Energy Access and Urban Poverty

Energy and everyday life in an informal settlement in Maputo, Mozambique

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The great majority of people without access to modern energy services are rural and, rightly, much of the discussion on energy access focuses on how to reach them. However, despite their greater geographical proximity to grid electricity and other supplies of clean energy, people living in poverty in urban areas also lack energy access. The World Bank's own trials of the Global Tracking Framework demonstrated this for Kinshasa, Democratic Republic of the Congo. We need a greater understanding of how people access energy in these contexts, and what the barriers and opportunities are for improving that access. This paper explores these questions in the context of an in-depth study of the Chamanculo C settlement in Maputo, Mozambique.

Summary

Energy access is generally regarded as a rural issue, but the urban poor are also affected. The nature of energy poverty varies between rural and urban areas, but these differences are not often explored and the facets of urban energy poverty are in general under-researched. Moreover, what can be done about it will differ, depending on the possibilities for intervention that open up in an urban context.

This paper seeks to address this gap by reporting on research carried out in Chamanculo C, a historic settlement of Maputo, Mozambique with very poor provision of services. The research involved a survey of levels of energy access using Practical Action's Energy Supply Index and 'minimum standards' for energy services (Practical Action, 2010, 2014). In addition, a participatory workshop helped map the energy landscape, looking at how residents understand energy services. The two methods provide an insight into the current levels of energy access and people's priorities for improvement.

In terms of energy supply, electricity access is reasonably good (70 per cent connected) following the concerted effort of the national electricity company and the use of a pre-payment system. However, some remain outside the system and others suffer from intermittent access and/or supply. Access to clean cooking is far lower, with the majority using charcoal on an open fire.

This level of supply translates into a range of energy services, with electricity powering good levels of access to lighting, but also space cooling and refrigeration (80 per cent owned a fridge or a cooling box). There were high levels of access to communications through mobile phones, TVs, and radios. However, despite this, only 30 per cent of households met all the minimum standards for lighting, cooling, and communications. There were lower levels of access to a minimum standard of clean cooking, because the use of improved, efficient stoves is rare.

The participatory mapping workshop revealed the importance of other aspects of energy access. First, it brought out the importance of street lighting for creating safe and welcoming neighbourhoods. Second, it highlighted how energy is deeply intertwined with local livelihoods supplying energy, or relying on its use. A third insight was the extent to which urban energy access is related to the characteristics of the built environment. The ability to access electricity was linked directly to housing quality and people's ability to control and fraction payments. Finally, the participatory workshop highlighted the extent to which cooking is a socially embedded practice, again linking to the built environment, the use of outdoor space, cooking and food preferences, and concerns over safety.

In conclusion the paper calls for greater attention to energy access in debates about urban energy and urban development. It demonstrates the importance of a Total Energy Access approach which considers energy beyond the household in community spaces and productive uses. While indicators can help to provide a diagnosis of the problems faced, prioritizing solutions always requires a more community-based, participatory approach.

Introduction

Energy access: debates and definitions

Energy access is now recognized as one of the cornerstones of development. Following the United Nations 'Sustainable Energy for All' (SE4ALL) initiative since 2012, the Sustainable Development Goals (SDGs) now include the imperative of ensuring 'universal access to affordable, reliable and modern energy services' by 2030. However, there is still debate about exactly what this means and how it can be achieved. As each successive edition of the *Poor People's Energy Outlook* (PPEO) has demonstrated, energy access is a complex issue which depends on multiple social, physical, and institutional factors (Practical Action, 2010, 2012, 2013, 2014). The starting point for the PPEO series has been to look at energy from the perspective of poor people: understanding how the supply of energy meets people's actual needs for energy in relation to its use (energy services) to improve their well-being and livelihoods.

The PPEO also called for a more nuanced definition of energy access. The SE4ALL Global Tracking Framework has now built an understanding of energy access based on multiple attributes of the energy supply, to develop aggregate, multi-tier indicators of energy access (ESMAP, 2015). For example, the Framework identifies six attributes of electricity supply, namely quantity (peak available capacity), duration, evening supply, affordability, legality, and quality, in addition to the actual uses supported. In relation to cooking solutions, the Framework considers the technical characteristics of fuel (efficiency, pollution, safety) and whether the actual uses conform to needs, are convenient and adequate. In this way the Framework aims to develop a reliable way of understanding global energy access in relation to a complex web of indicators to determine how people access energy services.

Indicators alone are not sufficient to design appropriate interventions

Standardized instruments like those proposed in the Framework will not only help to track progress against the global objective of achieving universal energy access, but also support planning and design interventions to facilitate access to energy. Understanding which attributes of energy supplies are lacking may enable tailored interventions that address deficient aspects in the most effective way. However, indicators alone are not sufficient to design appropriate interventions.

Energy matters to people because it supports specific services such as communication, lighting, heating, cooking, motive power for machinery, and mobility. These services provide health, social, and livelihood benefits essential for people's well-being. The way these services are delivered is shaped by life practices and culture. Local perceptions of energy needs and expectations of the energy system shape which improvements are a priority for people living in different parts of the world. This means abandoning the idea that there are simple, single solutions that will be effective in every context. Instead, any planning or design solution will need to emphasize that both people's perceptions of energy access and how they use energy depend on where they are: the resources they have at hand, how energy interacts with the built environment, and the possibilities for energy to sustain local livelihoods.

Energy access and urban poverty

How does this understanding apply to the context of poor urban communities? The Global Tracking Framework suggests that around 80 per cent of people without access to electricity live in rural areas. Urbanization has generally been associated with improved

energy access, because people may gain access to grid electricity and cleaner fuels (for a recent analysis see DeFries and Pandey, 2010). However, there are huge inequalities within urban areas between rich and poor areas, and this also applies in terms of energy access. Poor urban communities are sometimes not grid-connected, and even if they are, they will continue to suffer from energy poverty, relying on dirty and dangerous fuels to cover some of their basic energy needs. For example, the 2012 PPEO presented a case study of energy access in Kibera and Mukuru slums in Nairobi, Kenya, which showed the continued use of charcoal and kerosene in both households and small enterprises, despite the availability of electricity and cleaner fuels. Similarly, the (IEA and World Bank 2015:32), showed that in Kinshasa, although 90 per cent of households are grid-connected, 41 per cent still had access at only Tier 0 (no supply) or Tier 1 (electricity for less than four hours a day with 1–2 hours in the evening). Thus, when looking at sustainable energy planning in urban areas, there is a need to understand the factors that sustain the local economy, the attributes of the energy supply, and how local culture and opportunities shape energy use.

Urban communities continue to suffer from energy poverty

Mainstream debates on planning for energy and urban development, often following the preoccupations of global or more developed cities, have emphasized the possibility to achieve emissions reductions through gaining efficiency in the built environment and through urban design (EUEI-PDF, 2015). The Global Network on Energy for Sustainable Development (GNESD) is one of the few organizations that have been working on issues of urban energy poverty. Their seven-country study completed in 2008 did much to highlight some of the reasons the urban poor struggle to access clean energy: low and irregular incomes, inaccessibility and informal status of settlements, and poorly targeted subsidies (GNESD, 2008). Building on this, their 2015 report emphasized the need to recognize urban poor populations as potential energy customers that could be supported through specific planning mechanisms (Singh et al., 2014). For example, relaxing regulations for new electricity connections and the extension of LPG networks may have a great impact. Overall, the report highlights the gap in understanding of how urbanization and planning may address the energy access needs of the urban poor.

Scope of research

To contribute to this debate, this briefing has three objectives. First, it proposes a framework – urban energy landscapes – to understand energy services in relation to the social and material constraints of the built environment. Second, it explains the nature of demand for energy services as shaped by urban culture, lifestyles, and livelihoods with reference to a study of energy poverty in Maputo, Mozambique (Castán Broto et al., 2014). Third, it proposes a participatory methodology to study the local perceptions of energy supply and its use in urban areas through the participatory mapping of energy landscapes alongside a household survey. This methodology is intended to complement indicator-based assessments when a richer understanding of the specific context of energy access is needed: for example, when planning energy services and designing and implementing energy access projects. The starting point is that understanding how energy matters to people may help us to find specific avenues for energy improvements tailored to the context of intervention.

This brief focuses on energy poverty in Maputo, the capital city of Mozambique. This city has seen significant achievements in access to grid electricity in the last decade, by improving both its technical characteristics and the institutional mechanisms for electricity delivery. Yet, the case shows how certain forms of energy poverty are pervasive.

We conducted a case study in an informal neighbourhood called Chamanculo C, with more than 25,000 inhabitants. This is a historical neighbourhood, but also one which lacks services such as paved roads and sanitation. To assess energy access in Chamanculo C we combined a Total Energy Assessment (TEA) survey with a participatory mapping workshop. The case study shows how specific interactions with the built environment shape how energy is used, what energy needs are a priority, but also, the extent to which supply systems are suited to the existing urban society and economy. Overall, our research demonstrates the need to strike a balance between indicator-based and participatory assessments of energy access depending on the information needs of each situation.

Participatory mapping of energy landscapes

The concept of an 'energy landscape' is useful in highlighting the relationships between energy and society (Castán Broto et al., 2014). Energy landscapes refer to landscapes in which energy plays a key role in shaping both the perceptions and the experiences of a particular area. For example, an energy landscape may relate to how charcoal is distributed in a given neighbourhood, how local markets shape people's access to this particular fuel, or to how street lighting allows for the development of commercial business in some streets. In an urban setting, landscapes are related on the one hand to the flows of energy supplies (fuels and other resources), and on the other to the cultures and social habits that shape uses.

Energy landscapes: where energy plays a key role in shaping perceptions and experiences of a place

Understanding urban energy landscapes requires multi-method analysis of energy flows, social practices, and urban histories. A quick but valuable way to understand energy landscapes is to focus on local experiences of energy in a particular place, and how local residents describe their relationship with energy and its use. This knowledge can be accessed, for example, through the use of participatory methods with local communities.

Participatory mapping of energy landscapes emphasizes the multiple forms of expertise that exist about how energy is used and why it matters. Participants help researchers to make sense of the energy landscape, highlighting for example what key aspects of it improve or hinder energy access. Rather than adopting the role of experts, facilitators attempt to make local knowledge explicit by establishing the terms of reference for a debate about energy. Participants should discuss their concerns in a process that reveals not just what matters to them but also their understanding of how the energy system functions in their neighbourhood. The word 'mapping' refers to the use of visual methods (sometimes using actual topographic maps) to foster an open discussion about energy uses and needs. Visual methods are particularly useful to move away from expert-led discussions of energy whose language may not be understandable for participants.

The approach

In Chamanculo C, participatory mapping was used to complement an assessment of energy access using Practical Action's TEA methodology, which assesses key energy services against minimum standards. While these minimum standards have been partly incorporated into the Global Tracking Framework Tiers, we found this methodology particularly useful in the context of Chamanculo C because it also offers a minimum cut-off point which we could report back to participants directly. We implemented the

Participatory mapping exercise

TEA survey in Chamanculo C in July 2014, in partnership with Fundação AVSI, an international NGO working on urban development in this neighbourhood.

The TEA survey is designed to be implemented without specialist knowledge, and thus, it focuses on relatively straightforward questions and easily observable indicators. The TEA survey consists of two parts: a questionnaire that evaluates the energy access situation for households and three indicators evaluated by the interviewer which comprise the Energy Supply Index (ESI) (see Tables 1 and 2). In the TEA survey, questions focus on the extent to which a household meets nine minimum standards of energy service. The ESI indicators evaluate separately the use of biomass (household fuels), electricity access, and mechanical power.

We trained 10 young professionals to use and apply the TEA questionnaire and we carried out pilot interviews with them in selected households in Chamanculo C. They completed 40 questionnaires with households. The questionnaires took about one hour to complete, always within the household, giving the interviewers the opportunity to observe different fuels and energy uses.

We also conducted a workshop for participatory mapping of energy landscapes in a community space in Chamanculo C in July 2014. We recruited 25 participants from across the neighbourhood, selected through the community structure to represent diverse *quarteirões* (a subdivision of 50 to 100 houses). Participants represented a broad range of ages (from 18 to >80) including both men and women. Local neighbourhood leaders also attended. The workshop took the whole day and ended with a party as a means to acknowledge everybody's participation and time. The workshop consisted of three parts. During the first part, participants were provided with photographs of energy-related artefacts to discuss their relevance to the neighbourhood. During the second part, participants discussed energy services (cooking, lighting, cooling, communications), drawing relationships on paper and using multiple media materials such as stickers and modelling clay. During the third part, participants guided the facilitators in a walk

Table 1 Energy supply index

Energy supply	Level	Quality of supply
Household fuels	0	Using non-standard solid fuels such as plastics
	1	Using solid fuel in an open/three-stone fire
	2	Using solid fuel in an improved stove
	3	Using solid fuel in an improved stove with smoke extraction/ chimney
	4	Mainly using a liquid or gas fuel or electricity, and associated stove
	5	Using only a liquid or gas fuel or electricity, and associated stove
Electricity	0	No access to electricity at all
	1	Access to third-party battery charging only
	2	Access to stand-alone electrical appliance (e.g. solar lantern, solar phone charger)
	3	Own limited power access for multiple home applications (e.g. solar home systems or power-limited off-grid)
	4	Poor-quality and/or intermittent AC connection
	5	Reliable AC connection available for all uses
Mechanical power	0	No household access to tools or mechanical advantages
	1	Hand tools available for household tasks
	2	Mechanical advantage devices available to magnify human/ animal effort for most household tasks
	3	Powered mechanical devices available for some household tasks
	4	Powered mechanical devices available for most household tasks
	5	Mainly purchasing mechanically processed goods and services.

Table 2 Minimum standards of total energy access

Energy service		Minimum standard
Lighting	1.1	300 lm for a minimum of 4 hours per night at household level
Cooking and water heating	2.1	1 kg woodfuel or 0.3 kg charcoal or 0.04 kg LPG or 0.2 litres of kerosene biofuel per person per day, taking less than 30 minutes per household per day to obtain
	2.2	Minimum efficiency of improved solid fuel stoves to be 40% greater than a three-stone fire in terms of fuel use
	2.3	Annual mean concentrations of particulate matter ($PM_{2.5}$) < 10 μg/ m^3 in households, with interim goals of 15 μg/m^3, 25 μg/m^3 and 35 μg/m^3
Space heating	3.1	Minimum daytime indoor air temperature of 18°C
Cooling	4.1	Households can extend life of perishable products by a minimum of 50% over that allowed by ambient storage
	4.2	Maximum apparent indoor air temperature of 30°C
Information and communications	5.1	People can communicate electronic information from their household
	5.2	People can access electronic media relevant to their lives and livelihoods in their household

across the neighbourhood to describe key artefacts in their energy landscape. Both small group and plenary discussions exposed local understandings of the relevance of different energy services in people's lives and how energy is understood in relation to energy needs and the local uses of energy.

The following two sections summarize the main findings of this research looking at the dimensions of energy access and energy uses in Maputo, and describing the findings of the TEA survey, and the additional insights that emerge from the participatory mapping of energy landscapes.

Dimensions of energy supply, energy access, and energy uses in Maputo

Chamanculo C is a historic neighbourhood located near the centre of the city. This is the part of the city which is popularly known as 'the reed city', as opposed to 'the cement city', with unplanned settlement and infrastructure deficiencies, especially in water and sanitation and unpaved roads. Chamanculo C has 25,318 inhabitants, distributed in 74 *quarteirões*; it has 5,630 buildings of which 5,231 are for housing (AVSI, 2013).

Energy supply

Tables 3 and 4 provide a short summary of the Energy Supply Index, which evaluates energy access in relation to household fuels and electricity. In terms of electricity, 70 per cent of households had level 5 supplies (a reliable connection). Only one household of the 40 surveyed had no access to electricity, but another 11 (27.5 per cent) had access for less than four hours a day. In this case aspects of mechanical power were not explored, as they are less relevant in an urban context.

Only 1 of 40 households had no electricity, but another 11 had access >4 hours a day

A state-owned company, Electricidade de Moçambique, E.P. (EDM), supplies electricity to the city of Maputo. The history of the different neighbourhoods has shaped the provision of electricity. Chamanculo C is in the District named NIhamankulu (former District 2), where in 2007 only 57 per cent of households had access to electricity. This situation has, however, improved considerably in recent years. A key factor that has facilitated increased electricity access has been the prepaid system of electricity provision (called Credelec) that EDM has rolled out since 1995 to prevent the company's insolvency. In 2010, approximately 85 per cent of EDM's clients in Maputo city used a prepaid meter within the Credelec system. However, electricity remains expensive in relation to household incomes. Moreover, access to electricity depends on individual efforts to connect to the electricity network and requires substantial initial investments as well as ability and time to deal with the paperwork and bureaucracy involved (Baptista, 2013).

According to AVSI (2013), 73 per cent of the population in Chamanculo C use the prepaid system, which corresponds to the rates of access to electricity in our survey. People had positive views on the prepaid system because, they argue, it enables control over household expenses while it reduces the possibility of mistakes in the bills sent by EDM. This resonates with previous findings by Baptista (2013) who argued that the sense of autonomy and control associated with prepaid systems is highly desirable for these communities.

Table 3 Energy Supply Index: electricity

Level	Quality of supply	% households
0	No access to electricity at all per day	2.5%
1	Access to third party battery charging only	0
2	Access to stand-alone electrical appliance	0
3	Own limited power access for multiple home applications	0
4	Poor quality and/or intermittent AC connection	27.5%
5	Reliable AC connection available for all uses	70.0%

Table 4 Energy Supply Index: household fuels

Level	Quality of supply	% households
0	Using non-standard solid fuels such as plastics	0
1	Using solid fuel in an open/three-stone fire	0
2	Using solid fuel in an improved stove	75.0%
3	Using solid fuel in an improved stove with smoke extraction/chimney	2.5%
4	Mainly using a liquid or gas fuel or electricity and associated stove	22.5%
5	Using only a liquid or gas fuel or electricity and associated stove	0

For cooking, our survey found that the majority of households (77.5 per cent) continue to use solid fuels (generally charcoal although a few use wood), but do so with an improved stove. These stoves are of a basic design and are locally made. The key priority in their design is to fit with local cooking practices, rather than to save fuel or reduce emissions. A smaller number of households (22.5 per cent) mainly use a modern fuel. For some this is electricity (although this is an expensive option), and at least one used LPG. In fact, a larger number had access to some form of modern fuels (65 per cent in total) but only 22.5 per cent used this as their *main* source of energy for cooking.

Energy services for households

Of the four aspects of energy services in the TEA survey – lighting, cooking, thermal comfort, and communications – cooking and indoor space heating are the aspects that score the lowest in terms of energy access standards in Chamanculo C (Figure 1). Our survey shows, however, that there is great variability in energy access for different households not just with respect to how they cope with lack of energy access, but also what services they prioritize.

The standard for indoor air pollution was rarely met, rarely met (only 10 households, those at levels 3 and 4 of the ESI). In contrast, communication standards were met in most households. Even when we exclude the indicators for indoor air pollution (consistency) and indoor space heating, our survey shows that only 30 per cent of the households surveyed met all the standards simultaneously.

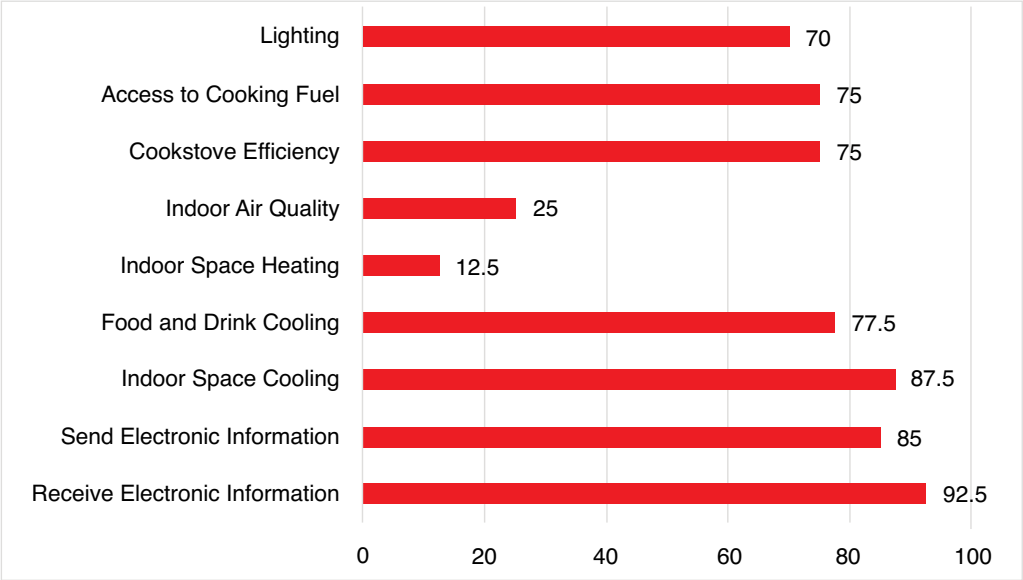

Figure 1 Percentage of households meeting the energy service standards

Regarding lighting, 70 per cent of households met the minimum standard, which links to the overall levels of grid electricity supply. There were no alternative, off-grid systems in use here. Despite a grid connection 11 households still failed to have a minimum of four hours of lighting per night due to the variability of incomes, meaning they were not always able to afford to use the electricity.

In the TEA survey there are three indicators for cooking: the quantity and quality of fuel used for cooking; the use of improved stoves; and the indoor air quality, based on the type of fuel used and the presence of a chimney. The majority of households still rely on charcoal as a key fuel for cooking and heating water. In the households surveyed 75 per cent met the standard for ease of access to cooking fuels and for the minimum efficiency of cook stoves. However, only 10 households met the standard for indoor pollution. The AVSI research confirmed that in Chamanculo C, 73 per cent of dwellers cook outdoors, (AVSI, 2013). This is due to the lack of appropriate systems of ventilation indoors.

The fourth question about cooking relates to the amount of time a day spent collecting fuel, which in this case is very short. The neighbourhood is well served with fuels; there are many small-scale street vendors and also some large depots for coal and wood. The trading of charcoal constitutes an important livelihood for people in Xipamanine Market, next to Chamanculo C, where many residents work. Street vendors, almost always women, sell small amounts of charcoal for 10 Meticais, the equivalent of US$0.30.

Space heating is rarely a concern but only 10 per cent met minimum standards all year round

In the context of Maputo, space heating is rarely a concern because the weather is generally 'pleasant' and comfort can be addressed without additional consumption of fuel, using sweaters or blankets, so most households should meet this standard. However, the survey data indicates that only 12.5 per cent of households met minimum standards, because in their answers respondents recall the few instances during the year in which their house was too cold – for example, during flooding – and indoor heating devices are rare. Here, the results highlight the importance of interpreting the survey data appropriately and in relation to the city's context. In some sense, space

Street vendors sell small amounts of charcoal

heating is less of a priority than other standards, so the survey may misrepresent the situation. Regarding space cooling, the standard was met by 87.5 per cent of the households surveyed. Fans are common and were found in 82.5 per cent of the households surveyed.

Cooling also relates to keeping food by extending the life of perishable products at home. This increases the access to fresh food and reduces food waste from the lack of adequate storage. From the households interviewed 77.5 per cent met this minimum standard; 33 households (82.5 per cent) reported ownership of a fridge or a cooling box. For those who do not meet this standard, fresh food can be bought on the streets, but that may also pose health risks, since, for example, meat and fish are not refrigerated. Selling food on the streets is an important source of livelihoods, with vendors selling a variety of products from fresh fruit and vegetables to seafood and cooked food.

In the TEA survey, information and communication uses are divided into two standards; the first one refers to people's ability to communicate electronic information from their household (e.g. having a landline, mobile phone, or internet access). In our case, 85 per cent met this standard. The second standard refers to access to electronic media in the household. In Chamanculo C, 92.5 per cent met this standard, meaning that most of the people have mobile phones, radio, or a TV in their houses. This is consistent with Practical Action's research that suggests that information and communication are the standards most often met in households worldwide. Mobile phones have relatively low energy consumption and, in Maputo, the costs of the device and service are accessible, according to the survey observations. People often express their interest in and desire for internet access because of the potential benefits from using this service, as a means of communication and using social networks, but also as an opportunity to access information for all purposes including education and work.

People often expressed their desire for internet access

Energy services and local livelihoods

Energy plays an important role in sustaining local livelihoods. Additional fieldwork observations showed that there are a variety of livelihoods associated with energy, both directly and indirectly. For example, charcoal is present in the street landscapes: on the street you can see women selling small amounts of charcoal, suitable for a family meal. The work of street vendors is to organize piles of charcoal, each pile corresponding to the amount of fuel needed per day in an, approximately, 5-person household. Many combine this activity with cooking and selling food, which also depends on using charcoal. Large-scale trading of fuels also provides livelihood opportunities. Big depots store large sacks which are sold to smaller sellers or directly to families who have both capital and storage space. Unlike street selling, the depots are all run by men, who manage the premises, take care of the facilities, and transport charcoal in wheelbarrows to households and workplaces.

The introduction of the prepaid electricity system has supported the development of small businesses that sell the electricity credits directly to households and, thus, have an additional source of income. Electricity also supports small businesses locally. Beauty parlours, restaurants, and shops, for example, depend on electricity to support a range of appliances (from blow driers to fridges) as well as resources to promote their business, such as music and external lighting. Many residents also commented on their dependence on mobile phones to find jobs or to respond rapidly to new or temporary employment opportunities.

The prepaid electricity system has supported the development of small businesses.

Following a TEA approach also means considering the extent to which energy access supports community services (Practical Action, 2013). This was one of the the key aspects that we explored in the participatory mapping exercise, as explained below.

Charcoal traders

Small shops sell electricity credits

Findings from the participatory mapping exercise

The participatory workshop threw light on the subjective understandings of energy which relate to perceptions and experiences in the energy landscape of Chamanculo C. This relates to the physical artefacts that enable energy uses, but also to ideas of what is a good city, for whom, and how energy services can be met in that urban context.

Electricity supply

Intermittent access to electricity: partly supply problems, and partly variable incomes so people could not always afford credits

The participatory workshop in Chamanculo C revealed that, above all, participants had a great sense of pride in the improvements made to the electricity network. They greatly valued the control they felt over payments through the Credelec system. They were also proud of the Cahora Bassa dam in the north of Mozambique, one of the largest hydropower facilities in Africa. This dam operates by virtue of a reciprocal arrangement between EDM and the South African energy company Eskom, whereby Cahora Bassa provides energy to Johannesburg and Eskom provides cheaper electricity to the south of Mozambique. Participants spoke of Cahora Bassa as something they would like to learn about and attached great significance to it, as the dam is an important symbol of the modernization of the country. People did talk about the problems of intermittent access to electricity, which was partly due to problems with supply, and partly due to the variability of incomes meaning people were not always able to buy credits.

There was little mention, in comparison, about the discovery of the large offshore reserves of natural gas in the north of Mozambique which are likely to transform Mozambique into one of the largest exporters of natural gas. Although the discovery is likely to transform the national energy system, there are no guarantees that the current government and energy providers will have the appropriate regulatory frameworks and distribution systems to actually provide gas to impoverished households (Mahumane and Mulder, 2015).

Electricity in community life and public spaces

While talking about uses, participants emphasized the household as a site of energy use. However, when walking around the neighbourhood, participants described electricity and fuels as public goods. Electricity, for example, plays a key role in community life and public spaces. This is not just because it is linked with commercial activities, but also because lighting plays a key role in building up a safe and welcoming neighbourhood. Participants, for example, explained how the upgrading and extension of public lighting had changed their everyday life. In Chamanculo C most roads are extremely narrow and lighting is very poor. Residents explained that without public lighting, many errands were suspended or involved elaborate detours using wider streets. For those who only have access to public sanitation facilities in the neighbourhood, public lighting is essential.

Housing quality and design: implications for energy access

Street lighting plays a key role in building up a safe and welcoming neighbourhood

Space also plays a key role in relation to the way the structure and position of the household conditions energy access and its use. Residents explained that connecting the household to the electricity network depends on the structure of the house and whether it is suitable for connection (e.g. reed houses would not be considered suitable). As house quality has improved, people have accessed electricity. Yet, for the few people still living in reed homes, connecting to the network may not be possible. Housing improvements have gone hand in hand with access to the network. In some cases, for example, electricity posts were built together with the houses.

Households in Chamanculo C tend to consist of several separate rooms around a patio, each used for diverse functions at different times of the day. The house architecture allows for cooking to take place outside the independent rooms where people sleep and take shelter. The cookstove(s) constitutes a central point in the house, where the rhythms of cooking intersect with the needs for hot water. Having multiple stoves is crucial for

According to Chamanculo C residents, street lighting improves security after dark

Cooking outside using both an improved stove and a traditional stove for heating water

Any solution needs to work with the variety of pot sizes, multiple pots, and the use of stoves for heating water

daily cooking and cleaning activities. Alongside the cooking stoves, a larger stove is used to heat large quantities of water with residual heat. Hot water is needed for a multitude of uses, such as personal hygiene and washing clothes. Having a place to boil water may also have important health benefits when the water supply is unreliable and of dubious quality. However these arrangements mean that multiple uses co-exist spatially, and residents associate this with the high frequency of accidents around the cookstove.

Residents choose to cook outside partly because they have the space to do so on their patios, but also as a strategy to avoid indoor air pollution. If possible, through cleaner fuels or stoves, interviewees said they would prefer to cook indoors. This would free up their outdoor space for other uses, and could reduce accidents. However, any solution would also need to work with the variety of pot sizes, multiple pots being used at once, and the use of stoves for heating water.

Local improved cookstoves programme

The Fundação AVSI, an international NGO with a range of successful community-led programmes in Chamanculo C, is one of the local organizations delivering a pioneering programme for the replacement of approximately 5,000 traditional cookstoves with improved cookstoves. As AVSI explained at the SE4ALL meeting in May 2015, they have involved 'customers' as a means to promote their cookstoves and create demand. Users explain how the new cookstoves allow for cooking indoors (because they produced less pollution), are safer for children, and use much less charcoal than the traditional model made of iron and recycled metals. Because of their portability, the cookstoves have the potential to help women adapt to different circumstances. However, the new cookstoves do not meet the full range of cooking needs because the model chosen is of a very small size not necessarily suited for cooking large amounts. Moreover, cooking tends to use a few stoves simultaneously, as different components of a meal may require separate cooking pots. Improved

Improved, portable cookstove being promoted by local NGO

cookstoves may also not meet the needs of people whose livelihoods depend on cooking in the street.

The development of pioneering projects like AVSI's will continue to show how cookstoves can improve the lives of people, but they also show that there are limitations in delivering cookstoves which require a deeper preliminary investigation of the context. This means shifting towards an understanding not just of local energy needs, but also of the precise patterns of cooking and how they may depend on the cookstove's design. Unfortunately, this kind of research may not always be available to NGOs operating on limited budgets.

Livelihoods in energy supply value chains

Another factor highlighted by local residents was the importance of iron works – especially those making cookstoves – in providing local livelihoods, both for those who make the cookstoves and those who sell them in local markets. The nearby market of Xipaminine, for example, has a whole section dedicated to selling cookstoves. However, the improved cookstoves being promoted by AVSI are subsidized and imported from the US, which may damage local cookstove markets. Nevertheless, the project provides temporary employment for the young professionals who distribute the cookstoves. A more sustainable approach could entail the design of locally tailored? Same word appears twice in a sentence models of cookstoves, built with local resources, tailored to local patterns of energy use, and providing an additional opportunity for local businesses.

The continued use of charcoal also depends on the complex relationships that emerge within and beyond the neighbourhood. Here, our discussions with residents during the participatory workshop as well as qualitative interviewing relate urban energy landscapes with the flows of fuel that shape their provision and use. The charcoal used in Chamanculo C comes from different sources, but mainly from the Gaza province, which

Locally produced charcoal stove

The energy system is related to a complex web of livelihoods, social practices, and resource transformations

is the main supply area of charcoal for Maputo markets. In the Gaza region, deforestation due to charcoal production is a pressing environmental problem. A small percentage of this fuel comes from artisanal producers near Maputo, for example in Matutuine. In a visit to Matutuine a local producer explained the complex stages of artisanal charcoal production and how it has sustained him since childhood, revealing the important role that urban consumption of charcoal plays in sustaining extremely poor neighbourhoods in rural areas. Overall, the energy system entails something more than just ensuring the reliability of supply and understanding use: it is related to a complex web of livelihoods, social practices, and resource transformations.

Priorities for energy access

Interpreting the results of the TEA survey and the participatory mapping exercise together, we can distinguish three immediate priorities for energy access as described by local residents: 1) extending street lighting as far as possible as a public service to every corner of the community; 2) improving the safety of cooking without increasing household costs; and 3) facilitating the extension of information and communications networks, particularly gaining access to the internet. This highlights that although the majority of residents failed to meet the minimum standard for space heating (due to short periods of cold) they prioritized street lighting and communications.

People welcomed the huge improvements in electricity supply, although intermittency and affordability remained issues. There is less interest in fuel substitution, perhaps because there is not yet a vision among local residents and government authorities about how cleaner fuels such as LPG could improve the lives of those in Chamanculo C. However, in the light of the new discoveries of natural gas in Mozambique, we believe that it is important to explore alternatives for the substitution of household fuels together with the potential implications for the numerous people whose livelihoods depend on charcoal.

Conclusion

Participatory mapping of energy landscapes revealed priorities and areas of intervention

This briefing note demonstrates how quantitative assessments of energy access can be complemented by rich qualitative information obtained through an energy landscape perspective. The case of Chamanculo C demonstrates that while the TEA helped to identify the key areas of energy *deprivation* (especially the continued reliance on charcoal), the participatory mapping of energy landscapes revealed people's priorities and several areas of *intervention*. This may be particularly important in urban settings, where the complexity of social and economic relations around energy shape the eventual success of those interventions. Participatory mapping of energy landscapes is a relatively low-cost means to involve communities in the visioning and design of their future energy landscapes. Notes of caution are needed about the instrumental use of participatory methods which focuses more on meeting donor conditions than making a genuine contribution to improving the lives of people (see for example a powerful critique in Dagnino, 2007). However, participatory methods constitute a great complement to quantitative surveys of energy access such as ESI/TEA or the more recently defined Global Tracking Framework Tiers. Planning for energy is not a mere technical matter, but rather a matter that should engage with people in urban energy landscapes.

Particular insights from the workshop revealed, for example, how much people valued electricity for improving communication and lighting. Attention is turning more to intermittency of supply and people's ability to afford credits, so that they can access these services more continuously. It reminds us that having an electricity connection does not guarantee a continuous level of service. In cooking, the introduction of charcoal-based improved cookstoves seems to offer an immediate and effective solution to improve the safety of local residents while reducing the pollution caused by cooking practices. However, there are specific design and economic considerations which could improve the integration of improved cookstoves within the local economy, leading to higher rates of uptake and usage.

The participatory mapping workshop drew out the relevance of a 'Total Energy Access' approach which focuses not only on household uses, but also on community services and local livelihoods. An energy landscape perspective shifts the focus away from the household to the neighbourhood as a complementary site of energy use. A reliable electricity network is essential to provide public lighting, for example, to create safe and accessible public spaces. Charcoal flows shape the local economy and the spatial distribution of markets, making a cooking fuel available in large or small quantities in locations near to the place of consumption. Finally, the local accounts also point towards the connections that energy flows establish with other locations: for example, the production of charcoal in areas where sustaining poor livelihoods relates to the degradation of forest resources.

The global debate about energy access has tended to focus on rural areas, and when it does talk about urban energy, the focus has largely been on issues of energy efficiency and reducing carbon emissions. There is a lack of understanding about the nature of energy poverty in urban areas, but recent research highlights how, even when people have an electricity connection, they may still fail to access a minimum level of energy services on an affordable, reliable basis. This is particularly true for cooking, but also applies to electricity. Thus, if we are to achieve SDG 7 – 'affordable, reliable, sustainable and modern energy *for all*' – we must not neglect the needs of the urban poor.

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Front page photo: The electricity network in the streets of Chamanculo C
All photos in this breifing paper belong to Vanesa Castán Broto,Bartlett Development Planning Unit, UCL.

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