income areas, such as Polana Caniço A, many residents are not connected individually but, instead, they share electricity meters with landlords and fellow tenants. This phenomenon is most common among low-income residents renting small one-room houses. Such agreements mediate the supply of electricity, and often those responsible for re-charging meters (typically landlords) forbid the use of electricity for cooking and heating.

If an energy justice perspective implies questions of fairness and happiness, then such embedded use of electricity as fuel becomes crucial. As previously explained, although residents are happy with the dominant prepaid electricity system 'Credelec' [67], they often enact a form of disciplined autonomy [67] to control their electricity use. One respondent replied, 'We feel limited because the price is high; what we do, we can turn off the fridge because there is no food in there; we also try not to use many different appliances at the same time, [for example] we try to us a gas stove rather than an electrical stove' (Interview 36, Polana Caniço A). Most residents perceive tariffs to be expensive and resultantly monitor their usage extremely closely. As in the case above, electricity is often used as a back-up to alternative fuels. Moreover, many residents remain without re-charging their meter for extended periods of time. Residents in poorer areas pay proportionately more per 'useful unit of energy,' meaning distributional inequalities may affect the poor disproportionately [74].

Despite being percieved as expensive, electricity remains more widely available than LPG. Previous research has estimated that only 3% of the population in Maputo use gas exclusively [71] although our survey suggests that 22.5% of respondents use LPG in some capacity. The barriers to gas access in Maputo are the costs of stoves, the cost of canisters (4500 meticals as of March 2017), the cost of refilling the gas itself, and transportation (ibid.). Gas is sold and distributed predominately at petrol stations and small-scale depots, often far from people's homes. Low-income residents also have safety fears. These issues leave gas inaccessible to many low-income people and distribution skewed in favour of higher- and middle- income areas (such as Magoanine C). An average household's monthly consumption of gas in Maputo totals approximately 659 meticais, whereas the equivalent figure for charcoal is currently double (in many cases triple) this amount. As such, despite the lower costs of LPG in comparison to charcoal, a rapid transition to LPG is not taking place.

Also affecting the energy transitions of families in Maputo is a localized crisis in the production and distribution of charcoal. From 2010 until 2013, the Maputo municipal council estimated that charcoal prices increased by 260% [71]. A typical 70–90 kg sack of charcoal that cost 250 meticais in 2010, costed 840 meticais in 2013 [75]. Our survey shows that the price of charcoal has further increased to unsustainable levels and peaked in late 2016 at approximately 1800–2000 meticais in some neighborhoods. This increase is putting heavy financial pressures on residents. Findings from the survey suggest that 54% of respondents felt they didn't have sufficient energy to meet their needs, and 79% stated there were times when they lacked fuels. Energy insecurity appears to be generally high in Maputo despite the increased availability of fuels.

One reason for the crisis in charcoal production/distribution is deforestation surrounding Maputo which leaves charcoal prices highly vulnerable to costs of transportation, governmental decisions to temporarily halt informal production, and variations in weather. For example, the 2016 Mozambican financial crisis, linked to a government debt scandal, affected charcoal distribution and consumption through an increase in petrol prices in September 2016 which increased distributional costs leading to a heightened sense of fuel poverty.

An automatic shift to alternative 'modern' fuels is also not occuring because charcoal is part of the everyday life of Maputo residents. For example, previous research shows there are profound spatial relations which shape energy access and its lived reality [76]. In Chamanculo C, residents explain the multiple ways in which the physical structure and spatial layout of the house relates to the type of network connection, and practices of charcoal use. A household with a patio area often means that a lot of the cooking takes place outside, in a collective space, simultaneously creating contradictions of use and safety. For example, accidents with children around cookstoves are common. The familiarity of children with cookstoves means that they learn how to cook from a very young age. The cookstove plays a central role in structuring the life of the household, with different types of cookstoves and different energy sources often used simultaneously to, for example, cook different types of foods.

In recent years, an Italian NGO, AVSI (Associazione Volontari Servizio Internazionale), has led a cookstove improvement programme to replace the most commonly used iron cookstoves (most often made from recycled metals). However, these new cookstoves were found not to meet the full range of cooking needs, as they were too small to boil water and only have one mouth. AVSI is now experimenting with alternative programmes to enroll communities in building cookstoves, thus providing opportunities to deliver autonomy in the development and use of cookstove technologies.

A transition away from charcoal would also have profound effects on employment and livelihoods. As many as 3 million people are employed in the charcoal industry in Mozambique [77]. Those who derive the most benefit from the charcoal industry are large-scale distributors [78]. However, charcoal also plays a crucial role in survival economies and as a back-up to solve income difficulties. Some respondents to the survey suggested that in recent years they have abandoned charcoal production/distribution as a livelihood strategy due to it becoming uneconomical, which could foster a transition away from charcoal.

In sum, although physical access to fuels has increased in Maputo, this has not translated into fuel security for the majority. People are concerned about how the government manages fuel markets and decisions which affect fuel prices. The prevalence of centralized models of provision in cities and the national government's control of fossil fuel resources mean that strategies to improve energy access overlook people's energy needs. While the government continues to develop strategies for energy export, residents have developed intimate socio-spatial strategies that enable more reliable access to energy. Multiple, over-lapping fuel use (or fuel stacking) is one such strategy. The persistence of charcoal as a fuel in Maputo - giving residents' a heightened sense of control over resource access and costs – is another. There are no clear-cut mechanisms to build more autonomy into an energy system fraught with complex socio-politcal interactions at differing scales.

6. Discussion

Empirical evidence from research in postcolonial contexts has already destabilized common assumptions in energy research. Like in Mozambique, the design of an energy system alongside a rural-urban divide undermines the delivery of sustainable energy futures while ignoring the challenges in both rural and urban areas (cf. [79]). Moreover, the observation that households use multiple sources of fuels and electricity to improve energy security extends beyond Mozambique and reveals the inadequacies of a linear account of the energy ladder (cf. [80]). Socio-spatial factors shape energy use and such factors need to be understood from the perspective of the very people who live and experience them. Overall, there is a sense of uneasiness about current models of assessment that overlook household needs and do not lend themselves to policy recommendations [81].

The challenge is compounded with the pressing need to integrate ideas of justice in current energy policy. We are living through a significant turn in energy studies, where interdisciplinary approaches with normative intent are rapidly gaining ground [22]. The tendency is towards universalizing approaches that enable internationally comparable approaches. The post-colonial perspective is a corrective that invites us to look at the energy challenge within specific geographical and historical contexts. In doing so, the postcolonial angle activates interdisciplinary perspectives that, having long been ignored [82], have enormous potential to deliver policy innovation in postcolonial contexts. In this article we have proposed an energy sovereignty framework as a means to harness postcolonial analysis in practical recommendations to advance energy justice. Rather than a new framework to deliver justice, our analysis highlights three principles that question how current energy policy is imbricated in the delivery of social wellbeing.

The first dimension of energy sovereignty relates to socio-ecological

responsible relationships. In our analysis we observe a disconnect between the exploitation of energy resources and the delivery of universal energy access goals, which has its most extreme manifestation in the rising prices of charcoal as a consequence of rapid deforestation discussed in the third section. The expansion of the grid depends on the extraction and availability of fossil fuels. The most promising policies are those that attempt to deliver low carbon innovation through off-grid, solar PV but current models of territorial organization have circumscribed these initiatives to rural areas. Renewable technologies' potential to spread rapidly through urban areas - which could lead to an overall transition making these technologies more available in rural areas - is curtailed by territorial policies. Furthermore, current policies around the energy grid reinforce this model. What is needed in Mozambique is a transformation of current ideas of electrification and increased collaboration between FUNAE and EDM to transcend a self-imposed territorial barrier.

The second dimension relates to the possibilities for self-determination in the deployment of business models and technologies. The case of Mozambique suggests that the success of certain modes of energy provision and their pervasiveness depends on the extent to which these models are integrated into peoples' livelihoods. Credelec has become a successful business model for electricity provision because it offers increasing possibilities for self-administration and control. Equally, fuel stacking and the continuous use of charcoal are strategies for households to increase control of their supply. In contrast, efforts to implement renewable systems in rural areas have been thwarted by the limited fit between renewable aspirations and local needs. Instead of reaffirming models of fuel substitution, energy sovereignty points towards understanding energy needs and how they are currently met, to deliver changes that fit within people's objectives and aspirations.

The third dimension relates to participation in both decision-making and innovation. In a context with a remarkable tradition of active participation of citizens in service provision - in the absence of the state - energy institutions have remained remarkably opaque. EDM's and FUNAE's attempts to realize their social visions are undermined by lack of accountability and limited success in service delivery.

Attempts to introduce more environmentally sound renewable energy innovations contrast with the persistence of injustices embedded in the expansion and functioning of Mozambique's electricity grid. Some of the conditions that perpetuate such injustices relate to the historical development of infrastructures under colonialism, decades of internal conflict, and a mismatch between the requirements of the liberalization of services and the social mandate promoted by institutions such as at EDM or FUNAE. Highly uneven governmental logics have resulted in fragmented and diverse forms of energy access. Recipients of grid and off-grid extensions have been created while an even greater number have been excluded through the ways in policies are implemented. The application of a universalist notion of energy justice is highly problematic and reveals the value of postcolonial perspectives to understand energy dilemmas.

7. Conclusion

The case of Mozambique reveals the challenge of responding to global energy challenges delivering a transition to sustainable energy in a just manner. The case emphasises the importance of contextual understandings of energy justice rather than universalizing approaches. This resonates with the need to pull back the apolitical veneer of technical 'fixes' and a focus on connection rates. There are wider questions about how the use of energy resources in countries with extremely low rates of energy access relate to the broader political economy of the country, and the extent to which elites can monetize the countries resources (coal, hydro, natural gas) in international markets. In Mozambique, for example, there is a continuing policy to export energy resources and power generation to increase public revenues.

A postcolonial approach requires engaging with the realities of energy access and renewable implementation, recognizing the heterogeneity of socio-political and historical conditions, and abandoning oversimplified blueprints for energy development. Postcolonial theory calls for analyses that reveal complex stories of symbolic domination. In Mozambique, this is manifest in the creation of deserving 'recipients' of energy expansion (businesses, consumers) at the expense of the needs of the majority of the population. Means to incorporate households into energy systems via mobile-based systems, for example, construct a deserving consumer who can manage debt, rather than seeking to develop models of collective ownership potentially more sustainable and democratic. The imposition of profit-led models of energy transition reproduces the abovementioned principles entrenched in the political economy of energy in resource-rich countries like Mozambique. Incremental changes, embedded in everyday cultural practices and the ways in which people value energy, have been comparatively underappreciated.

Considering the dimensions of energy justice - distribution, recognition, procedures - enables a critical analysis of the current energy situation and reveals the importance of adopting a normative perspective. The analysis reveals that people in Mozambique, at least in urban areas, cope with the current state of access by adopting solutions that enable higher degrees of control over energy access. Autonomy and self-determination are conditions for a just energy transition. Energy sovereignty represents a call for localized models of energy provision over which people can make decisions that affect the way they use energy. Further research on energy justice should examine both the methods for understanding energy justice dilemmas and the role of concepts such as energy sovereignty to throw further light on the principles that will enable a sustainable future.

References

[1] EDM. Comercialização. EDM Website; 2018 < http://www.edm.co.mz/ > [last accessed 1/05/2018].
[2] Frey A. Funding guaranteed for Mocuba solar plant – AIM. Club de Mozambique; 2017.
[3] Mentis D, Andersson M, Howells M, Rogner H, Siyal S, Broad O, et al. The benefits of geospatial planning in energy access – a case study on Ethiopia. Appl Geogr 2016;72:1–13.
[4] Bhattacharya M, Paramati SR, Ozturk I, Bhattacharya S. The effect of renewable energy consumption on economic growth: evidence from top 38 countries. Appl Energy 2016;162:733–41.
[5] Büscher B. Connecting political economies of energy in South Africa. Energy Pol 2009;37(10):3951–8.
[6] Khennas S. Understanding the political economy and key drivers of energy access in addressing national energy access priorities and policies: African perspective. Energy Pol 2012;47, Supplement 1(0):21–6.
[7] Newell P, Mulvaney D. The political economy of the 'just transition'. Geogr J 2013;179(2):132–40.
[8] Power M, Newell P, Baker L, Bulkeley H, Kirshner J, Smith A. The political economy of energy transitions in Mozambique and South Africa: the role of the Rising Powers. Energy Res Social Sci 2016;17:10–9.
[9] Goldthau A, Sovacool BK. The uniqueness of the energy security, justice, and governance problem. Energy Policy 2012;41:232–40.
[10] Goldthau A, Sovacool BK. The uniqueness of the energy security, justice, and governance problem. Energy Pol 2012;41(Supplement C):232–40.
[11] Baptista I. Space and energy transitions in sub-Saharan Africa: understated historical connections. Energy Res Social Sci 2018;36:30–5.
[12] LaBelle MC. In pursuit of energy justice. Energy Pol 2017;107(Supplement C):615–20.
[13] Heffron RJ, McCauley D, Sovacool BK. Resolving society's energy trilemma through the energy justice metric. Energy Pol 2015;87(Supplement C):168–76.
[14] Sovacool BK, Dworkin MH. Global energy justice. Cambridge University Press; 2014.
[15] Sovacool BK, Dworkin MH. Energy justice: conceptual insights and practical applications. Appl Energy 2015;142(Supplement C):435–44.
[16] Sovacool BK, Heffron RJ, McCauley D, Goldthau A. Energy decisions reframed as justice and ethical concerns. Nat Energy 2016;1:16024.
[17] Sovacool B. Energy and ethics: justice and the global energy challenge. Springer; 2013.
[18] Bickerstaff K, Walker G, Bulkeley H. Energy justice in a changing climate: social equity and low-carbon energy. Zed Books Ltd.; 2013.
[19] Hall SM, Hards S, Bulkeley H. New approaches to energy: equity, justice and vulnerability. Introduction to the special issue. Local Environ 2013;18(4):413–21.
[20] Perez AC, Grafton B, Mohai P, Hardin R, Hintzen K, Orvis S. Evolution of the environmental justice movement: activism, formalization and differentiation. Environ

Res Lett 2015;10(10):105002.
[21] Fuller S, McCauley D. Framing energy justice: perspectives from activism and advocacy. Energy Res Social Sci 2016;11:1–8.
[22] Jenkins K, McCauley D, Heffron R, Stephan H, Rehner R. Energy justice: a conceptual review. Energy Res Social Sci 2016;11:174–82.
[23] McCauley D, Heffron R, Pavlenko M, Rehner R, Holmes R. Energy justice in the Arctic: implications for energy infrastructural development in the Arctic. Energy Res Social Sci 2016;16(Supplement C):141–6.
[24] Schlosberg D. Defining environmental justice: theories, movements, and nature. Oxford University Press; 2009.
[25] Agyeman J. Introducing just sustainabilities: policy, planning, and practice. Zed Books Ltd.; 2013.
[26] Rasch Elisabet D, Köhne M. Practices and imaginations of energy justice in transition. A case study of the Noordoostpolder, the Netherlands. Energy Pol 2017;107(Supplement C):607–14.
[27] Walker G. Environmental justice: concepts, evidence and politics. Routledge; 2012.
[28] Cowell R. Wind power, landscape and strategic, spatial planning—the construction of 'acceptable locations' in Wales. Land Use Policy 2010;27(2):222–32.
[29] Gross C. Community perspectives of wind energy in Australia: the application of a justice and community fairness framework to increase social acceptance. Energy Pol 2007;35(5):2727–36.
[30] Möller B. Spatial analyses of emerging and fading wind energy landscapes in Denmark. Land Use Policy 2010;27(2):233–41.
[31] Ottinger G. The winds of change: environmental justice in energy transitions. Sci Cult 2013;22(2):222–9.
[32] Pasqualetti MJ. Opposing wind energy landscapes: a search for common cause. Ann Assoc Am Geogr 2011;101(4):907–17.
[33] Finley-Brook M, Holloman E. Empowering energy justice. Int J Environ Res Public Health 2016;13(9):926.
[34] Heffron RJ, McCauley D. Achieving sustainable supply chains through energy justice. Appl Energy 2014;123(Supplement C):435–7.
[35] Hoffman SM. Negotiating eternity: energy policy, environmental justice, and the politics of nuclear waste. Bull Sci Technol Soc 2001;21(6):456–72.
[36] Global Tracking Framework. Progress toward sustainable energy. Washington: The World Bank; 2017.
[37] Silver J. Incremental infrastructures: material improvisation and social collaboration across post-colonial Accra. Urban Geogr 2014;35(6):788–804.
[38] Anderson W. Introduction: postcolonial technoscience. Soc Stud Sci 2002;32:643–58.
[39] Bridge G. The map is not the territory: a sympathetic critique of energy research's spatial turn. Energy Res Social Sci 2017.
[40] Sze J, London JK. Environmental justice at the crossroads. Sociol Compass 2008;2(4):1331–54.
[41] Schlosberg D, Carruthers D. Indigenous struggles, environmental justice, and community capabilities. Glob Environ Polit 2010;10(4):12–35.
[42] Urpelainen J. RISE to the occasion? A critique of the World Bank's regulatory indicators for sustainable energy. Energy Res Social Sci 2018;39:69–73.
[43] Palit D, Chaurey A. Off-grid rural electrification experiences from South Asia: status and best practices. Energy Sustain Develop 2011;15(3):266–76.
[44] Tomlinson R. Introduction 'Best practice'in development planning: products, processes and networks. Int Develop Plan Rev 2015;37(2):119–28.
[45] Munro P, van der Horst G, Healy S. Energy justice for all? Rethinking sustainable development goal 7 through struggles over traditional energy practices in Sierra Leone. Energy Pol 2017;105(Supplement C):635–41.
[46] Yenneti K, Day R. Procedural (in) justice in the implementation of solar energy: The case of Charanaka solar park, Gujarat, India. Energy Pol 2015;86:664–73.
[47] Altieri MA, Funes-Monzote FR, Petersen P. Agroecologically efficient agricultural systems for smallholder farmers: contributions to food sovereignty. Agron Sustain Develop 2012;32:1–13.
[48] Bonilla Y. Unsettling sovereignty. Cult Anthropol 2017;32(3):330–9.
[49] Sturm C. Reflections on the anthropology of sovereignty and settler colonialism: lessons from native North America. Cult Anthropol 2017;32(3):340–8.
[50] Edelman M, Weis T, Baviskar A, Borras SM, Holt-Giménez E, Kandiyoti D, et al. Introduction: critical perspectives on food sovereignty. J Peasant Stud 2014;41(6):911–31.
[51] McMichael P. Historicizing food sovereignty. J Peasant Stud 2014;41(6):933–57.
[52] Castán Broto V. Energy sovereignty and development planning: the case of Maputo, Mozambique. Int Develop Plan Rev 2017;39(3):229–48.
[53] Ryan RM, Deci EL. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. Am Psychol 2000;55(1):68–78.
[54] Mavhunga CC. Transient workspaces: technologies of everyday innovation in Zimbabwe. Cambridge (MA): MIT Press; 2014.
[55] Castel-Branco C, Massarongo F. Introduction to the public debt problematic: Context and immediate questions. Maputo: IDeIAS, no.85. IESE; 2016.
[56] Calvert K. From 'energy geography' to 'energy geographies': perspectives on a fertile academic borderland. Prog Hum Geogr 2015:1–21.
[57] Ahlborg H, Hammar L. Drivers and barriers to rural electrification in Tanzania and Mozambique–Grid-extension, off-grid, and renewable energy technologies. Renew Energy 2014;61:117–24.
[58] Cuamba B, Cipriano A, Jaime Turatsinze R. Investment incentives for renewable energy in southern Africa: the case of Mozambique. Winnipeg (Canada): IISD, Trade Knowledge Network; 2013.
[59] Fundo de Energia. Bodas de Cristal. Maputo, FUNAE; 2012.
[60] Fundo de Energia. Relatório Anual de Actividades 2014. Maputo, FUNAE; 2014.
[61] World Bank. Mozambique energy sector policy note, Report No: ACS17091. Washington, DC; 2015.
[62] McDonald D. Electric capitalism: recolonising Africa on the power grid. London: Earthscan; 2009.
[63] Söderbaum F, Taylor I. Transmission belt for transnational capital or facilitator for development? Problematising the role of the state in the Maputo Development Corridor. J Mod African Stud 2001;39(4):675–95.
[64] Baptista I. Serviço Público de Energia Eléctrica de Moçambique: Perspectivas sobre o serviço prestado pela EDM. E.P. Oxford, UK: Department for Continuing Education, University of Oxford; 2017.
[65] EDM. Relatório Anual de Estatística / Statistical Annual Report 2015. Maputo, Moçambique: EDM, Electricidade de Moçambique; 2017.
[66] Buque José. Credelec: O sistema pré-pago da EDM. Seminário Internacional sobre Pré-Pagamento de Energia Elétrica. Brasília, Brasil: Agência Nacional de Energia Elétrica (ANEEL); 2011.
[67] Baptista I. 'We live on estimates': Everyday practices of prepaid electricity and the urban condition in Maputo, Mozambique. Int J Urban Reg Res 2015;39(5):1004–19.
[68] Baptista I. Maputo: Fluid flows of power and electricity - Prepayment as mediator of state-society relationships. In: Luque-Ayala A, Silver J, editors. Energy, Power and Protest on the Urban Grid: Geographies of the Electric City. Abingdon, UK: Routledge; 2016. p. 112–31.
[69] Baptista I. Prepaid electricity in Maputo, Mozambique: Challenges for African urban planning. In: Silva CN, editor. Urban Planning in Lusophone African Countries. Farnham, UK: Ashgate; 2015. p. 225–37.
[70] Baptista I. Electricity services always in the making: Informality and the work of infrastructure maintenance and repair in an African city. Urban Studies; in press.
[71] Falzon J, Vignati F, Halstead M, van der Linden N, Pols D. Accelerating uptake of LPG in Maputo for lower-income households: study to support scoping of an intervention. SNV – Netherlands Development Organization; 2013.
[72] International Energy Agency. Mozambique: balances for 2015; 2018 < https://www.iea.org/statistics/statisticssearch/report/?year=2015&country=Mozambique&product=Balances > .
[73] Masera OR, Saatkamp BD, Kammen DM. From linear fuel switching to multiple cooking strategies: a critique and alternative to the energy ladder model. World Dev 2000;28(12):2083–103.
[74] Arthur MDFSR, Zahran S, Bucini G. 'On the adoption of electricity as a domestic source by Mozambican households. Energy Policy 2010;38:7235–49.
[75] De Koning PC, Atanassov B. Sustainable charcoal value chain Mozambique: literature and field research on sustainable charcoal production options that can be supported under the framework of the UN framework convention on climate change. Maputo (Mozambique): Energy Engineering Solutions; 2013.
[76] Castán Broto V. Energy landscapes and urban trajectories towards sustainability. Energy Pol 2017;108:755–64.
[77] Cuvilas CA, Jirjis R, Lucas C. Energy situation in Mozambique: a review. Renew Sustain Energy Rev 2010;14:2139–46.
[78] Baumert S, Luz AC, Fisher J, Vollmer F, Ryan CM, Patenaude G, et al. Charcoal supply chains from Mabalane to Maputo: who benefits? Energy Sustain Develop 2016;33:129–38.
[79] Castán Broto V, Stevens L, Ackom E, Tomei J, Parikh P, Bisaga I, et al. A research agenda for a people-centred approach to energy access in the urbanizing global south. Nat Energy 2017;2(10):776.
[80] Hiemstra-Van der Horst G, Hovorka AJ. Reassessing the "energy ladder": household energy use in Maun, Botswana. Energy Pol 2008;36(9):3333–44.
[81] Pelz S, Pachauri S, Groh S. A critical review of modern approaches for multi-dimensional energy poverty measurement. Wiley Interdisc Rev: Energy Environ 2018:e304.
[82] Sovacool BK. Energy studies need social science. Nature 2014;511(7511):529.