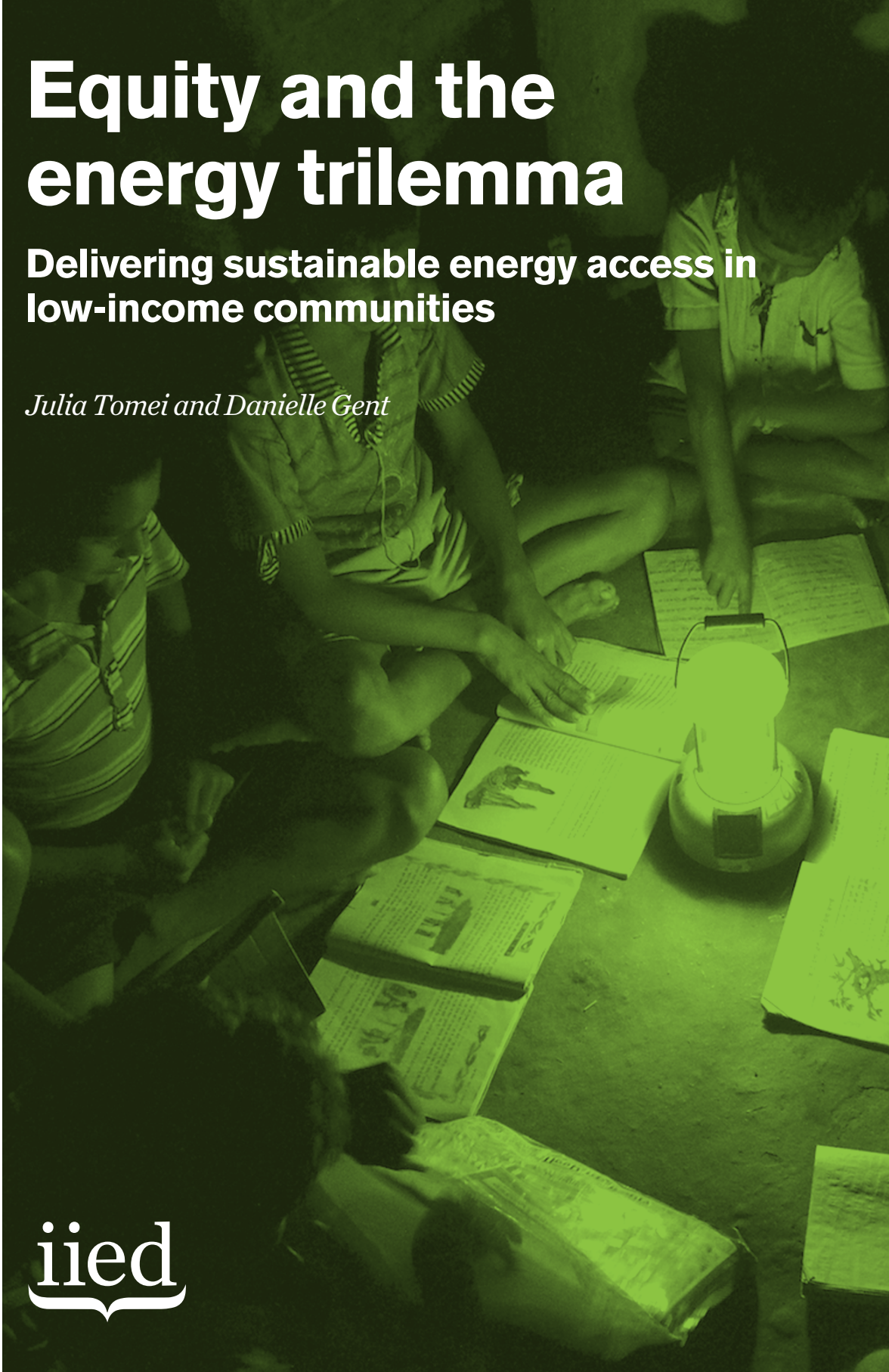
Equity and the energy trilemma

Delivering sustainable energy access in low-income communities

Julia Tomei and Danielle Gent



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Equity and the energy trilemma

Delivering sustainable energy access in low-income communities

The issue of energy access for the poor is gaining momentum globally. This collection of papers by early-career researchers draws on in-depth field research in Latin America, Asia and Africa to explore the challenges of delivering access to modern energy services. The chapters document the ongoing inequities of energy landscapes across a range of geographies, scales and political economic contexts. The authors draw attention to the need to take local people's needs and livelihood aspirations into account in efforts to address the 'energy trilemma'. Highlighting the complexity and multiple dimensions of energy equity, the authors demonstrate the difficulties of disentangling energy poverty from the two other elements of the trilemma – climate change and energy security.

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Acknowledgements

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The Sustainable Markets Group works for a vision of markets that promotes sustainable development at local and global levels, rather than undermining it. The group brings together IIED's work on the green economy, environmental economics, small and informal enterprise, and energy and extractive industries.

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Acronyms

AGO	Automotive gas oil (diesel)
AMES-M	Access to Modern Energy Services Mozambique (Programa de Acesso ao Serviço de Energia Moderna em Moçambique)
BPL	Below poverty line: a socioeconomic group created by the government of India
COP 21	United Nations Climate Change Conference, December 2015, Paris
CSR	Corporate social responsibility
EDM	Mozambique Electricity (Electricidade de Moçambique)
FCRA	Foreign Contribution Regulation Act, India
FUNAE	Mozambique's National Energy Fund (Fundo Nacional de Energia)
GIZ	German International Cooperation
GWh	Gigawatt hour
HCB	Cahora Bassa Hydroelectric (Hidroeléctrica de Cahora Bassa)
HDI	Human development index
HHK	Household kerosene
HPI	Human poverty index
IEA	International Energy Agency
IFIs	Indian financial institutions
IPP	Independent power producer
IMF	International Monetary Fund
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
MDGs	Millennium Development Goals
MFIs	Micro-finance institutions
MW	Megawatt
NERC	Nigerian Electricity Regulatory Commission
NFPs	Not-for-profit organisations
NNPC	Nigerian National Petroleum Corporation
PAYG	Pay-as-you-go systems
PHCN	Power Holdings Company of Nigeria
PMS	Petroleum motor spirit
PPPRA	Petroleum Product Pricing Regulatory Agency, Nigeria
PV	Photovoltaic
RBI	Reserve Bank of India
RETs	Renewable energy technologies
RGGVY	Rajiv Gandhi Rural Electrification plan (Rajiv Gandhi Grameen Vidyutikaran Yojana), India
S3IDF	Small-Scale Sustainable Infrastructure Development Fund
SE4ALL	United Nations Sustainable Energy for All initiative
SEBI	Securities and Exchange Board of India
SELCO	Solar Electric Light Company Foundation, India
SIEPAC	Central American Electrical Interconnection System
SMEs	Small and medium enterprises
SHS	Solar home systems
TWh	Terawatt hour
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change

1 Introduction

by Julia Tomei, Danielle Gent and Emma Wilson

This edition of IIED's Access to Energy series has its origins in a session at the Royal Geographical Society and Institute of British Geographers Annual International Conference held in August 2013. It contains a selection of experiences shared at the event. The conference aimed to bring together early career researchers, who through in-depth overseas field research have been investigating emerging geographies of energy and development. The strength of the submissions we received following the event is testament to the interest in this critical and topical issue, and the contributions of early career scholars to this field. Drawing on learnings from their field research, this collection highlights the ongoing inequities of Southern energy landscapes across a spectrum of geographies, scales and political economic contexts. This collection comprises updated versions of the papers presented during the conference, with a brief editorial and discussion to connect the contributions, and to situate them within the context of ongoing debates on global energy governance and the delivery of sustainable energy to all.

A central challenge for global energy governance is to manage a complex 'energy trilemma' which involves the interconnected, but often competing, demands of energy security, climate change mitigation and energy poverty (Gunningham, 2013). Inevitably there will be trade-offs between the different dimensions of the trilemma and, all too often, it is the poverty dimension that is lost. Addressing the energy poverty challenge will require concerted effort if the needs of the 1.3 billion people without access to electricity and the 2.7 billion who rely on traditional biomass for cooking are to be met (IEA, 2014). This means that the poorest three quarters of the global population use less than 10 per cent of global energy (Bazilian and Pielke Jr., 2013), a statistic which brings into sharp relief deep and persistent global energy inequities. The papers in this collection emphasise the energy poverty dimension of the energy trilemma, drawing attention to the needs of the poorest and the embedded inequalities of the global energy system. However, as the contributions which follow also illustrate, energy poverty cannot be easily disentangled from climate change and energy security drivers.

The challenges embodied in the energy trilemma are increasingly under the spotlight and constitute key areas of international governance. This year represents a critical milestone for delivering the political conditions, environments, metrics and means of implementation for expanded access to clean energy, as well as for lower emission development pathways. Two key events are likely to determine the political landscape for years to come. Firstly, in September 2015, the UN post-2015 development framework will be negotiated, providing the roadmap for international development to 2030.[1] The delivery of sustainable energy for all is likely to form an important component of this framework, and

1 United Nations Summit to adopt the post-2015 development agenda, 25–27 September 2015, New York. See: www.unep.org/unea/sdg.asp

may take as its starting point the United Nations Sustainable Energy for All (SE4ALL) initiative.[2] Launched in 2011, SE4ALL has three objectives by 2030:

- Ensure universal access to modern energy services,
- Double the rate of improvement in energy efficiency, and
- Double the share of renewable energy in the global energy mix.

Secondly, in December 2015, the world will gather in Paris[3] to secure a legally binding, global climate change agreement, the framework needed to limit average global temperature increases to below 2°C and avoid the worst impacts of climate change. This collection contributes to debate in this critical year by drawing attention to the multiple scales of governance and the multiplicity of energy needs that must be considered in tackling the energy trilemma.

However, as the papers in this collection highlight, the global decisions and frameworks designed to solve the energy trilemma translate differently into nations, regions and communities. Decisions made at the global level are often far removed from the realities of the vast populations living in energy poverty, and solutions may not always play out as intended. The collection makes explicit the ways in which the energy trilemma unfolds across countries and contexts and as such presents a series of nuanced country and region-specific analyses. It also offers recent empirical insights into the social, economic and political dimensions of energy poverty and equity issues, a focus on global energy drivers, governance and transmission to local levels, and an appreciation of local-level energy realities.

Ankit Kumar's paper grapples with one of the high-level goals emerging through the United Nations system, that of 'sustainable energy for all'. Through the lens of electricity access interventions in the Indian state of Bihar, Kumar unpacks the terms 'access' and 'all' and explores the challenges of expanding 'access for all'. He shows how, in Bihar, access is achieved through different technologies which deliver electricity of varying quantities and qualities. Kumar's research reveals a wide range of user needs and priorities, which also shift and evolve over time. This often results in a mismatch between users' and developers' understandings of 'access' and 'all'. Instead of delivering standardised approaches to electricity access, Kumar argues that first it should be about understanding the needs and priorities of users, and designing energy systems accordingly.

Danielle Gent and Julia Tomei also examine high-level shifts in global energy governance. Through the case of power sector reform in Central America, Tomei and Gent explore how changes in global energy priorities transmit to and are translated by actors at the regional and national levels. They also discuss the consequences of these shifts for the countries' power sectors, and the emergence of new challenges and opportunities for the region. This paper also draws attention to the trade-offs and complementarities between the different dimensions of the energy trilemma, arguing that energy security imperatives and market forces combine to take precedence over climate change and energy access. Dissecting the historical political economy perspective, Gent and Tomei raise questions about the potential for a sustainable and equitable energy landscape in the region, and the consequences for the 7 million people currently living without access to modern energy services.

2 See: www.se4all.org

3 United Nations Climate Change Conference (COP21 or CMP11), 30 November to 11 December 2015, Paris. See: www.cop21.gouv.fr/en

Boris Lopicich focuses on financing energy access and, in particular, he examines the regulatory barriers to financing microgrids in India. Microgrids have been highlighted as a potential energy solution for the more than 400 million Indians who currently lack access to electricity. He analyses the obstacles to international investment that arise from the Foreign Contribution (Regulation) Act of 2010 and finds unnecessary bureaucracy and regulations that disadvantage newer organisations, hindering foreign investment in microgrids. Lopicich therefore argues for further regulatory changes, which he contends will be necessary if India is to attract the foreign investment required to provide electricity to those who need it most.

Julia Tomei, Jennifer Hodbod and Tina Blaber-Wegg continue the theme of governance and inequity, this time in the context of a specific energy source – ethanol from sugarcane. They examine the equity dimensions of sugarcane-ethanol systems in three different countries: Brazil, Ethiopia and Guatemala. They show how governance arrangements influence the equity outcomes, with typically negative impacts on marginalised and vulnerable actors. They argue that, despite claims that biofuels can meet the energy needs of local communities, in practice they rarely do, even where the provision of local energy access has been a policy driver.

Ali Naibbi and Richard Healey provide the first of two in-depth national case studies. In particular, they focus on access to cooking fuel in Nigeria, examining the factors behind the slow transition from traditional biomass to modern cooking fuels. Naibbi and Healey find that cooking fuel consumption and distribution patterns are affected by the insufficient supply of fossil fuels, largely due to the corruption inherent in the system, which has caused households to actually descend the so-called 'energy ladder'. This research draws critical attention to the trade-offs between the three dimensions of the energy trilemma, specifically the negative consequences of the removal of fossil-fuel subsidies on the poorest within Nigeria.

Finally, Joshua Kirshner presents his empirical research from an emerging energy frontier, Mozambique. He explains how, in a country where recent mineral and energy discoveries have generated widespread interest, there are multiple energy transitions underway which aim to address the needs of both energy-intensive and energy-poor users alike. Through his examination of five case studies of small-scale, decentralised energy initiatives, Kirshner draws out factors which determine the success or failure of such projects. In common with Kumar, he highlights the importance of incorporating the needs of the end user in energy planning. His paper, however, also points to the continued disconnect between the different facets of the energy trilemma, and the missed opportunities for this country which has reached a critical juncture in determining its energy future.

The final chapter draws together some of the key themes to emerge from this collection, including energy equity, the overlooked role of the end user, and the importance of examining the multiple scales of energy governance. Collectively, these papers provide evidence to suggest that without greater consideration of these issues, initiatives to promote universal access to modern energy services may not provide the expected opportunities for sustainable development. Rather, initiatives to promote sustainable energy for all may serve to reinforce existing power structures. We hope you enjoy reading this collection, which we believe provides an exciting and timely contribution to this important debate.

2
Sustainable energy for all: can we take care of the 'all'?

by Ankit Kumar

2.1 Introduction

The idea of 'sustainable energy for all' has been built around three key objectives, 'ensuring universal access to modern energy services, doubling the global rate of improvement in energy efficiency and doubling the share of renewable energy in the global energy mix' (UN, 2012). The first of these three objectives is most relevant for this chapter. The project of ensuring universal access to modern energy services for all raises two basic questions:

- How do we define 'access'?
- What do we mean by 'all'?

These two questions themselves are closely connected to each other. How we understand one would affect our conceptualisation of the other. What we understand by energy access and how this interacts with the target population would also have a bearing on our understanding of 'energy equity' and 'energy poverty', since access, equity and poverty are closely linked concepts.

This chapter explores these two questions or concepts with the help of empirical evidence collected through ethnographic work in rural India. The ethnographic work was part of nine months fieldwork in five villages in Bihar state, India, conducted for my PhD research which looks at the politics of energy access. The chapter uses case studies of the national grid and two renewable energy projects to understand how energy access, energy poverty and energy equity are being operationalised in rural India. It looks at the advantages and disadvantages associated with these electricity systems and it critiques many of their developmental claims. It links the problems associated with these projects to the normative ideas around the energy–development nexus.

Ultimately, the chapter argues for a new lens – that of development – to look at energy access and the need to tailor energy access for the 'all'. Although 'sustainable energy for all' refers to several types of energies (electricity, heat), this chapter uses electricity as an entry point to understand the questions raised above.

2.2 The critical questions

The first question, 'How do we define "electricity access"?' has been debated globally, although not very widely. Various scholars have argued the importance of 'modern energy', 'affordable prices' and 'connection to the grid' while discussing energy access (Kanagawa and Nakata, 2008; Winkler *et al.*, 2011). Pachauri (2011) has included 'adequacy', 'affordability', 'quality and reliability' and 'basic energy needs', to operationalise the definition of 'energy access'. The International Energy Agency (IEA, 2011) places stress on 'connection', 'minimum consumption level' and 'increasing electricity consumption over time' indicating that 'access' is dynamic.

Along with the spatial variability discussed earlier, we could argue that access also has a temporal variability. Drawing from these, electricity access may be defined as the ability

to connect to and secure affordable, adequate and reliable electricity supply for basic needs. However, income levels of the target groups would define 'affordability' and specific electricity services would define 'adequacy' of electricity supply. The electricity services would themselves define, and be defined by, 'basic needs', which may again depend on the target groups. Connecting to the earlier argument, it must be emphasised that basic needs are fluid and change with time (and in space) thus making access also fluid and dynamic. These multiple dependencies and contingencies indicate that access may also be seen to be linked to self-determination. Rehman *et al.* (2012) argue that access is related to freedom of choice. The dependency on basic needs, affordability and adequacy makes the definition of electricity access highly contingent on the definition of 'all' and the scalar heterogeneity of the 'all'.

Let us examine the second question now: what do we mean by 'all'? In the context of sustainable energy for all, the term has been used at the global level. I argue that 'all' is a very scalar term, meaning one that changes depending on the scale to which it is applied. At the global level, about 19 per cent of the population is without electricity access (OECD/IEA, 2012). However, as we zoom into India we find that about 33 per cent[4] of households lack electricity access (Census, 2011). If we zoom further into the research area for this chapter, Bihar, an eastern state of India, we find that about 84 per cent of households do not have electricity access (ibid). These figures give a sense of the vertical scales of variation for 'all'.

In addition to the vertical element 'all' also shows a horizontal variation. In Bihar, figures suggest that a striking difference exists between urban and rural areas with about 67 per cent and 10 per cent electrification respectively (Census, 2011). Even at the national level, while about 93 per cent of urban households have access to electricity, the figure is only 55 per cent for rural households (Census, 2011).

These numbers indicate that we need to add a geographical context to our understanding of 'all'. 'All' at the global level may be seen as a homogeneous group of people who are **characterised only by their lack** of electricity access. However, this homogeneous group (as seen from the top) has different levels of heterogeneity at various geographical (both vertical and horizontal) scales. Some common elements contributing to heterogeneity in the Indian scenario are class, caste, gender, age, knowledge and migration patterns. These elements greatly impact peoples' needs, wants and aspirations. Thus, heterogeneity has a deep bearing on actual and aspired electricity uses and is reflected in people's ideas of electricity access. The heterogeneity of ideas determines what 'energy poverty' and 'energy equity' mean for different people in different contexts.

2.3 How does electricity access fare on the ground?

Now that we have some idea of the two concepts – 'electricity access' and 'all' – we can begin to grapple with 'electricity access for all', and whether we can take care of the 'all'. For this, the chapter uses case studies of three electricity provision systems. These include a solar lantern project, a biomass gasification-based microgrid system and the central grid network of India. The three systems have different capabilities – real and perceived – with respect to the electricity services they provide. The solar lantern project provides only light, the microgrid commonly provides light and mobile charging facilities, and the central grid provides various household electricity services (including lighting and mobile charging). All of them act as agents of electricity access, prioritising certain electricity services and, through them, proposing and operationalising their own definitions of 'electricity access'. But do the

4 Percentage of households that use electricity as a lighting source, based on 2011 Census data.

priorities of these electricity provision systems match people's priorities?

2.3.1 The solar lantern project

This project uses a solar lantern and charging station-based model to provide lighting services. The project trains and encourages village entrepreneurs to set up and operate solar lantern-charging stations thus providing local livelihoods. The solar lanterns are charged during the day and in the evening are rented out to the village households. Since the project only provides lighting services, it competes with kerosene lamps and lanterns that are commonly used in the absence of electricity supply from the national grid. In fact, one of the main motives of the solar lantern project is to replace kerosene-based light sources like lamps and lanterns.

Children use solar lanterns for studying in the evening.
Photo: Ankit Kumar

Light from solar lanterns are seen as superior and users seem to find these better than kerosene[5] for lighting. However, light is not the only electricity service that fulfils people's needs. With reference to this, one domestic user of the solar lanterns remarked:

> *It is very good as an alternative for the kerosene lamp or lantern. But ultimately it is a matter of laachaari [helplessness] because [grid] electricity does not stay. So, this is OK. The main thing is that this is not something for [our] satisfaction.*
> Bimlesh Kumar, farmer, Sahariya[6]

Mr Kumar above argued that the solar lanterns worked well for lighting when compared to kerosene lamps or lanterns. However, his electricity requirements are not only limited to lighting, which can be fulfilled by the grid electricity. For him, the use of solar lanterns is a compromise because the grid electricity in his village is unstable and unpredictable.

Lighting is certainly a very critical electricity service, one that mobilises education and improves the working environment. However, there were other electricity services that people desired and, in several cases, prioritised. The solar lantern project was fairly successful for some people in a particular village because light is connected with one of their key priorities, education. Education is seen as the window to a better future by some in the village, who use the solar lanterns so that children can study in the evenings under better light. However, in these households too, other members still rely on kerosene lanterns. Thus, the solar lanterns mobilise the aspirations of a particular section of society. However, this priority was highly contextual and changed as one moved to other parts of the same village or to another village.

While future aspirations dictate some people's priorities, others are motivated by the present monetary benefits from the investment in this new light source. In another village someone using a solar lantern in his tea shop pointed out that he did not use it at home as there was no direct monetary benefit from it. On being

5 In these parts of India, since electrical grid supply is either absent or highly erratic in most villages people heavily depend on kerosene for lighting.

6 The names of people and villages have been changed to protect their identity. Pseudonyms have been used to avoid the dehumanisation of the research participants.

asked if those at home would live in the dark he remarked,

> *Of course they would live in dark [...] this is not London [...] they use kerosene lamps.*
> Pyare Mandal, tea vendor, Bijuriya

By comparing his village to London, Mr Mandal was referring to the lack of infrastructure provision in his village. Many things that would otherwise be seen as needs have become luxuries. He saw the domestic use of solar lanterns and the additional payment for them as a luxury rather than a need. With no connection to income generation, he could not justify the use of solar lanterns, which highlights the interconnections between income and affordability.

The problem of affordability means that this particular electricity service is also not available to everyone. Even those who can rent the lanterns for domestic use do not do so for all spaces in their homes as evident from this statement from a former lantern user:

> *Who doesn't long for lalak [lights] in every room? [...] but I have my own limit. The limit was that I could only rent only two lanterns in a month [...] as per my capability.*
> Rajendra Singh, farmer, Bijuriya

Although Mr Singh belongs to a higher socioeconomic class, due to the high rental costs of the solar lanterns, he still cannot afford to light all the rooms in his household. Most people want to light every room in their home with the 'superior lights'. However, invariably the solar lanterns end up sharing space with kerosene lanterns.

2.3.2 The biomass microgrid

The biomass microgrid was found to be more capable when compared to the solar lanterns as it goes beyond just lighting to could provide other electricity services. However, it still fell short of matching people's priorities. The basic services – lighting and mobile charging – provided by the microgrid go a step further than the solar lanterns. But as people connect[7] to the microgrid, new needs and wants emerge. In most cases, aspirations take over, as pointed by a user of the system.

> *We don't need much electricity now. Right now there is no electricity and we are even having problems charging mobile phones. But, after it [electricity] came [through the microgrid] bulbs were lighted. After bulbs we thought we could have fans too. After fans we wanted [water] pumps. It [the microgrid] did not have enough electricity.*
> Biswajeet Yadav, farmer, Bijuriya

The subsequent emergence of new needs in case of the microgrid points to the temporal fluidity of 'access' and the need to accommodate increasing demand on any system that claims to provide electricity access. Affordability of the service was again a question here according to a former manager of the biomass system.

> *Everyone has colour TV, laptop, computer [...] but in 100W [which reflects in the monthly rental] they want to use everything.*
> Bimlesh Gupta, former manager, biomass microgrid, Hardiya

The microgrid system has various levels of tariffs for different levels of consumption (defined by wattages as exemplified in the above quote). Most people can afford a connection for only lights and mobile charging but want to run other electronic equipment that they already own. In Berangpur – the village without electricity – many people own television sets that they have either bought – to run on batteries – or received as a dowry. However, these are stored in their boxes, waiting for electricity to arrive in the village. I observed similar cases in all five research villages – the photo shows a television set in Kedar Singh's household which was

7 I purposefully avoid the use of 'get access to' here.

Television set in Kedar Singh's house in Bijuriya
Photo: Ankit Kumar

initially run on batteries charged from the nearby town, then on microgrid electricity, then grid electricity and finally on solar panels. However, most people in the villages cannot pay for a microgrid connection for television sets and the affordability of electricity curtails people's access to certain services here.

2.3.3 The central grid

The central grid is perceived as the most superior by the research participants in terms of its capabilities, i.e. the provision of diverse electricity services. It is also considered the most desirable. Theoretically, the central grid could provide the wide range of services that the people need, want or aspire to. However, in reality the scenario is somewhat different. This is reflected in a statement from one of the respondents from a village where both the central grid and the biomass system are operational.

If we get continuous electricity supply we could get our own tube wells [for irrigation] installed or could start doing other small [commercial] works that could be done with electricity [...] but relying on this [the central grid] is an absolute waste. Since the electricity supply does not even reach the town there is no question of it reaching the village. Shivendra Kumar, farmer and businessman, Hardiya

A bulb lighted by the central grid shares space with a kerosene lantern. Photo: Ankit Kumar

A solar lantern hacked to charge mobile phones. Photo: Ankit Kumar

In this village, the central grid has been present for a longer duration than the biomass microgrid and still has not been able to instil confidence with its performance. It lacks reliability of electricity supply. Although the availability of electricity is in question here, the central grid only covers the residential areas of the village and does not extend to the fields. As highlighted by the villagers, this rules out a critical electricity service: irrigation. The unreliability of the central grid in terms of quantity and quality of electricity supply also affects its capabilities. This point was reflected upon by one participant in a group discussion in a grid-connected village.

> *I cannot turn off my [kerosene] lamp [...] electricity would come, I would extinguish [the lamp], it [electricity supply] would go again [...] if the situation was that it would come at 7 and stay until 9 then I could have extinguished [the kerosene lamp].... [But] there is no limitation on how long it would stay [...] there is no saving [of kerosene].*
> Group discussion 3, farmers, Rangpur

During group discussions, the villagers argued that even after being connected to the grid, due to its poor performance, they had to rely heavily on kerosene. Another mismatch between the central grid and the people's priorities relates to the timing of supply. People prefer the electricity supply in the evening hours as they can maximise the benefits during this time. However, it is available mostly during the day, late at night or the early hours of the morning.[8] Most people argued that these timings render electricity practically unusable for them.

8 Rural areas are not very profitable ventures for electricity utilities due to the heavily subsidised and controlled electricity prices. The utilities prefer to supply electricity in these areas during the low-load, off-peak hours when electricity is less expensive.

From the evidence presented above, it could be argued that most elements considered to be critical for electricity access (discussed in Section 2.1) do not come together in any of the electricity systems analysed here. This is primarily due to a gap or mismatch between the perspectives of the users and electricity providers. A mismatch is detrimental to both and should be avoided.

2.4 A focus on matching priorities

The empirical evidence presented here demonstrates the advantages and disadvantages of the various electricity systems, and highlights the need to accommodate people's – the user's – priorities. Failing to do this may lead to irregularities that could result not only in negative consequences for people, but for the electricity systems too. The mismatch of priorities often results in people informally hooking-on, modifying and hacking the systems. During the research, I observed that solar lanterns and their panels were being hacked by people to charge mobile phones and the biomass microgrid was being hacked to use electronic equipment like televisions, fans and water pumps. It was very common for people to informally hook onto the central grid. Practices like overconsumption have been attributed to the lack of flexibility to accommodate people's needs in supply systems (Winther, 2012). On being asked the reasons behind hacking into the central grid, most respondents argued that the poor state of the electricity supply was a strong deterrent for them to enrol as paying customers.[9] In fact, a few customers were contemplating migration in the other direction i.e. towards giving up their electricity connections. One, a man from the below poverty line (BPL)[10] group, who received free electricity connection a few years ago argued,

> *[Kerosene] oil also burns [in lamps] and I have to pay [the electricity bill] too. I would rather get disconnected [from the grid].*
> Bechan Mahto, farmer, Rangpur

The poor electricity supply means that he has to pay for and manage multiple energy sources. This additional burden has had a negative impact on his domestic economy. Like many others around him, he was considering giving up the electricity connection and perhaps instead informally hooking onto the central grid.

However, once those from the socially, politically and financially weaker sections of the society (such as the person quoted above) break away from the system, it becomes very difficult for them to get back in again, even informally. As Winther (2012: 115) argues,

> *[M]ost privileged individuals tend to be the ones who commit plain stealing since the wealthy often possess more knowledge about how the system works. Their higher level of consumption (more at stake) and their social and political power (less afraid of sanctions) may also account for why they are more likely to exploit the system compared to ordinary people.*

In one discussion in a grid-connected village, a person looking after the cattle of the village head man pointed out that his home was not connected to the grid as it was too difficult to get a connection. On being asked why he didn't just 'hook on' like others, he argued that he did not want to be seen as someone who was taking advantage of his position of proximity to the village head. It later emerged that the village head himself was not a customer and was just 'hooked on' to the grid. The head man, who came from a higher social, political and economic position, was certainly much better off in this case, compared to the other person who

9 In this context, 'customers' are formally a part of the system and pay bills whereas 'consumers' informally access the system and do not pay bills.

10 BPL (below poverty line) is a socioeconomic group created by the government of India for the prioritised disbursement of certain entitlements like free electricity connections.

Several households informally hooking-on to the central grid. Photo: Ankit Kumar

came from the lower socio-politico-economic strata of society.

Similar observations were made by several users of the biomass microgrid. They recognised electricity theft as one of the main reasons for the shutdown of the biomass system and argued that people from the higher castes and classes were more involved in stealing than those from the lower castes and classes. Thus, the essential socio-politico-economic agenda seems to be left out in these electricity systems, which has resulted in breakdowns that affect the weakest the most. Indeed, those with greater capabilities benefit and exploit these systems the most. Instead of raising the capabilities of the socioeconomically weaker, the electricity systems seem to reinforce the existing power structures of the society.

Graham and Marvin (2001: 386) argue that even though (infrastructure) networks have always tried to promote uniformity, standardisation, homogeneity and modernity, they have been left with 'unevenness and bias in the ordering of infrastructure networks – in terms of both quality and accessibility'. Furthermore, they argue that 'modern infrastructural ideals' fall short of being 'emancipatory of women, the disabled, indigenous and colonised populations or other marginalised social groups'. These biases created by the infrastructure networks have led to fightbacks in various forms (illegally hooking on, modification and hacking) that 'constantly threaten premium and secessionary network spaces' (ibid: 394).

Whether the ideals of uniformity, standardisation, homogeneity and modernity followed by these systems work or not thus becomes an issue of deep contention. This raises pertinent questions about whether it is possible to achieve these ideals. Should we even try, or should we acknowledge heterogeneity rather than uniformity?

2.5 Development and electricity

The issues raised in this chapter are, on the one hand, that of heterogeneity and diversity of perspectives (on the user's side) and, on the other – as Graham and Marvin argue – of uniformity, standardisation and homogeneity (on the infrastructure side). These problems call for an alternate way of thinking and an alternate framework of understanding for these issues. Using the development lens to understand 'energy access', 'energy poverty' and 'energy equity' may give critical insights for redefining and re-theorising them.

In the past, electricity access has been linked to development by seeing it as a driver of development (Burney, 1995; UNDP, 2005; Kanagawa and Nakata, 2008).[11] Electricity access has also been seen in terms of a basket of services that we must try to define to operationalise development. Ideas about mobilising development through electricity have resulted in top-down approaches to understanding electricity access. Escobar (1995) contests this approach arguing that different problems and priorities may be relevant for different communities. He further argues

11 More recently, energy has been called the 'missing Millennium Development Goal (MDG)' (Yumkella, 2012) and also seen as a driver for the other MDGs (Modi *et al.*, 2005).

(1992: 45–46), 'most often, the interpretation of people's needs is taken as unproblematic, although it can easily be shown otherwise' and recommends a reinterpretation of the 'language of "needs"'.

Escobar recommends a change of the current approach in which 'the process of needs interpretation and satisfaction is inextricably linked to the development apparatus'. Hence, there is a need to flip the traditional lens. We need a new framework, one that starts from development before moving onto electricity. Borrowing from debates around the theoretical concept of post-development, which sees people as 'active agents and subjects' of development (Power, 2003: 84), people must not only be seen as passive beneficiaries, but also as providers and maintainers of electricity access.

We saw earlier that a mismatch between people's and the electricity provision system's understandings of access may result in a breakdowns detrimental to both. In seeing people as the providers and maintainers of access, the first step should be to understand their priorities and configure systems accordingly. This is not to argue for a withdrawal of state, which would leave poorer people to plan, organise, set-up and maintain their own energy systems. Rather, the argument is to develop state–people partnerships, which would enable the development of relationships of co-production for the planning, organisation, set-up and maintenance of energy systems.

Here, one could also subscribe to Amartya Sen's (1999) idea of 'development as freedom' that takes 'very much an agent-oriented view' of development where the actors and their freedoms are the 'primary means and principal ends of development'. Political, economic and social freedoms are the basic freedoms that Sen argues for in order to operationalise development as freedom. He argues for 'freedoms of individuals as the basic building blocks' of development (Sen, 1999: 18). This gives an indication of how, and of the extent to which, we need to disentangle the 'all'. We must deconstruct the 'all' and go down to the most micro – individual – scale to find suitable definitions of 'electricity access'. I purposefully use the plural 'definitions' here, mindful of the fact that no single definition could apply to all. Fulfilling people's needs, wants and aspirations is the principle aim of all efforts to provide electricity access. To make them effective the same needs, wants and aspirations should be considered as the means for formulating multiple definitions of access. This would introduce necessary complexity into electricity access. Complexity in defining electricity 'access', 'poverty' and 'equity' may be the ideal answer to the complexity of the 'all'. Complexity in this case may be necessary for sustainability.

3
Responding to global energy paradigms? Electricity reforms in Central America

by Danielle Gent and Julia Tomei

3.1 Introduction

A new energy era is emerging, one which sees the confluence of three global policy drivers: energy security, climate politics and energy poverty. This energy trilemma now defines the global political economy of energy. While energy policy agendas have typically been dominated by concerns for energy security, this agenda has been complicated by the mainstreaming of climate change politics and energy poverty debates. Indeed, traditional concerns for supply security have been complemented by the recognition of the central role of energy in climate change mitigation. Most recently has been the re-interpretation of long standing social concerns – like poverty alleviation – in ways that place energy at their core. In 2012, the UN Secretary General Ban Ki-moon described sustainable energy as 'the golden thread that weaves together economy, environment and equity' (UN, 2012).

Over the last century, shifting energy paradigms have resulted in different energy governance regimes and policy solutions. Goldthau (2012) uses the concept of 'energy paradigms' to analyse shifts in national and international energy policies and governance over time. He argues that energy paradigms have shifted to reflect wider economic paradigm change, thus the shift from statism to neoliberalism over recent decades. Most recently, we see a shift to a hybrid state–market model, which Goldthau labels 'interventionist'. The interventionist paradigm is one in which energy is viewed as having strategic qualities in several critical policy fields, and has arisen in response to the recognition that the market alone cannot deliver more normative energy goals.

Many scholars argue that current modes of energy governance are unable to match the nature and scope of the challenges presented by the energy trilemma. Indeed, Bradshaw (2010: 275) reminds us that these challenges will require 'a low carbon energy revolution on a scale beyond the first industrial revolution in a much shorter time frame'. This energy revolution will require new governance arrangements that incorporate a wide array of stakeholders, including governments, private sector actors, civil society and multilateral organisations.

In this chapter, we examine the consequences of shifts in global energy paradigms in Central America, a region which has so far been overlooked in energy research. This is perhaps surprising given the scale of energy investments underway in the region, and the continued energy poverty of a large proportion of the population. Central America is also highly vulnerable to climate change, and the projected changes pose a clear threat to the people and economies of the region. In many regards, Central America is also a 'rule taker', as it is a region which is strongly influenced by outside interests – most notably those of its powerful neighbour, the United States. The region therefore offers an interesting setting in which to examine how global energy priorities play out in a particular region.

In this chapter, we draw on academic and grey literature, as well as interviews that were conducted as part of our doctoral research, which was carried out between 2011 and 2013. We begin with a brief introduction to the Central American context, and outline how the region's power sectors have evolved over the past 60 years. Bringing the discussion up to date, we highlight some of the energy challenges facing the region, as well as potential opportunities. We conclude the chapter with a discussion of how the energy trilemma is shaping the contemporary dynamics of the Central American energy landscape, questioning whether an energy revolution of the scale and ambition required is underway.

3.2 Introducing Central America

Central America is a relatively small region, located on a narrow strip of land between North and South America. It includes six states (Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama), which have many commonalities, including shared languages, cultures and histories. The region is also characterised by inequality and poverty. Even in Costa Rica, which has the region's highest GDP per capita, around 20 per cent of the population live below the poverty line (CEPAL, 2011). Although electrification has increased, the region's real energy matrix remains dominated by traditional biomass consumption. The photo below shows women and children on their return from collecting firewood – a common activity throughout the region.

In terms of the power sector, since 1990 the maximum regional electricity demand has more than doubled, reaching 7,093 megawatts (MW) in 2011 (CEPAL, 2012). Table 3.1 shows that over the same period installed capacity almost trebled. Electricity coverage across the region has also increased – dramatically in some

Women and children collect firewood, Pacific Coast, Guatemala. Source: Julia Tomei

Table 3.1
Evolution of the Central American electricity sectors, demand and electricity coverage, 1990 to 2010–2011

COUNTRY	MAXIMUM DEMAND (MW)		INSTALLED CAPACITY (MW)		NET GENERATION (GWH)		ELECTRICITY COVERAGE (PER CENT)	
	1990	2011	1990	2011	1990	2011	1990	2010
CR	682	1,546	887	2,650	3,543	9,760	91	99.2
ES	412	962	650	1,504	2,164	5,813	77*	91.2
GU	452	1,491	811	2,591	2,318	8,147	35.8	85.3
HO	351	1,240	533	1,731	2,274	7,127	39.1	81.3
NI	253	567	363	1,094	1,251	3,567	44.7	74.6
PA	464	1,287	883	2,296	2,709	7,703	72.8	90.1
C. America	2,614	7,093	4,127	11,866	14,259	42,117	56.7	86.9

CR = Costa Rica; ES = El Salvador; GU = Guatemala; HO = Honduras; NI = Nicaragua; PA = Panama
MW = megawatt; GWh = gigawatt hours
* 1995 data.
Note: net generation in three countries (GU, NI and PA) appear to be greater than installed capacity. This may be due to reporting errors or unreported off-grid generation capacity.
Sources: CEPAL (2009, 2011, 2012).

countries. However, it is important to note that levels of electrification vary significantly between and within countries. For example, some urban areas in Guatemala, Honduras and Nicaragua have coverage rates of up to 90 per cent, while rural areas have as little as 20 per cent. This highlights the distributional inequity of grid-supplied electricity in Central America.

3.3 Power sector governance in Central America

Until the 1960s, the generation and distribution of electricity in Central America was dominated by the private sector, with only minimal government participation. Access to electricity was limited, reaching 12–20 per cent of the population, with access largely restricted to urban areas. From the 1960s to the 1990s, much of Central America experienced upheaval and repression as revolutions met with counter-insurgencies. Despite this, state involvement in the energy sector increased during the 1960s and 1970s, with efforts focused on expanding electricity coverage, again focused on urban areas. Following the oil crises of the 1970s, Central American states sought to reduce dependence on oil for electricity generation. The share of oil declined from 50 per cent in 1970 to 27 per cent by 1985, and was mainly substituted by hydroelectric power (Solá Monserrat, 1989).

By the 1990s, more than three decades of civil war, oil price increases, deteriorating terms of

trade and excessive external borrowing had left Central American economies on the verge of collapse. Deteriorating power sectors faced high levels of supply losses, scarce resources and were rife with inefficiencies. Responding to a global economic paradigm shift, throughout the 1990s and into the 2000s, neoliberal reforms led to structural changes in most of the Central American power sectors. These reforms included the privatisation of state-owned utilities and the restructuring of national power systems. In the five countries that underwent structural reforms, electricity sectors experienced a shift from public to private ownership (Table 3.2). Only Costa Rica imposed restrictions on private investment in generation and the Costa Rican Institute of Electricity remains a state-run, vertically integrated company.

The transition from state to market-led governance had a considerable impact on the way in which electricity was generated, distributed and consumed. In terms of power generation, although dependence on oil had been increasing prior to privatisation, this process accelerated following the reforms (see Figure 3.1). Between 1990 and 2007, twice as much new generation capacity derived from fossil fuels was built than generation capacity from renewable resources (Cayo, 2011).

For private investors, diesel generation presented lower perceived risks than renewable electricity generation in terms of lead times and upfront costs. Furthermore, the low price of oil and signals sent by the policy and regulatory frameworks meant that reforms, with the exception of Costa Rica, led to an increased

Table 3.2
Electricity sector reform in Central America: institutional arrangements and shifts in ownership

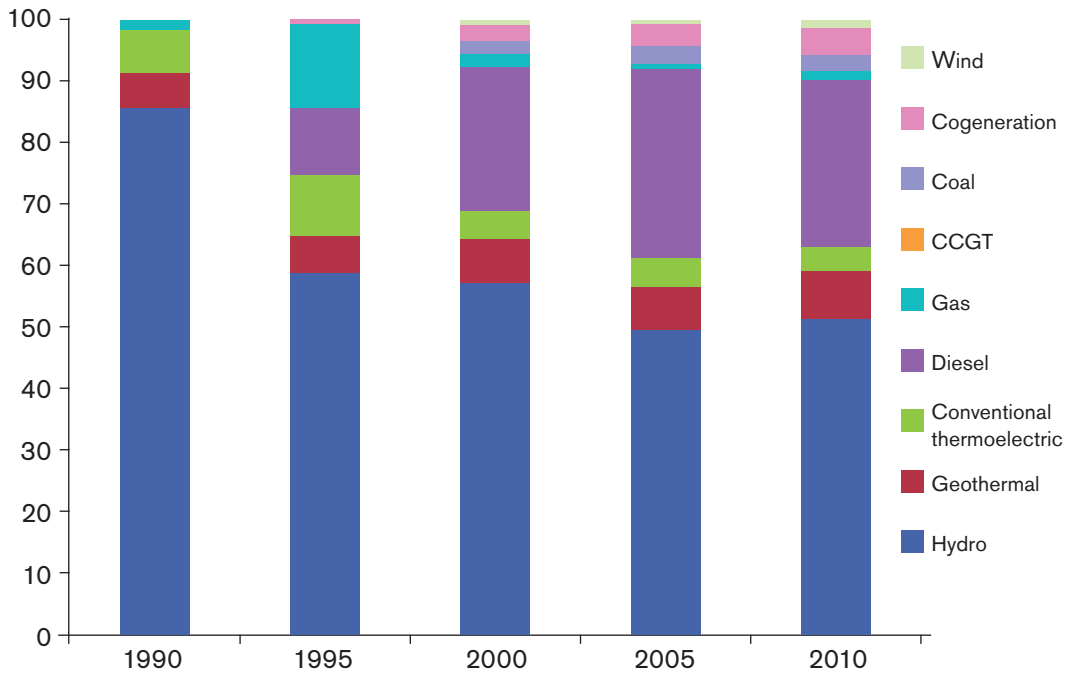
COUNTRY	YEAR OF REFORM	INSTITUTIONAL ARRANGEMENTS	NET PRIVATE OWNERSHIP OF ELECTRICITY GENERATION (PER CENT)					
			1990	1995	2000	2005	2010	2011
CR	1995	Integrated	0	1.6	16.3	13.1	19.8	16.1
ES	1997	Retail competition	0	6.1	43.7	66.3	64.6	65.5
GU	1998	Wholesale competition	0	32.3	58.7	70.0	69.9	68.9
HO	1994	Integrated	0	31.6	39.5	70.6	62.7	65.0
NI	2000	Wholesale competition	0	0.6	55	77.6	80.5	86.1
PA	1998	Wholesale competition	3.1	3.8	100	89.3	88.2	86.0
C. America			0.6	12.4	50.4	68.4	59.8	60.1

CR = Costa Rica; ES = El Salvador; GU = Guatemala; HO = Honduras; NI = Nicaragua; PA = Panama
Source: adapted from CEPAL (2011, 2012)

reliance on fossil-fuel based generation. However, diesel generation also locked countries into higher costs in the longer term due to reliance on imported fuels, and therefore exposure to international price volatility. Since in some cases, political constraints prevented states passing rising fuel costs onto consumers, such costs were subsumed by governments. This represented a 'good deal' for private investors who were able to mitigate risks, including the demand reduction that may have occurred if full costs were passed through to consumers.

In terms of electricity coverage, the outcomes of the reforms of the 1990s and 2000s were varied. Access to electricity increased from 57 per cent in 1990 to 87 per cent by 2010, but electrification rates continued to vary significantly amongst the Central American states. The three countries that had the lowest electricity access – Guatemala, Honduras and Nicaragua – increased electrical coverage from roughly 40 per cent in 1990 to 75–85 per cent by 2010 (see Table 3.1). El Salvador and Panama experienced growth in rural electrification at a similar rate to the years prior to privatisation, while Nicaragua experienced stagnation in the late 1990s and early 2000s. The extent to which neoliberal reforms were successful and indeed appropriate for the Central American context has been contested. While in some countries, the reforms created more reliable and efficient power sectors, in others they led to increased electricity prices, low distributional equity and a shift from public

Figure 3.1
Percentage share of net electrical generation by source, 1990–2010



Source: adapted from CEPAL (2012)

to private monopolies. In some cases, high system losses were maintained, and by the late 2000s many of the region's electricity sectors were facing renewed capacity challenges. For example, Nicaragua experienced a severe energy crisis during 2006–7, which culminated in rolling blackouts and contributed to the near collapse of the economy. The realisation that the market alone would not deliver normative energy goals, including environmentally and socially sustainable energy, has led to the re-emergence of the state across Central America, indicative of a turn towards Goldthau's interventionist era.

3.4 The re-emergence of the state?

Today, the six Central American states face a number of energy challenges, and while some of these are new, others are not. Tackling these challenges will require new modes of governance, and partnerships between both state and non-state actors.

- **Market size:** the region's electricity markets are relatively small. In 2010, the region generated approximately 40 terawatt-hours (TWh) of electricity, which is equivalent to around 70 per cent of the annual electricity supply of a medium-sized Latin American country such as Chile or Colombia. Small markets do not provide a sufficiently large demand base to support competition in generation, which carries the risk of the sector being dominated by one or two players.
- **Electricity access:** Central America has a population of 43 million people, of whom an estimated 7 million do not have access to electricity. Furthermore, around 20 million people continue to use traditional biomass to meet their basic energy needs (Dolezal *et al*., 2013). Typically, national governments view the alleviation of energy poverty as synonymous with the expansion of electricity grids. However, the reliance on traditional biomass, and the remote location of many communities, means that meeting the energy needs of the region's population is unlikely to be satisfied through grid expansion alone.
- **Dependence on oil imports:** increased private sector participation in electricity generation has led to an increasing reliance on imported oil. As a result, the region is highly vulnerable to volatility in global oil markets and when the price of oil is high, the region's economies suffer. Membership of Petrocaribe, the regional oil alliance established by Venezuela, has mitigated this impact for some countries, but has also increased foreign debts to Venezuela and created disincentives for investment in clean energy technologies (Trinkunas, 2014).
- **Balancing supply and demand:** several countries in the region have faced challenges in balancing supply and demand, at times leading to supply deficits and rationing. This has been most acute in Honduras and Nicaragua, which have both experienced recent power shortages. Continued economic growth means that regional energy demand will likely continue to rise, requiring the continued expansion of electricity generation capacity.
- **Climate change:** Central America is highly vulnerable to climate change, which is expected to lead to increased temperatures and a decline in rainfall. This will affect agricultural productivity, with clear implications for food and bioenergy quality and production (CGIAR, 2014). Reducing the region's dependence on fossil fuels will be required, as will investment in renewable energy technologies, in order to stave off more costly adaptation interventions.

Despite these not inconsiderable challenges, there are also opportunities. One such opportunity is the creation of a common electricity market, which would mitigate the challenge of each country's small market size. Since the late 1990s, various treaties have been signed to integrate the six countries' electricity

markets, and an interconnected electricity grid – the Central American Electrical Interconnection System (SIEPAC) – became a reality in June 2013. Despite this, the market remains largely untapped (Johnson, 2014).

Another opportunity arises from the region's significant renewable energy resources, which have been noted by governments and investors alike. Indeed, since 2006, Central America has attracted more than US$4.9 billion in investments in clean energy (IDB, 2013). Currently, renewable energy (mainly hydropower) accounts for 65 per cent of the electricity generated in the region (Meza, 2014). Dolezal *et al.* (2013) argue that with the development and implementation of appropriate policies, Central America has the potential to meet all of its electricity demand from renewables. This potential was highlighted by an announcement in April 2015 that Costa Rica had not used any fossil fuels to generate electricity for 75 consecutive days (Tufft, 2015). Similarly, since the rolling blackouts, Nicaragua has ambitious plans to increase its share of renewable energy and the flood of private finance has led to an energy revolution, generating 51 per cent of its electricity from renewables (WWF, 2014).

However, in some countries, the social and environmental impacts of hydropower and other energy projects have led to opposition, particularly where affected local communities have not been informed or consulted; in Guatemala and Honduras, popular protests are often met with violence and repression. Given the region's history, there is a risk that without due consultation and engagement with local people, other clean energy projects will be tarred with the same brush.

Our analysis of recent energy policies reveals that national governments have responded to Central America's energy challenges with different strategies:

- As the region's only oil producer, an objective of Guatemala's energy policy is to 'explore and exploit' national hydrocarbon reserves, while also committing to further exploit indigenous renewable energy resources (GU-MEM, 2013).
- Conversely, Costa Rica's recent energy policy states that, for environmental reasons, no exploration of hydrocarbon reserves will be undertaken. Rather, the country plans to take advantage of its impressive renewable energy potential (MINAET, 2011).
- El Salvador is similarly planning to expand renewable electricity generation, including large-scale geothermal, hydroelectric and concentrated solar power, as well as small-scale wind and solar (CNE, 2010).
- Responding to the recent energy crisis, the Nicaraguan government is pushing to enact an ambitious overhaul of its energy system, through the transformation of the electricity generating mix, in addition to extending grid electricity to rural areas (NI-MEM, 2011).
- Honduras, which has historically suffered supply deficits, has ambitious plans to construct new electricity generation capacity. The state plans to replace large thermal generation plants with small and medium-scale renewable electricity generation projects (ARECA, 2010).
- Finally, Panama is planning to install an additional 1,300MW of generation capacity by 2023, 60 per cent of which will be met by hydroelectric and wind resources (SNE, 2009).

These policies indicate a resurgence of the state in the region's power sectors. For example, El Salvador's 2010 energy policy explicitly acknowledges that sectoral reforms have weakened the state's capacity to develop long-term energy strategies. It observes that, as a consequence, the ability to plan and think holistically about the energy sector has been lost. Thus, one of the four objectives of the

policy is to re-establish the role of the state in the development of the energy sector (CNE, 2010). This provides a clear example of Goldthau's interventionist paradigm.

Another example is provided by Nicaragua where discontent with the private-led energy model manifested in the part-renationalisation of the electricity distribution company Disnorte-Dissur (INE, 2009). There has also been an increased focus on 'electricity access without exclusion' (NI-MEM, 2011) – an explicit acknowledgement of the equity dimension of energy, which is highlighted by the energy trilemma. Costa Rica's (MINAET, 2011) and Guatemala's (GU-MEM, 2013) energy policies also point to the importance of the state in meeting normative objectives for energy access, energy security and environment.

However, this resurgence does not imply a return to the role of the Central American state as investor and operator that was characteristic of the 1980s and 1990s. Rather, states are now tasked with establishing the vision and targets, and with developing the policy instruments to safeguard the 'public interest' in the delivery of public goods (Goldthau, 2012: 204). Central American nations are therefore focused on strengthening the areas that were weak when the market reforms were initiated, specifically policy making, planning and regulation. The private sector, working in partnership with the state and other actors, such as international financial institutions, continues to play a vital role in realising these visions. In Nicaragua, for instance, the government has mandated support for an 'energy revolution' which would transform the electricity generating mix and extend grid electricity to rural areas (Johnson, 2014); this revolution is buttressed by financial support from the private sector and financial institutions.

While the six Central American countries have adopted different strategies to address the region's challenges, the re-emergence of the state appears to be common to all. This raises questions about what has driven this re-emergence. The conjuncture of the climate, energy access and energy security challenges for the region clearly map onto the challenges embodied by the global energy trilemma. Yet the extent to which these three facets garner equal attention is unclear. In some instances, particularly those that have been affected by supply shortages, the re-emergence of the state has been a response to external macroeconomic pressures, namely high and volatile oil prices. Indeed, across the region, reliance on imported fuel has required the state to take on a more prominent role to maintain macroeconomic stability and to avert social and energy crises. While climate change and energy poverty are important at the national and regional levels – and are issues that are certainly driving the financing landscape – it seems that concerns about energy independence and economic security have so far dominated this agenda. This raises interesting questions about what would happen in the event of falling oil prices, and what the impact of regime change in countries such as Venezuela would be on the region.

3.5 Discussion and conclusions

Three decades after electricity sector reforms were initiated, Central America continues to face a number of energy challenges. Recognition of these challenges, and of the strategic importance of energy to long-term social, economic and political stability, has led to a renewed focus on energy by Central American governments.

In particular, overreliance on imported fuels, awareness of the opportunities offered by the region's considerable renewable energy resources, and the need to tackle energy poverty have galvanised political will and led to action. Our analysis of the evolution of Central America's power sectors therefore finds evidence to support Goldthau's energy paradigm framework. We have shown that since the 1960s, the Central American states have transitioned from a statist to a neoliberal

and now to an interventionist mode of energy governance. This most recent paradigm is characterised by hybrid forms of governance, ones which involve a multiplicity of state and non-state actors and networks of private–public partnerships.

The current policy discourse and significant financial investment suggest that progressive steps are being taken to address Central America's energy trilemma. However, in this chapter, we have raised questions about the relative importance of the three dimensions of the energy trilemma in driving the current energy transition within Central America. We have argued that it has largely been driven by concerns about national energy security, and the need to address the social and economic crises that have arisen from high and volatile oil prices.

The focus on energy security does not, however, mean that the other dimensions of Central America's energy trilemma have been overlooked. Indeed, the interconnectedness of the energy trilemma means that action on one dimension will have knock-on impacts on the others. In Central America, these have been both positive and negative. For example, while the renewed push to exploit indigenous renewable energy resources is driven largely by the need to enhance national energy security, it has had other beneficial consequences such as attracting substantial investment in clean energy. However, the focus mostly remains on large-scale, centralised energy solutions. A key example is large hydropower, which continues to dominate renewable energy in the region.

While our chapter has not focused on energy access, this raises further questions about whether this top-down agenda is able to capture and meet the energy needs of the poorest, particularly those who reside in remote, rural locations. In such situations, decentralised energy systems which make use of existing resources are more likely to provide suitable and sustainable solutions. However, within the current discourse there is little acknowledgement of distinct energy realities, and little space to explore alternative energy visions. We therefore conclude that while an energy transition is underway in the region it is too early to tell whether it will be sufficient to address Central America's energy trilemma.

4
Funding challenges for microgrids in India

by Boris Lopicich

4.1 Introduction

In 2014, only few months after the election, the new Indian government commanded by the Prime Minister Narendra Modi set ambitious goals in the energy field. The new energy policy, which was proposed by the Ministry of New and Renewable Energy, sets a target of generating 60GW of wind energy – both offshore and onshore – and 100GW of solar photovoltaic energy between 2015 and 2022, among other renewable sources. For a country whose energy imports are dominated by oil and coal, this represents a colossal challenge. Nonetheless, the use of different renewable energy technologies has already been proven in many parts of India. The country has significant renewable energy potential, which could be used to meet the needs of the more than 400 million Indians who currently lack access to electricity. In 2006, India accounted for more than 35 per cent of the world's population without electricity access (Bhattacharyya, 2006). Rural localities face particular challenges in the delivery of access to modern energy services and local renewable energy sources offer an important opportunity.

Over the past 10 years, a myriad of policies have failed to deliver the desired rate of rural electrification, and a range of barriers have been identified including political, technological, regulatory, legal, social and cultural barriers. It is therefore important to look at past initiatives to deliver energy access in order to understand how these barriers might be overcome. For example, the Rajiv Gandhi Rural Electrification plan (RGGVY), which was launched in April 2005, is a scheme for rural electricity, infrastructure and household electrification. The RGGVY plan aimed to build rural electricity infrastructure by 2007 and household electrification by 2012. In terms of financing, 90 per cent of the capital subsidy was provided by the government of India through its Ministry of Power, towards the overall cost of the projects under the scheme; the remaining 10 per cent was provided by Indian states and/or loans from financial institutions.

While the RGGVY plan was arguably an improvement on previous policies to deliver electrification, technical and administrative issues meant that it failed to achieve its electrification goals (Caballero-Anthony *et al.*, 2012). Further, it did not lead to significant progress in India's energy transition from fossil fuels to cleaner sources of energy.

One of the solutions proposed by policymakers to achieve rural electrification is off-grid generation. This involves the use of diverse energy sources in decentralised electricity generation, often in remote localities. According to Yadoo (2012), decentralised energy has several advantages.

> *Community level mini-grids have the potential to be among the cheapest electrification methods available for rural areas on a per unit basis… [They provide] the opportunity for additional local benefits to be accrued, such as empowerment through local management [and] payment for feedstock.*

Microgrids are small-scale electricity distribution networks that generally operate below 11 kilovolts. These grids typically provide power to a localised community from a plurality of

Solar projects such as this by Indian solar company Mera Gao Power have been made possible by crowdfunding by companies such as SunFunder. Photo: Sameer Halai/SunFunder

energy sources and may operate both with and without storage (Tenenbaum *et al*., 2014). Microgrids therefore offer an important and affordable means of improving global access to energy, whilst delivering other benefits. In India, while the number of microgrids has grown over the past few years, there remain many barriers to their development and use. Some of these barriers are technological. Others are institutional or financial. This chapter aims to analyse the financial and technological barriers facing microgrids in India. In particular, I focus on the role of not-for-profit organisations (NFPs), as these organisations have made a significant contribution to the development of microgrids, and in supporting small solar enterprises. While for-profit organisations and small and medium enterprises (SMEs) have also made a contribution to the implementation of microgrids, they are not analysed in this chapter.

To date, NFPs have faced a number of barriers in their efforts to address India's low rural electrification, and one key obstacle has been Indian charity laws. In this chapter I focus on particular on the Foreign Contribution Regulation Act (FCRA) of 2010, and the way in which it affects different funding mechanisms for microgrids, such as donations from overseas. The FCRA regulates foreign contributions for Indian NFPs, and sets the conditions under which these entities may receive resources as a matter of national security. In this chapter, I also examine some of the technological barriers which can affect investment in microgrids, and aim to understand the experiences of different stakeholders affected by these barriers, such as solar entrepreneurs, private donors and foreign lenders. In the next section, I provide some additional context on renewable energy policy and microgrids in India before subsequent

sections examine the different financial and technological barriers.

4.2 Renewable energy policy and microgrids context in India

India is currently experiencing a 'renewables boom', one aided by international funds, yet much more remains to be done. One estimate suggests that around US$200 billion dollars will be required to finance the target of 170GW of clean energy by 2022 (Bloomberg, 2015). To attract the investment necessary to achieve this ambitious target India has opened up its borders and many new investors and actors have already emerged, for example to support early-stage technological innovations.

However, many barriers are still present, and incentives are needed to attract more private investment to the energy field, especially overseas funding sources. The energy field has to be understood as an integrated space where obstacles come from political, institutional, administrative and technical sources, funding being only one of these factors. Nonetheless, emerging funding opportunities are critical, and if these different dimensions are considered by policymakers, new policies promoting decentralised renewable energy in India may enable a proper environment for investors.

4.2.1 Microgrids in India

Currently, funding for off-grid projects comes from a variety of sources: international loans, user contributions, national budgets and others (Best, 2011). Community microgrids have the capacity to provide a cheap and clean form of electricity, one which also has the potential to provide a reliable service that can power a range of appliances (Yadoo, 2012). In addition to providing more reliable, affordable electricity with lower environmental costs, microgrids also offer benefits such as community empowerment (Burger and Weinmann, 2013), and positive impacts on education and health (Best, 2011).

Following Tenenbaum *et al.* (2014), primarily three types of regulatory decisions can affect microgrids and small power producers: commercial issues, such as subsidies, taxes and interest rates; technical and/or engineering factors, which may affect the feasibility of the project; and process decisions such as the enforcement of technical and economic issues. While this chapter focuses on the first of these issues – the commercial stage – the influence of the other two types of decisions over the funding mechanisms remains significant.

4.3 An overview of Indian regulation impacting microgrids

Current legislation which directly or indirectly affects the Indian electricity market includes the FCRA, (which influences donations from overseas for NFPs and is discussed in more detail below), regulations of the Reserve Bank of India (RBI) and of the Securities and Exchange Board of India (SEBI), all of which directly affect loans and capital flows. The different acts affecting funding mechanisms for energy projects are regulated by several public institutions. For example, since the FCRA is not a fiscal regulation but rather relates to internal security, this act depends on the Ministry of Home Affairs.

To provide an enabling environment to scale up microgrids, it is important to understand how the various RBI and SEBI regulations affect the flow of capital for different energy projects. It also requires an understanding of different partnership models between foreign lenders, local energy enterprises and entrepreneurs, as well as the operational challenges. In addition, regulation from various government bodies, such as the Ministry of New and Renewable Energy, the Indian Renewable Energy Development Agency, and the Power Finance Corporation must be taken into consideration to analyse the current status and possible development of microgrids in India.

4.3.1 Current funding: the role of financial Institutions

At present, one of the main funding sources for microgrids are Indian financial institutions (IFIs), which have different rates of interest depending on the specific IFI and on the state in which the project is located. These IFIs are regulated by the RBI. For small projects, it is common for developers to choose to obtain loans from micro-finance institutions (MFIs), cooperative banks, and/or regional rural banks. Von Ritter and Black-Layne (2013: 6) argue that MFIs:

> *[H]ave found ways to make the poor bankable and to demonstrate that their repayment performance in well-designed programmes is above average.*

They do this by charging 18–29 per cent rates for three-year period loans for energy systems. Cooperative banks and regional rural banks charge slightly lower rates, respectively charging around 15 per cent and 12–13 per cent. For these loan providers, the basic principle is that the higher the interest rate, the lower the requirements from the bank to the energy project to concede the loan. While interests are higher in MFIs, documentation requirements are reduced and bureaucracy is circumvented.

The difference in interest rates among IFIs has also created a niche for companies supporting entrepreneurs and enterprises in rural contexts. The Shri Kshethra Dharmasthala Rural Development Project (SKDRDP India) is one of the entities that specialise in entrepreneurship assistance, focusing its work on the empowerment of rural women. Others, such as Kinara Capital, aim to fill the gap between funding sources and small enterprises in India.

However, the commitment to assist in meeting the government's targets on access to energy does not only come from these small IFIs. Indeed, some larger, more powerful institutions have also demonstrated a commitment to addressing this issue; for example, in February 2015, the State Bank of India, India's largest bank, announced a commitment to contribute US$12.5 billion in debt financing specifically for renewable energy projects over the next few years. Through this initiative, the State Bank is expected to finance 15GW of renewable energy projects, most likely based on wind and solar energy (Mittal, 2015). However, such initiatives may not be sufficient to meet India's energy targets, and other banks will also need to incentivise off-grid energy generation, for example through preferential interest rates.

4.3.2 The use of slow money

Complementing private sector loans is the use of slow money, which is a funding approach that has emerged as a tangible alternative to decentralising financial sources. It incorporates socially responsible principles to investments and focuses on empowering local communities through the implementation of community-managed programmes. Slow money may help to disseminate renewable and decentralised energy. By lowering the initial debt, this type of capital can reduce interest rates to around 4 per cent. One interesting example of the use of soft capital is the Companies Act which, in 2013, replaced the previous one of 1956. Regulated by the Ministry of Corporate Affairs, the act applies across the whole of India and, from April 2014, has set compulsory corporate social responsibility (CSR) obligations.

Under this act, companies are subject to the CSR requirements if they have, for any financial year, a net worth of at least 5 billion rupees (US$80 million), a turnover of at least 10 billion rupees (US$160 million) or net profits of at least 50 million rupees (US$800,000). Both local and foreign companies are obliged to provide community payments to support environmental and social development projects. To achieve this, the act also establishes that companies must spend no less than 2 per cent

of the average net profit for its preceding three financial years in socially responsible activities. Some of the activities that might be included are related to micro grids, such as:

- Eradicating extreme hunger and poverty
- Promotion of education, which is closely linked to access to energy and improved education capacity
- Ensuring environmental sustainability, and
- Social business projects.

However, while the act presents an important opportunity to improve rates of energy access (since microgrids are included in the concept of social welfare), at present there is no evidence that it has benefitted activities in the energy field.

4.4 Not-for-profit organisations and microgrids

Turning now to the role of Indian NFPs in the development of microgrids, these entities have already made an important contribution to the provision of access to modern energy services in several regions. These entities are also affected by different regulations, particularly those related to the receipt of monetary contributions.

NFPs are not the only organisations working on improving access to energy for the poorest. Indeed, a range of domestic and foreign actors from within the private sector have seen the potential of India´s energy market and have established business models in this area. Drawn to India's energy sector, diverse actors are now supporting an empowered civil society to develop sustainable energy solutions, including SMEs, foreign lenders, NGOs, facilitators or 'brokers' who acts as go-betweens for capital providers, energy enterprises and rural entrepreneurs, private donors, regulators and policymakers. All are seeking to support the development of microgrids in rural communities throughout India.

One example of the work underway by NFPs to deliver microgrids is the Small-Scale Sustainable Infrastructure Development Fund (S3IDF). The S3IDF, which was registered under the FCRA in September 2010, brought a different model to the electricity market, by developing their social merchant bank approach (SMBA) to help solar entrepreneurs to grow their business. The fund provides entrepreneurs with the skills to enter the solar market and to rent solar appliances, typically lanterns and cook stoves. The approach claims to provide an innovative use of philanthropic and development capital, which it argues is critical to mobilise private-sector investment for pro-poor end-user and small-scale enterprise finance. One of the main objectives of the fund is to enable 'ecosystems' by removing the obstacles arising from governments' regulatory frameworks and policies (S3IDF, 2015).

Other initiatives, such as the Solar Electric Light Company (SELCO) Foundation, have focused on both solar appliances and microgrids, in what they have called 'solar powered interventions'. SELCO's efforts are focused on the provision of sustainable energy through decentralised clean energy initiatives and social entrepreneurship. The most recent project is a mini-grid that covers 65 households in Mangalore and, in terms of collection of the money to repay investors, and reliability of the technology used, has been deemed 'successful' (SELCO, 2015).

In common with S3IDF and SELCO, many other NFPs are focusing on smaller guarantees and niche markets to build up microgrids, and are seeking different funding sources to finance energy projects. However, most of these NFPs have in common the requirement for foreign contributions in order to continue funding energy projects and therefore many have focused their efforts on overseas investors. In the following section, I examine the barriers that NFPs are facing in receiving foreign funding, initially focusing on the FCRA as it applies to NFPs before turning to examine the project-level obstacles confronted by microgrids in India.

4.5 Barriers faced by foreign contributors in India

As highlighted above, there are a myriad of Indian NFPs who are focused on making an impact on the quality of life of vulnerable people living in rural areas of the country. For more than a decade, NFPs have been seeking to tackle India's low rates of rural electrification and, in spite of unfavourable laws, have found different ways to receive international funding for off-grid projects.

The Companies Act (2013) distinguishes different types of NFPs in India. These include: societies that are under the registrar of societies; public charitable trusts; and private limited non-profit companies under Section 8 of the act, which includes companies with charitable objectives such as the promotion of social welfare and the protection of the environment. Despite their different characteristics, they all have in common the duty of compliance with the FCRA when they receive foreign donations. Although other legislation will also influence the financial and investment climate of NFPs (see Section 4.3 in this chapter), I focus primarily on the FCRA because it acts as a key bureaucratic obstacle that NFPs must overcome.

4.5.1 The FCRA and the legal regime for foreign donors

Donations from overseas are regulated in India by the FCRA of 2010, which replaced an earlier act from 1976. The FCRA, which is applicable to all Indian states, was first implemented as a matter of national security. When the act was first dictated in the 1970s, the political climate was highly unstable and to limit foreign influence, the central government enacted the FCRA which meant that no individual or organisation could receive foreign funds unless registered under the act. Some decades later, the FCRA was modified, creating strict rules on the acceptance of foreign funds by NFPs.

The FCRA has been criticised for its bureaucratic burden, and concerns have been raised about the selective targeting of particular, more critical NFPs. Some funds, defined in Section 2(1j) are exempt from the act, and include those from well-established donor institutions such as the United Nations and its specialised agencies, the World Bank and the International Monetary Fund. Therefore, the act does not only apply to NFPs in the access to energy field, but also affects a broader spectrum of organisations with different interests and missions. The FCRA also applies not only to large energy investments, but also to smaller-scale energy initiatives. The Ministry of Home Affairs is the government agency responsible for monitoring and enforcing compliance with the legislation. Violations may lead to penalties, which include the cancellation of registrations, the freezing of funds, fines of up to five times the value of the foreign contribution, and imprisonment.

4.5.2 The FCRA and foreign funds

The preamble of the 2010 FCRA states that it is an act to:

> *[C]onsolidate the law to regulate the acceptance and utilisation of foreign contribution or foreign hospitality by certain individuals or associations or companies and to prohibit acceptance and utilisation of foreign contribution or foreign hospitality for any activities detrimental to the national interest and for matters connected therewith or incidental thereto* (Gazette of India, 2010).

In this context, a foreign contribution is any donation, delivery or transfer made by a foreign source (Article 2-I-H), which may be a foreign government and its agencies, international agencies, foreign citizens, companies, trade unions, trusts, societies, or any type of organisation registered outside India. This includes multinational corporations and any company where more than 50 per cent of the share capital is held by foreign governments,

entities or citizens (Article 2-I-J) (Gazette of India, 2010). To receive foreign contributions, Indian NFPs must comply with several requirements, which include:

- A definite cultural, economic, educational, religious or social programme
- Registering with the central government, and
- Agreement that all contributions will be received through designated banks.

NFPs must also maintain separate books of accounts with regard to all receipts and disbursement of the foreign funds received, which are also required to report all foreign contributions received within 30 days and to file annual reports with the Home Ministry. In addition, NFPs are required to provide documentation, which entail a substantial bureaucratic burden. These include:

- Completion of an online application
- Hard copies of the application signed by the Chief Functionary of the association
- Details of activities of the organisation during the last three years
- Accompanying copies of audited statements of accounts (assets and liabilities, receipts and payments, income and expenditure), and
- Payment of a fee of 2,000 rupees (US$32) – a significant amount considering that the monthly minimum wage is 15,000 rupees.

Fulfilling these requirements presents a challenge for many NFPs, which may have limited human and economic resources. Given these organisations struggle to obtain foreign funding, delays in providing the documentation may lead to the loss of foreign funds. Another key challenge faces NFPs that are less than three years old. These organisations must also complete an application to seek 'prior permission' to accept foreign contributions, which involves a different online form from that described above. Hard copies of all of the documents listed above must reach the Foreigners Division of the Ministry of Home Affairs within 30 days of the submission of the online application. This documentation also requires detailed information about the specific amount to be received, the specific purpose for which it will be used, and the specific donor. Under the 'prior permission', every new donation received is subject to a 2,000 rupee fee, which can take up to 90 days to process.

For those NFPs that are more than three years old, there is a little more flexibility in receiving foreign funding. These organisations can apply for 'registration', which provides an approval that lasts for five years. Once NFPs are in receipt of prior permission or permanent registration, they are required to submit the required documentation at the end of every financial year, and will be subject to government checks on the destination of the foreign funds. A further criticism of the FCRA is that foreign funders and lenders often lose interest in projects due to the long time it takes NFPs to apply for prior permission or permanent registration.

4.5.3 Challenges for microgrids derived from the FCRA

While the government needs to oversee foreign investment in Indian markets, it is also necessary to enable a proper financial climate. And the requirements of the FCRA present several challenges to foreign investors. Firstly, it may be difficult for an Indian NFP to obtain all the necessary permits to receive foreign contributions. The procedures are lengthy and are not easy to meet. As a result, some NFPs work with intermediaries; these are organisations that have been authorised to receive foreign funds. However this creates additional difficulties as the FCRA also regulates such partnerships, requiring organisations that receive funding through an intermediary to obtain authorisation, and implying an additional cost.

Consequently, the FCRA is seen by stakeholders in the energy domain as another regulation that companies have to comply with in order to obtain foreign funding. However, the complex process of compliance also offers advantages. Once NFPs are qualified via prior permission or permanent registration, this signifies that the government has looked closely at the organisation, its accounts and goals, and that the organisation is deemed to be 'clean'. While the process may be long winded, that an NFP has been given a 'clean check' is a benefit for organisations seeking foreign funding since it gives confidence to foreign organisations and donors about the reputation of the NFP. A challenge for NFPs is to take advantage of this long application process, by showing to foreign funders how they are validated by the Indian government.

4.5.4 Barriers to collective funding

Some NFPs have also used crowdfunding platforms (i.e. collective funding from different donors, mainly foreign) to obtain the money to fund sustainability projects. This approach implies a new funding mechanism based on the FCRA regulations. Crowdfunding platforms, such as SunFunder and Milaap, have shown the viability of collective funding as a financial approach and one that supports the inclusion of different actors. It is often highlighted that loans for microgrids can often be repaid by the borrower's avoided cost of alternative energy – typically kerosene. In this sense, these loans provide different advantages, such as lower costs and risk tolerance from investors.

A vendor in India uses energy produced by a microgrid funded by SunFunder. Photo: Sameer Halai/SunFunder

The case of Milaap provides an interesting example. This private social enterprise was launched for the 'explicit purpose of providing capital for unconventional essential service loans, such as energy lending' (REMMP, 2014). Milaap has diversified its sources of funding, broadening the target of potential investors to include foundations and other private donors. As argued by REMMP:

> *[B]y diversifying its sources, Milaap is able to grow the overall level of capital deployed and smooth out any month-by-month inconsistencies in funds secured via its lending platform, therefore increasing the predictability and consistency with which capital can be made available to its partners (2014).*

However, if other organisations are to similarly broaden their funding base, particularly from overseas donors, it will be necessary to increase the flexibility of current regulations and to reduce the obstacles to return loans to foreign lenders. At present, SEBI's regulation does not allow money to be raised from the public which promises a return of investment unless the company is listed on a stock exchange, a 'complicated and costly' process (Mukherjee, 2013).

Other platforms are facing similar problems. Kiva India, which acts as a lending platform in the country, has raised awareness of the fact that loans made to non-governmental MFIs are required to remain in India for at least three years (REMMP, 2014). The platform has sought to address this barrier by holding onto loans for this entire period before sending repayments back to lenders. Even though this is a regulation from the RBI and not specifically from the FCRA, it illustrates the inflexibility of the current regime. Additionally, Kiva warns its users that 'lenders assume the risk that repayments may be delayed due to regulatory difficulties transferring funds out of India' (Kiva, 2015), which only increases the uncertainty for potential foreign lenders.

Overcoming the barriers for collective funding is an urgent task for Indian regulators. If India is to achieve its electrification goals, it is critical to understand crowdfunding as a financial mechanism for microgrids, and this may require amendments to existing legislation (Lopicich, 2015).

4.5.5 Technological factors affecting microgrids funding

In addition to the regulatory and institutional barriers presented above, there are a number of project-level barriers that are worthy of attention. These barriers are closely linked to the financial barriers discussed previously, since they can affect the trust of the private sector in some microgrid projects. As a result, this will affect the funding opportunities for NFPs seeking to implement microgrids. The use of appropriate technologies will be important to enable a proper financial climate in the energy sector. Common factors of concern for microgrid developers are the reliability of the project, the quality of the business plans, and the collection of payment from final users. These different dimensions demonstrate the range of issues that projects must address including maintenance, the ownership of the grid and, eventually, the hardware and software production of smart meters, pay-as-you-go (PAYG) systems, and different technologies to collect payments.

Related to the reliability of the microgrid, an important task is to build local willingness to pay. Poor maintenance due to longer distances to rural communities and short-term management from investors looking for a rapid return of investment is a factor that can directly affect the collection of the payment. Providing a reliable and functioning service incentivises the end user to make payments on a weekly or monthly basis to the entrepreneur or energy enterprise, helping to ensure the continued sustainability of the microgrid. At the same time, the quality of the business plan has an influence on attracting foreign donors. Trustworthiness is

not only about keeping customers satisfied by paying attention to maintenance issues (which are, of course, essential for the success of the enterprise), but also has to do with presenting credible high-quality projects to investors. Although funding mechanisms that can be accessed quickly are available, they have yet to be matched to businesses that can absorb a higher level of capital and meet the risk requirements of more conventional investors.

Finally, a related issue that affects foreign investment and that depends on available technology is the collection of the payment from costumers. This task can be particularly tough for entrepreneurs working in remote rural communities. Here, a strong link to the community is key, as it will enable project developers to understand local energy and livelihood needs, as well as their capacity and willingness to pay. Local NGOs and religious institutions may provide these links, while other projects may seek to provide training to local collectors.

The financial sustainability of the model is always critical, but here it is important to differentiate between capital and operational costs. Capital costs may not be recovered in the short term, while operational costs are commonly charged on a monthly basis. Different strategies to recover the operational costs have been implemented, and these include systems such as PAYG (which can operate even from mobile phones), pre-paid meters, designation of one respected member of the community to collect the money, and inclusion of local entities and regional NGOs. Examples of such systems include the 'joint liability group model' of Mlinda, a Bangalore-based facilitator. Basically, if one household does not pay, the entire community contributes to pay its debt.

Other systems for collection are the PAYG system implemented by Simpa or Mera Gao Power. Mera Gao has deployed an MFI-type collection process, which requires collectors to visit villages in order to collect fees in person during group meetings. The process requires a lot of discipline to be effective, but the experience of MFIs has been shown to work. The problem of this particular strategy is that the customer base can expand faster than the internal processes of the company collecting the money. Despite this, if effective, it is cheaper than PAYG technology and helps to keep customer fees low, thus minimising the payback period of the company's investments. The collection of money has a direct influence on the credibility of the project presented to foreign funders and it is an aspect that needs more attention from local NFPs.

All the technical barriers mentioned above will affect the implementation of microgrids, no matter the business model selected by the energy company, and need to be taken into account by foreign private investors, donors and lenders. Nevertheless, if both the regulatory and financial environments are properly designed, Deshmukh *et al*. argue that every microgrid:

> *[C]an thrive – regardless of whether they are for-profit, partially subsidised, or government owned and operated – if they carefully design their revenue stream, customer relationships, ongoing maintenance, and community involvement for their particular context (2014: 6).*

4.6 Reflections and lessons

This chapter has highlighted some of the regulatory, financial and technical barriers faced by Indian NFPs implementing microgrids. Political will is going to be important in overcoming some of these barriers and changes will need to be made to reduce bureaucracy and to ensure that the limited resources of NFPs are spent on what matters: the provision of access to modern energy services.

4.6.1 Overcoming financial barriers

FCRA is seen more as a hindrance than a help by stakeholders seeking foreign contributions for their projects. Conversely, it may strengthen the reputation of local NFPs and make them

appear more reliable when they pitch their projects to foreign funders. Since the reliability of business plans and the quality of projects are key factors taken into account by investors to fund microgrids, FCRA can provide an important assurance. However, as discussed above, it may also represent a challenge to Indian NFPs many of which have access to only limited resources. A further issue is that the foreign funders may be less specific in how funds are spent than national sources. In this sense, the FCRA route may offer benefits. For many organisations it is vital to have access to funds from abroad, and the less programme-specific the funding is, the more applicable it will be for microgrids and other energy projects. Another possible benefit is that exposure to international organisations can sometimes create links to other funders; this will assist NFPs to access further funding for projects that tackle energy access.

4.6.2 A more flexible approach to foreign contributions

The FCRA will need to become more flexible if India is to enable an adequate environment for foreign donors, lenders and investors in general. Such changes will involve:

- A reduction in the documentation required from NFPs
- Speeding up of the current 90-day registration process
- A reduced requirement for hard copies and the implementation of a reliable online platform to apply
- Changes to the 'prior permission' route for NFPs which are less than three years old, which does not require an application for every foreign funding opportunity, and
- The ability to take advantage of other regulations, such as the New Companies Act, which would allow NFPs to receive funding for environmental projects from foreign-owned or foreign-controlled entities.

Mobilising finance for microgrids will require the development of better policies, which create enhanced subsidy structures/programmes that mainstream financing in financial institutions. Working within these types of barriers by employing de-risking mechanisms, such as partial risk guarantees, is basic for the success of new funding mechanisms, such as foreign contributions and loans and donation-based crowdfunding, which can complement more traditional sources of funding. The FCRA is an example of a regulation which requires changes in order to attract new private actors to address India's energy access challenge.

4.7 Conclusions

India's most recent energy policy has set ambitious yet achievable goals for providing universal access to sustainable energy. A number of factors mean that the opportunities are rife, and these include an improved policy environment for microgrid entrepreneurs, political determination in setting ambitious renewable energy targets, and more flexible policies. However, to achieve this India will have to address regulatory barriers, which currently prevent projects from obtaining foreign funds. Both operationally and financially, more flexible policies are urgently required. Requisites to establish partnerships with NFPs need to be reviewed, since they are preventing projects from receiving essential foreign funds. In terms of financial barriers, speeding up access to funds is also required and here the FCRA has to be made more flexible.

Finally, as a proven and cost-effective technology which also offers climate benefits, microgrids provide an appropriate and critical solution to meet India's energy access challenge. Electrification based on microgrids is reliable and robust, and the Indian government would do well to create an enabling environment for private investment in this energy solution. For many people living in rural India, the lack of access to electricity is an urgent issue that cannot wait much longer.

5
Equitable biofuels? Sugarcane-ethanol systems in Brazil, Ethiopia and Guatemala

by Julia Tomei, Jennifer Hodbod and Tina Blaber-Wegg

5.1 Introduction

The concept of the global energy trilemma encapsulates three major challenges facing today's world: climate change, energy security and energy access. Biofuels have the potential to address all three dimensions of the energy trilemma. Ostensibly carbon neutral, biofuels have also been promoted by governments worldwide because of their ability to meet local energy demand whilst enhancing energy security. However, the production and use of biofuels has not been without its critics as highlighted by controversies over, for example, food versus fuel, land grabs and indirect land-use change. What these controversies have highlighted is the need to take social impacts of biofuels into consideration, particularly because less powerful actors such as small-scale farmers, estate workers and local communities are likely to bear a disproportionate share of the costs. The system of governance will therefore play an important role in shaping the equity outcomes in biofuel systems.

At present, only first-generation biofuels (i.e. those produced from food crops) are commercially viable and economies of scale mean that large-scale, agro-industrial systems today dominate biofuel production (Von Braun and Pachauri, 2006). Such large-scale production is likely to favour those actors who are best able to take advantage of the opportunities provided by the growing global demand for biofuels. These actors are most likely to be well-capitalised domestic producers, who may work with transnational corporations and governments to establish the conditions within which biofuels develop. Furthermore, political economies and the power dynamics between states, corporate actors, non-governmental organisations (NGOs) and civil society will be key determinants of the winners and losers of biofuel development. This picture is further complicated by the globalisation of biofuels, which means that the site of production may be located far from the site of consumption. Increasingly complex and globalised supply chains – which involve and affect different actors at the promotion, production and consumption stages of biofuels – require more sophisticated governance mechanisms that may cross national boundaries. Who wins and who loses from biofuels development is therefore a key issue, and one that this article examines.

Here, we explicitly focus on the social and equity outcomes for one biofuel feedstock, sugarcane, in three countries: Brazil, Ethiopia and Guatemala. The three case-study countries have very different governance systems. In Ethiopia, the production of fuel-grade ethanol is entirely driven by the state: cultivation, processing and demand are all controlled and promoted by the national government (Hodbod, 2013). By contrast, in Guatemala, the state is virtually

absent from the sugarcane-ethanol system. Instead, it is left to private actors, specifically those that own the sugar mills, to promote the production and consumption of ethanol and this situation has resulted in a focus on more profitable export markets (Tomei, 2014). Brazil represents an intermediary case, wherein the national government and the private sector, as well as other actors such as NGOs, are involved in the governance of the sugarcane-ethanol system (Blaber-Wegg, forthcoming). These differences have important implications in terms of the system that develops and the distribution of the impacts. Table 5.1 outlines some key features of the different sugarcane-ethanol systems in these three case-study countries.

In this paper, we draw on our doctoral field research, which was conducted between 2010 and 2012, applying a multi-scalar approach

Table 5.1
Comparing sugarcane-ethanol systems in Brazil, Ethiopia and Guatemala

YEAR	BRAZIL[i]	ETHIOPIA[iii]		GUATEMALA[v, vi]
	2011	2009	2015	
Land under sugarcane (hectares)	9,600,000	24,000	400,000	260,000
Sugarcane yield (tonnes/hectare)[vii]	80	133		99
Number of active sugar mills	408[ii]	3	14	13
Number of active ethanol distilleries	408[ii]	1	14	5
Ethanol produced (million litres/year)	23,000	8	385	230
Domestic ethanol mandate	E25	E5	E10	None
Domestic ethanol demand (million litres/year)	18,000	8	31[iv 12]	

Sources: [i]UNICA (2014); [ii]USDA (2013a); [iii]Sugar Corporation (2014); [iv]Hodbod (2013); [v]USDA (2013b); [vi]Tomei (2014); [vii]FAO (2013).

12 Whilst the biofuel strategy of Ethiopia mandates ethanol production expansion from 8 to 128 million litres of ethanol per year, this was the first expansion plan and was later superseded by the Growth and Transformation Plan. Whilst not explicit, it is widely perceived that these totals include the potential for export and calculations of actual domestic demand are far lower, therefore only the domestic demand is listed here.

Sugarcane cultivation in Kesem, Ethiopia. Photo: Jennifer Hodbod

to collect primary data at a local scale (São Paulo, Brazil (Blaber-Wegg, 2014); Metehara, Ethiopia (Hodbod, 2013); and the Pacific Coast and Polochic Valley, Guatemala (Tomei, 2014)), and at the national level. All three studies utilised multiple methods, including household surveys, ethnographic research and interviews in multiple localities, as well as interviews with key national stakeholders, supplemented with documentary evidence.

Dividing the biofuel production chain into three phases – promotion, production and consumption – we have used these data to identify winners and losers within each:

- Promotion involves the endorsement and marketing of sugarcane-ethanol for both domestic and international markets.
- Production includes all stages from the cultivation of sugarcane to the processing of sugar and ethanol.
- Finally, consumption refers to the end-market for ethanol.

Where a strong positive or negative impact was identified, we have attributed the actors as winners or losers, respectively. If the actor group was isolated from impacts or there is the possibility of a strong positive or negative impact in the future, but not at present, the actor is listed in the 'neutral' category.

While this paper presents homogenised groups of actors such as governments or small-scale farmers, we recognise that these groups will contain diverse opinions. For example, within national governments there may be tensions

between those ministries which focus on environmental protection and those which promote trade and investment. Similarly, small-scale farmers involved in the cultivation of biofuel feedstocks may have different perspectives to those who are excluded from their cultivation. By applying expert judgment based on our in-depth knowledge of the case studies, we present a synthesis of how different governance regimes influence equity in these sugarcane-ethanol producing countries.

5.2 Winners and losers: promotion, production and consumption

5.2.1 Promotion

The Brazilian sugarcane-ethanol system is more established than in either Guatemala or Ethiopia and involves more actors, many of whom benefit from the promotion of biofuels. In the promotion phase, winners are more likely to exist where the style of governance is more inclusive, purposefully incorporating a wider range of actors across public and private sectors, as seen in Brazil. However, Table 5.2 shows that even in this governance system, those who benefit from the promotion phase tend to be larger-scale actors, particularly national governments and those who own sugar mills.

In Brazil and Ethiopia, federal governments benefit from economic development, foreign investment and promotion of their country, and by having their products in global markets. Sugar-mill owners benefit from increased investment and additional, high value-added markets for their products. Guatemala provides a contrasting case, principally due to the lack of a domestic market for biofuels; uninterested in developing a domestic market for biofuels, government and sugar-mill owners remain bystanders in efforts to promote domestic consumption. As a result, the only actors who currently benefit from the status quo are the oil companies who are able to retain the full market share for transport fuels.
NGOs benefit where they are larger, international agencies with access to funds and resources. For example, in Brazil, NGOs are working with the government and the Brazilian Sugarcane Industry Association (UNICA) on retraining programmes for sugarcane cutters. We also acknowledge that the current level of inclusion of Brazilian NGOs is partly a result of a more established sector that has long been criticised for human rights violations (see

Table 5.2
Winners and losers: promotion

PROMOTION	WINNERS	LOSERS	NEUTRAL
Brazil	Sugar-mill owners; NGOs; sugar-mill workers; local communities; government	Small-scale farmers	Oil companies
Ethiopia	Sugar-mill owners (government); government	Small-scale farmers	Biofuels development agency; NGOs
Guatemala	Oil companies		Government; sugar-mill owners; NGOs

e.g. Duarte *et al*., 2013; Oxfam, 2013); this has resulted in the formation of initiatives and policies to address such issues. However, the inclusion of NGOs in the promotion phase creates legitimacy for their perspective, making them an actor with some degree of power. By contrast, in Guatemala NGOs are typically critical of biofuels, but are excluded from decision-making processes. This exclusion also occurs in Ethiopia for both domestic and international NGOs, although the latter have had greater success in engaging with the government. Exclusion from the process isolates NGOs in Guatemala and Ethiopia from receiving benefits – i.e. support for their beliefs – but also means they do not bear any costs. However, they could quickly become losers due to the lack of voice and legitimacy in the promotion phase.

Local communities benefit from the promotion of the industry in Brazil via increased social and economic development in regions with high levels of agribusiness. For sugar-mill workers in Brazil, the promotion of the industry and higher levels of sustainability (including social issues such as workers' rights and employment laws) have for many led to higher wages, reduced working hours, and opportunities for professional development. However, it is the larger mills that are more likely to be able to afford these measures and therefore both workers and local communities are only likely to benefit where there are larger mills with high levels of corporate social responsibility.

Across the three case studies, our analysis reveals that small-scale farmers are likely to be losers, or are at least amongst those least likely to benefit, since they are separate from the promotion of biofuels. In Brazil this is because they are less able to promote themselves through sustainability schemes, due to a lack of access to information and investment, which creates barriers to export markets. Greater access to finance and investment flows would allow small-scale farmers to invest in equipment and practices that meet European standards or domestic markets. Similarly, out-grower schemes, such as those operating in Brazil, can benefit small-scale farmers, for example, by assuring consistent demand for their produce. However, small-scale farmers may also be vulnerable to land-rights abuses, as seen in Ethiopia where the promotion of biofuels has begun with the relocation of pastoralist households to establish sugarcane estates. In Guatemala, there are no small-scale producers of sugarcane.

5.2.2 Production

The distributive outcomes of sugarcane and ethanol production vary according to the country. However, across the three case studies, the winners tend to be the owners of the sugar mills, whether these are privately or government owned (see Table 5.3).

Our analysis reveals that the majority of sugar mills benefit. Biofuels provide an additional market for their produce, and the increased specialisation that fuel-grade ethanol entails implies greater value added. Mill owners in both Brazil and Guatemala benefit from sustainability certification, which provides a powerful rejoinder to those who question the sustainability of biofuels, but smaller mills are less able to meet the costs of compliance and accreditation, which presents a potential market barrier. Mills that are dependent on external biofuel markets, mainly those in Guatemala, are also exposed to the risk of fluctuations in global market prices. In Brazil, oil companies are increasingly involved in sugarcane cultivation, which has led to further concentration and greater integration of the energy and agricultural sectors. This is also true for Ethiopia, although via a different mechanism, as another government agency – the Ethiopian Petroleum Enterprise – is responsible for the purchasing of ethanol and distribution to petroleum companies, who are mandated to purchase, blend and sell the ethanol.
Local communities are both winners and losers of sugarcane and ethanol production. For example, the expansion of sugarcane cultivation offers both direct and indirect employment

Table 5.3
Winners and losers: production

PRODUCTION	WINNERS	LOSERS	NEUTRAL
Brazil	Sugar-mill owners; sugar estate workers; sugar-mill skilled workers; small-scale farmers; local communities; government; oil companies	Local communities; sugar mill-owners (small); sugar estate workers	NGOs
Ethiopia	Sugar-mill owners (government); government; small-scale farmers; sugar estate workers; sugar mill skilled workers	Downstream users; national parks; small-scale farmers; sugar estate workers	Local government; local communities
Guatemala	Sugar-mill owners; sugar-mill skilled workers; government; local communities	Local communities; sugar-mill owners; downstream users	Sugar estate workers; government

opportunities, as well as increased economic opportunities for local communities. In all three countries, the mills also take on some state responsibilities, providing schools, infrastructure and health centres, but only within their 'zones of influence' i.e. those regions where a large percentage of the temporary workforce resides. As a consequence, proximity to a mill leads to investment in infrastructure and in Ethiopia, employees and local smallholders also benefit from the agricultural residues, which are used as fuel and fodder.

However, communities, especially small-scale farmers and pastoralists, are also negatively affected by the expansion of sugarcane cultivation. Communities lose access to land either through forced evictions (in the cases of Ethiopia and Guatemala) or through increasing land prices, which prevents small-scale farmers from buying or leasing land (Brazil and Guatemala). As a consequence of the loss of land access, these actors suffer from a loss of traditional livelihoods (and, in the cases of Brazil and Guatemala, agricultural biodiversity) and, in Guatemala and Ethiopia, reduced food security.

In Guatemala, the expansion of sugarcane has also led to greater proletarianisation, with the result that families became more dependent on monetary income and paid employment. However, this is framed as a positive in Ethiopia, where sugarcane expansion is presented as a driver for 'modernisation' of rural communities, via the same mechanism. While increased cultivation does create employment, jobs are typically unskilled and sugarcane harvesting in particular is physically demanding and poorly remunerated. Therefore, some sugar estate workers win and some lose, dependent on

their previous livelihood and current working conditions. In contrast, skilled workers can expect to benefit due to their higher chances of retaining work – this is true in all three countries.

In Ethiopia and Guatemala, the impacts of cultivation have largely negative outcomes for those actors located downstream. In Guatemala, the diversion of waterways to irrigate sugarcane estates leads to flooding in the wet season and droughts in the dry season. Increasing concern about climate change has, however, led Guatemala's sugar mills to fund research into water management, although this is more likely to benefit upstream communities. In Ethiopia, downstream users will similarly be affected by the loss of access to water due to increased abstraction upstream. Expansion is mainly occurring on two river basins, the Awash and the Omo, the latter of which is raising particular concern due to its transboundary nature and key role in feeding Lake Tana in Kenya, and the livelihoods the lake supports (International Rivers, 2011).

A feature of the Ethiopia case is the impact on wildlife; here, national parks are affected by increasing encroachment for sugarcane cultivation or as local communities utilise the parks for grazing and charcoal production, resulting in the loss of biodiversity, resource depletion and habitat fragmentation. Finally, although field burning is being phased out within Brazil, in all three countries the impacts of burning on air pollution are well documented, both as an environmental cost and due to the negative impacts on health, which affect actors

Sugarcane cultivation adjacent to communities, Pacific Coast, Guatemala. Photo: Julia Tomei

not directly associated with the sugarcane estate.

5.2.3 Consumption

In the consumption phase, national governments are the main winners in all three countries (see Table 5.4). Benefits occur though two mechanisms: firstly, reduced foreign exchange on oil products; and secondly, through increased export earnings and tax revenue.

The proportion of economic benefit differs across the three countries due to different levels of consumption and exportation. For example, Guatemala solely benefits from export earnings, whereas Brazil benefits from reduced foreign exchange. Due to the low levels of petroleum consumption in Ethiopia, ethanol substitution will create some foreign exchange savings but the savings are estimated to be less than 1 per cent of the total annual import bill (Hodbod, 2013). However, with the planned expansion, the government (as the main trading actor) stands to create huge export earnings, as exporting all the excess ethanol would total 273 million litres, and could create export earnings of US$550 million post-2015, increasing national export earnings by 15 per cent (Hodbod, 2013).

Replicating the findings of the promotion phase, as the Ethiopian government owns the sugar and ethanol mills in Ethiopia, they are the main beneficiary of the ethanol consumption phase. In Brazil and Guatemala where mills are privately owned, mill owners benefit via increased domestic and international markets for their products. The sugar-mill owners also benefit from the diversification of production; in Guatemala and Ethiopia where ethanol is produced from molasses, increased demand represents an opportunity to add value to what was previously a waste product, whilst also removing a potential environmental pollutant.

Table 5.4
Winners and losers: consumption

CONSUMPTION	WINNERS	LOSERS	NEUTRAL
Brazil	Sugar-mill owners; government		Brazilian consumers (petroleum blend); international consumers (petroleum blend); local communities; oil companies
Ethiopia	Government; consumers (refugees, ethanol)	Stove retailers	Consumers (urban, ethanol); consumers (petroleum blend); oil companies; local communities
Guatemala	Sugar-mill owners; government		Oil companies; international consumers (petroleum blend); local communities

With regard to consumers, the outcomes are mixed. A common theme within the biofuels literature is the potential for energy security benefits at the local scale, but this has not been found in our case studies where local consumers, even around sites of production, do not directly benefit. All ethanol produced goes onto the national market or is already sold as part of large-scale and international contracts. Ethiopia is the only case-study country with an alternative market for ethanol (household stoves), but ethanol stove adoption is minimal due to the prohibitive cost of stoves. Therefore, whilst refugee households given stoves and fuel for free do benefit from reduced air pollution and increased safety, these benefits are not felt by urban residents, although neither are they subjected to additional costs. However, the lack of adoption bears great costs on stove retailers trying to commercialise the stove.

The petroleum-ethanol blend is predicted to reduce price volatility and the import shortage for domestic consumers, but in reality Ethiopian consumers experience little impact, positive or negative, due to their lack of choice. Brazilian consumers are similarly isolated from the impacts of ethanol consumption due to its established and common nature. However, for both countries with domestic biofuel mandates, high global sugar prices coupled with an increase in global demand for ethanol may increase demand on domestic supplies of ethanol, reducing supply for the domestic market and increasing prices. International consumers similarly stand to gain an increase in energy security, but this has not necessarily been realised. Additionally, increased dependence on countries such as Guatemala, where the agricultural systems embed serious social and environmental inequalities, and consumers' lack of choice and/or compromised ethics may push them further towards becoming losers.

Finally, whilst oil companies could stand to lose in those countries with a domestic mandate, in Brazil oil companies are increasingly involved in joint ventures with sugar mills, reducing this potential conflict. In Guatemala, the potential reduction in the demand for petroleum and hence opposition from oil companies is a key rationale for the lack of a domestic market for biofuels. Oil companies are relatively isolated in Ethiopia as, again, there is a lack of choice in the situation and the national government supplies the oil companies with both the oil and ethanol.

5.3 Discussion

This analysis reveals an uneven distribution of winners and losers across the three case-study countries, which is partly dependent on the governance system. Our analysis shows that the hybrid approach adopted by Brazil is the most equitable of the three case studies, although it still has its challenges. Ethiopia's and Guatemala's biofuels industries – driven by the state and private sector respectively – are less equitable. We acknowledge that the governance system alone is unlikely to determine equity outcomes, but argue this is a critical factor worthy of investigation.

Our research finds that in Brazil – where legislation exists to manage and mitigate negative environmental and social impacts – a greater range of actors appear to benefit. Conversely, in Ethiopia and Guatemala, where there is little or poorly enforced legislation on these issues, there are fewer winners. In Ethiopia, despite a narrative of job creation and 'modernisation' of pastoralist communities, in practice there have been few equitable outcomes and it has been these same communities which have borne the costs of the rapid expansion of sugarcane. In Guatemala, where the sector is entirely private sector-led, the key winners are the sugar-mill owners who benefit from the absence of the state meaning they alone decide how the sector develops. Even in the arguably more equitable Brazilian system, the benefits tend to accrue to more powerful actors, while smaller, less powerful actors bear the costs. Typically, it is these powerful actors, such as sugar-mill owners and

governments, who determine the direction in which the sugarcane-ethanol system develops and the system is therefore designed to meet their interests.

Analysis of the different biofuel phases reveals different balances of winners and losers, but we argue that transparency is an important influencer of the outcomes. Opening up policy development to a wide range of actors during the promotion phase appears to be critical for directing the sector along more equitable lines. During the production phase, key factors that influence the distribution of winners and losers include regulation, how actors are incorporated into the production system, and the politico-economic context. Finally, in contrast to studies that suggest local communities may be expected to benefit from the increased production of biofuels, for example through increased local energy access, we find that the overall impact on local communities is neutral due to the national and international foci of the sectors. Our results indicate that so far, biofuel from sugarcane-ethanol systems are unlikely to contribute to sustainable development goals regarding energy.

Whilst our analysis shows that greater regulation with equity as a focus leads to more equitable outcomes, there is still much room for improvement. This will require greater transparency and legitimacy within the system, so that multiple voices are taken into account across the promotion, production and consumption of biofuels. We similarly caution against recommending that all sugarcane-ethanol systems follow the Brazilian example. Brazil has a long history of ethanol production, and therefore has had time to address many of the negative sustainability and equity outcomes associated with the sugarcane-ethanol system, but its social and ecological conditions may not be replicable worldwide.

5.4 Conclusions

We have shown that in the three case studies, the main negative impacts resulting from sugarcane-ethanol systems are felt by the least powerful actors. We have also shown that the governance regime is an important determinant of the equity outcomes, but that it should not be assumed that greater state involvement will lead to more equitable outcomes. As biofuel production and consumption continues to grow and to globalise, new modes of governance will be required to address the negative impacts and to ensure more equitable outcomes. This will be critical if biofuels are to contribute to the global drive for sustainable energy for all. We conclude with three main recommendations:

- While a majority of studies focus on the biofuel production phase, the equity impacts in the promotion and consumption phases are also important and require further attention.
- Research should continue in non-traditional biofuel producing countries as impacts on socio-ecological systems are not uniform in all producer countries.
- It is crucial to conduct in-depth, human-focused research that reveals the subtleties that shape the outcomes for different social groups.

By building on these three recommendations there will be a knowledge base from which to include social equity issues within assessments of biofuels. This will lead to a more nuanced understanding of the impacts of biofuel production which can then be built on to increase the likelihood of positive outcomes and reduce the degree of negative outcomes.

6
Access to cooking fuel energy in Nigeria: the early impact of subsidy removal

by Ali I. Naibbi and Richard G. Healey

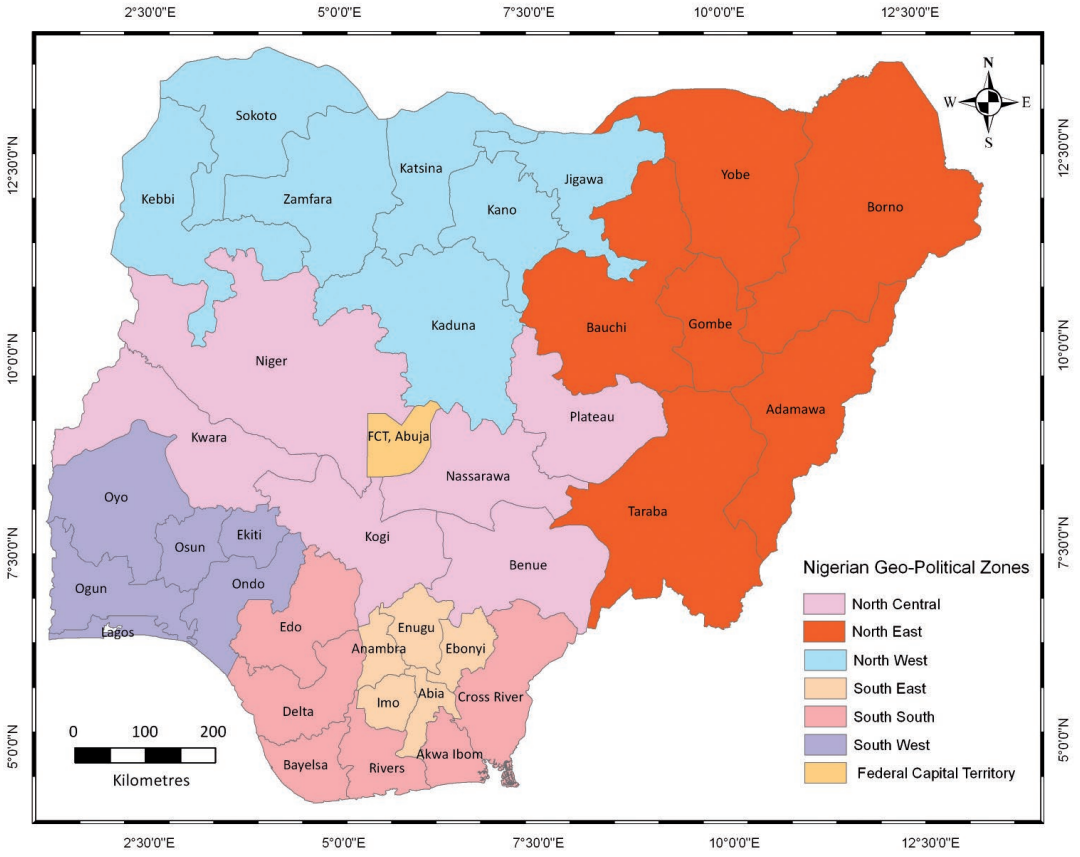
6.1 Introduction

Nigeria is a wealthy country in terms of human and natural resources. However, its social and economic development is slow. About 65 per cent of the country's approximately 170 million people are living below the poverty line (on less than US$1.25 a day) (UNDP, 2009, 2010). This figure is higher than the combined population of ten other West African nations, excluding Ghana and Cote D'Ivoire. Some of the socio-economic characteristics of Nigeria (UNDP, 2009) reveal that, with the exception of the Federal Capital Territory (the seat of power), poverty is more common in the northern part of the country. Comparatively, all the southern states have a better human development index (HDI) than the northern states (see Figure 6.1). Out of the top ten states with the highest HDI, eight are in the south; while, of the bottom ten states with the lowest HDI, nine are in the north. Since poverty is a major factor in development, it is therefore not surprising to see that the north east zone (which has the lowest human development profile) has the highest human poverty index (HPI) with an average score of 49 per cent.

About 65 per cent of government revenues in Nigeria come from oil and gas, which is produced in only nine out of Nigeria's 36 states (southern states, Abia and Imo states in the southeast, and Ondo state in the southwest – see Figure 6.1). Forty per cent of the revenue allocation to states from the Federation Account is divided between the nine producing states (Wilson and Van Alstine, 2014). Usually, the combination of Nigeria's oil and gas revenues and solid minerals would be considered a 'blessing' to the nation. Yet despite this, Nigeria's development indices have remained low.

Another area where Nigeria faces challenges is in the provision of energy for domestic and industrial users. The actual output of the energy sector continues to fall year on year. In particular, both electricity and fossil fuel supplies are erratic and of poor quality. For example, Nigeria has a total installed electricity generation capacity of 6,976 megawatts (MW) with the prospect of upward expansion from the National Integrated Power Projects (NIPPs) (Oche, 2014). However, in 2014, the total power generation output was less than 4,000MW (Izuora, 2014), leaving most consumers nationwide facing energy shortages. The per capita energy consumption is just 135 kilowatt hours (kWh), which is less than that of Ghana, Senegal, Angola and Kenya (Research and Markets, 2011). The huge supply deficit means that the majority of the population live far below the 4,000kWh level required for achieving a decent standard of human existence (UNDP, 2010). Without reliable and affordable energy, it will be difficult and expensive for Nigeria to sustain its economic growth and drive its diversification policy, achieve the Millennium Development Goals (MDGs), and encourage investors. Sambo (2008a) argues that the electricity sector would require an annual

Figure 6.1
Map of Nigeria showing its geopolitical zones



investment of more than US$6.46 billion to meet the UNDP's requirements. In recognition of the huge investment required and the precarious state of the national electricity supply, in 2013 the government introduced an electric power reform programme.

As part of the reform, the country's national energy provider, Power Holdings Company of Nigeria (PHCN), was privatised and formally handed over to the private sector on 1 October 2013. The new investors pledged to take over the company without any liabilities (Oche, 2014). The Nigerian Electricity Regulatory Commission (NERC) and the Bureau of Public Enterprises (BPE) were mandated to monitor the operations of the successor companies and sanction any core investor that does not deliver on the performance agreement made with the government (Izuora, 2014). However, this is unlikely to be achieved in the near future (ibid) and thus the majority of the Nigerian population continues to depend on traditional fuels to meet their cooking needs.

This chapter revisits and updates an earlier study we made, where we used secondary data sources and spatial analysis to analyse

the energy situation in Nigeria. Our study revealed the extent of spatial variations in the utilisation of different energy types across the country (Naibbi and Healey, 2013). This chapter evaluates the early impact of fuel subsidy removal, as well as the privatisation of PHCN as part of the government's effort to transform the energy sector. We draw on official census figures obtained from the National Population Commission of Nigeria (NPC 2009, 2010), as well as data on the distribution of fossil fuels (petroleum, kerosene and gas products) obtained from the Nigerian National Petroleum Corporation's (NNPC) Corporate Planning and Strategy Division (CP&S) for 2010 and 2013. In this chapter, we also use recent secondary literature, mostly derived from media reports because of their enormous influence in shaping public opinion, policy and individual behaviours. Our study illustrates the spatial inequalities in the distribution and use of cooking fuel from the national to the regional level. In so doing, it contributes to an improved understanding of energy poverty in Nigeria, which we hope policymakers will find useful in addressing the complex situation presented by the Nigerian energy crisis.

6.2 Background to fuelwood consumption in Nigeria

More than 80 per cent of households in Nigeria use fuelwood for their cooking needs, making it the most used form of cooking fuel (Sambo 2008b). The high dependence on fuelwood has been attributed to its availability and affordability compared to the other sources (Maconachie *et al*. 2009). For example, Olise and Nria-Dappa (2009) revealed that the poorest households in Nigeria earn about USD1-2 per day and spend about USD0.4 per day on energy. This represents about twenty to forty per cent of household income being spent on energy alone.

Even though this figure seems high, the fact remains that tThe availability and acquisition of fossil fuel products in Nigeria is extremely erratic due to the corruption that has become endemic in the NNPC (Tsan and Odemwingie, 2013; Siddig *et al*., 2014). This can be seen in the unwillingness of the NNPC and the Pipelines and Product Marketing Company (PPMC) to release the figures for the country's fossil fuel supply and distribution, following the recent problems the country experienced after the federal government withdrew the fossil fuel subsidy in January 2012. The subsidy removal itself was challenged by members of parliament (Tsan and Odemwingie, 2013), who questioned the huge spending on fossil fuel subsidy in the 2011 financial year, because it was not accounted for in the national budget. The House of Representatives final report of the Ad-Hoc Committee (2012) highlighted that while the domestic consumption of fuel in Nigeria was only 35 million litres a day, in 2011 the government paid subsidies on 59 million litres of fuel per day.

Farge and Brock (2013) note that the administration of the subsidy had facilitated around US$6 billion of corruption over three years. The Petroleum Product Pricing Regulatory Agency (PPPRA) and NNPC have been accused of aiding the abuse of government subsidies on petrol by approving and paying false claims from importers and marketers thereby inflating the cost of the subsidy (Siddig et al. 2014). Even though the government has been taking some measures to improve controls, the fact that certain companies that have been accused of participating in the earlier fraud are continuing to benefit from allocations of NNPC's petroleum products supply to the country, raises the question of whether the political will to change is sincere. For example, even though the Federal Ministry of Finance has previously promised that 'importers will not be delisted so long as they paid back money owed to the state', a document presented to reporters by the ministry (in the last quarter of 2013) showed that only around six per cent of questionable claims had so far been refunded by the defaulters (Farge and Brock 2013).

6.3 The pattern of cooking fuel usage in Nigeria

As demonstrated by Naibbi and Healey (2013), more fuelwood is being used for cooking than any other cooking fuel in Nigeria (see Figure 6.2a-d). Of the 28 million households in Nigeria, only Lagos state uses less fuelwood than other fuel types, while about thirty per cent of households in each of the remaining 36 states primarily use fuelwood for their cooking. Solar energy is the least popular form of energy. It is only used for cooking by 41,786 households in the country.

Figure 6.2a shows the northern states to be the largest users of fuelwood; in the southern part of Nigeria kerosene is the second most-used cooking fuel, particularly in Lagos, Oyo, Rivers and Ogun where the use of household kerosene (HHK) surpasses any other cooking fuel type (Figure 6.2b). For example, out of the 2.2 million households in Lagos State, about 1.7 million households (77 per cent) solely use kerosene for their cooking. By contrast, more than 70 per cent of households in most northern states use more fuelwood than any other cooking fuel type (Figure 6.2a).

6.3.1 Distribution scheme for fossil fuel in Nigeria

The national distribution figures for fossil fuel show that between 2010 and 2013, Nigeria improved its supply (see Table 6.1). However, similar patterns of distribution in the two periods are also observed and some areas receive more supply than others. As shown in Table 6.1, the southeast, northeast and north central zones received the lowest supply in 2013. In terms of the percentage share of the total increment of fossil fuel supply in Nigeria from 2010 to 2013, the southwest received the highest at 30.44 per cent, followed by the northwest region with 22.16 per cent. The northeast received 13.69 per cent, which is a significant improvement from 2010, while the south, with a population of over 20 million, received 10.69 per cent.

The north central zone received 7.38 per cent of the total supply. The FCT, with the smallest population of just over 1.4 million, received 8.41 per cent, which is about one per cent higher than the supply to north central and the northeast, which received 7.37 per cent and 7.21 per cent of the total supply respectively.

The disparity in the supply patterns of fossil fuels matches the differences in the consumption patterns of fuelwood in the various states of Nigeria. That is, areas with a lower supply of modern fuel are using a greater amount of fuelwood and vice versa. For example, the northern states of Kaduna and Kano receive a good deal of HHK, liquefied petroleum gas (LPG) and petroleum motor spirit (PMS) (3–10 litres per person) compared to the other northern states. However, their high population (first and third respectively in the country, with a combined total population exceeding 16 million people (NPC, 2009)), means that, even though they are adequately supplied with other fuels, they continue to use fuelwood.

(Note that from Table 6.1, the supply of LPG is not provided by the NNPC in 2013, and there were no further explanations given for that. Population figures are taken from NPC (2006). Also, the final column in the table is calculated based on all three types of petroleum products together).

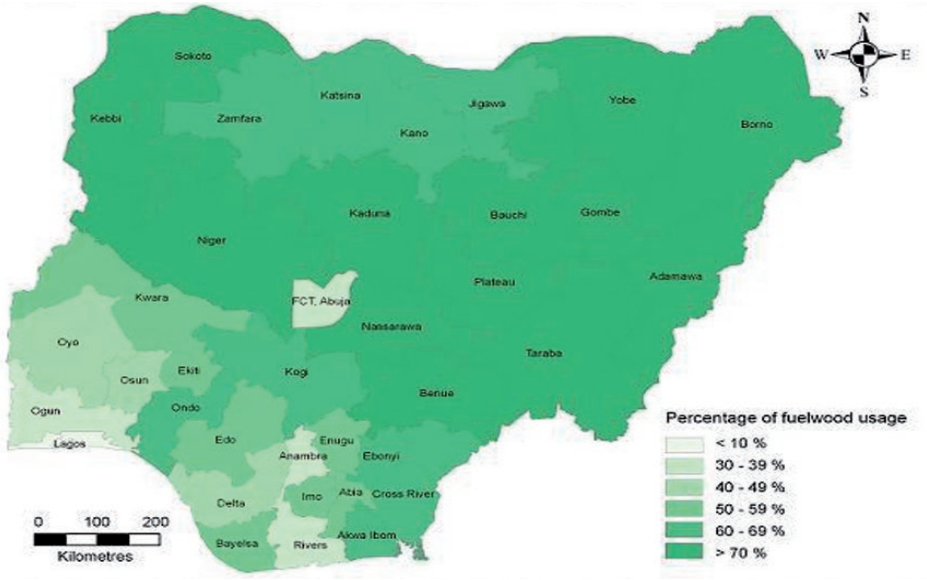
6.3.2 Understanding the strategy of fossil fuel distribution in Nigeria

6.3.2.1 Population and concentration of industries as factors

The analysis of the zonal distribution of fossil fuels in Nigeria (Table 6.1) shows an inconsistency in their distribution. Looking at the regional population distribution (Table 6.1), it is obvious that the distribution strategy for fossil fuels among the various states is not population dependent. For example, while the combined population of the southern part of the country is 46.4 per cent, it received about 56.52 per cent of the total fossil fuel in 2013. By contrast, the north with a population of more than 52.6 per

Figure 6.2
Spatial consumption and distribution of cooking fuel in Nigeria

a) Percentage of households using fuelwood for their cooking in the various states of Nigeria



b) HHK distribution by states in 2013

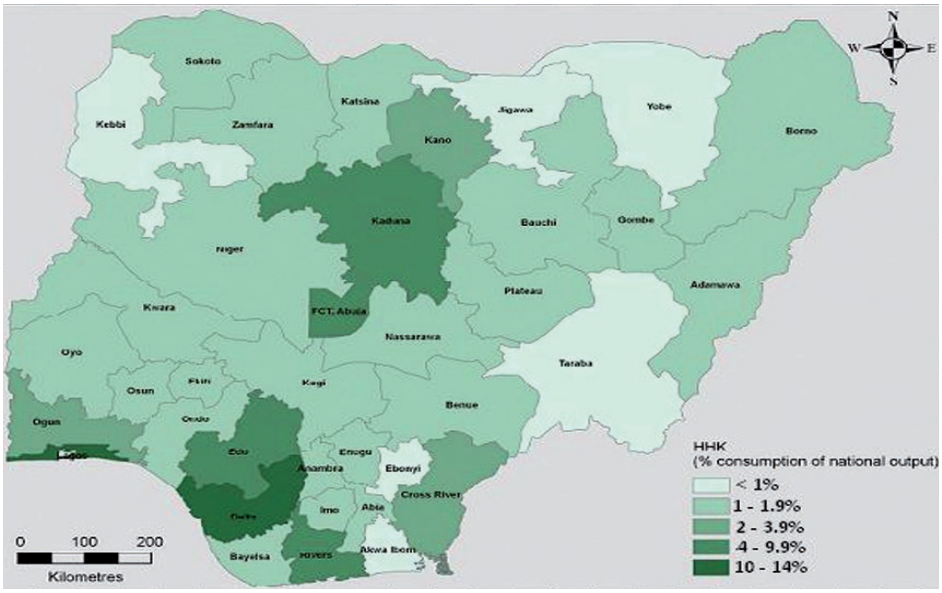
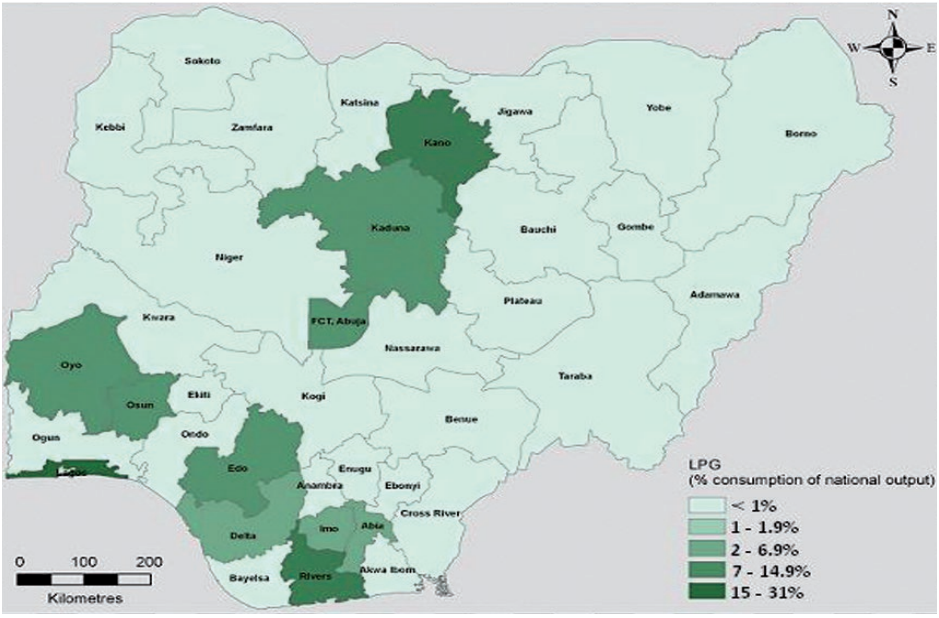


Figure 6.2
Spatial consumption and distribution of cooking fuel in Nigeria (cont.)

c) LPG distribution by states in 2010



d) PMS distribution by states in 2013. Source: Naibbi and Healey (2013)

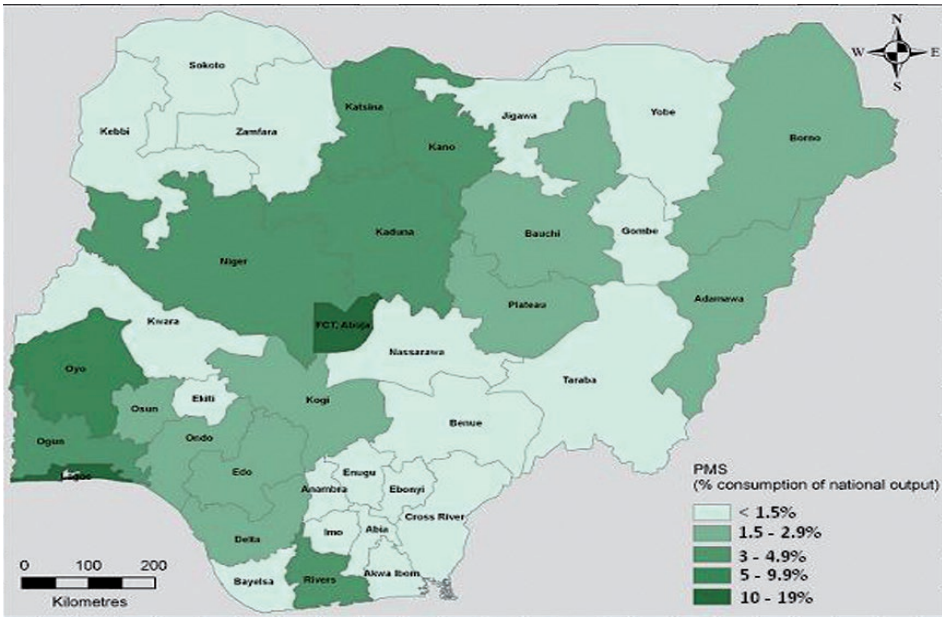


Table 6.1
Population size and petroleum products distribution by zones (000 litres) in 2010 and 2013

GEOGRAPHICAL ZONES	POPULATION
Southwest	27,722,432
Southeast	16,395,555
South	21,044,081
Northwest	35,915,467
Northeast	18,984,299
North central	18,963,717
FCT (Abuja)	1,406,239
Total	140,431,790

GEO-GRAPHI-CAL ZONES	LPG 2010	LPG 2013	PMS 2010	PMS 2013	HHK 2010	HHK 2013	INCREASE FROM 2010 TO 2013
Southwest	1,145	NIL	3,147,507	5,316,811	52,127	1,317,376	3,433,408
Southeast	85	NIL	189,225	1,016,188	13,713	232,356	813,164
South	2,2654	NIL	1,068,699	2,147,835	409,989	559,574	1,206,067
Northwest	438	NIL	419,229	2,675,673	20,205	264,461	2,500,262
Northeast	20	NIL	302,454	1,788,128	17,025	76,552	1,545,180
North central	216	NIL	869,471	1,679,285	141,283	163,820	832,134
FCT (Abuja)	154	NIL	356,933	1,270,552	14,206	49,480	948,740
Total	24,712	NIL	6,353,518	15,894,472	668,548	2,663,619	11,278,955

cent (excluding Abuja) only received 36.28 per cent in 2013, while Abuja, with one per cent of the population received 7.2 per cent of all fossil fuel.

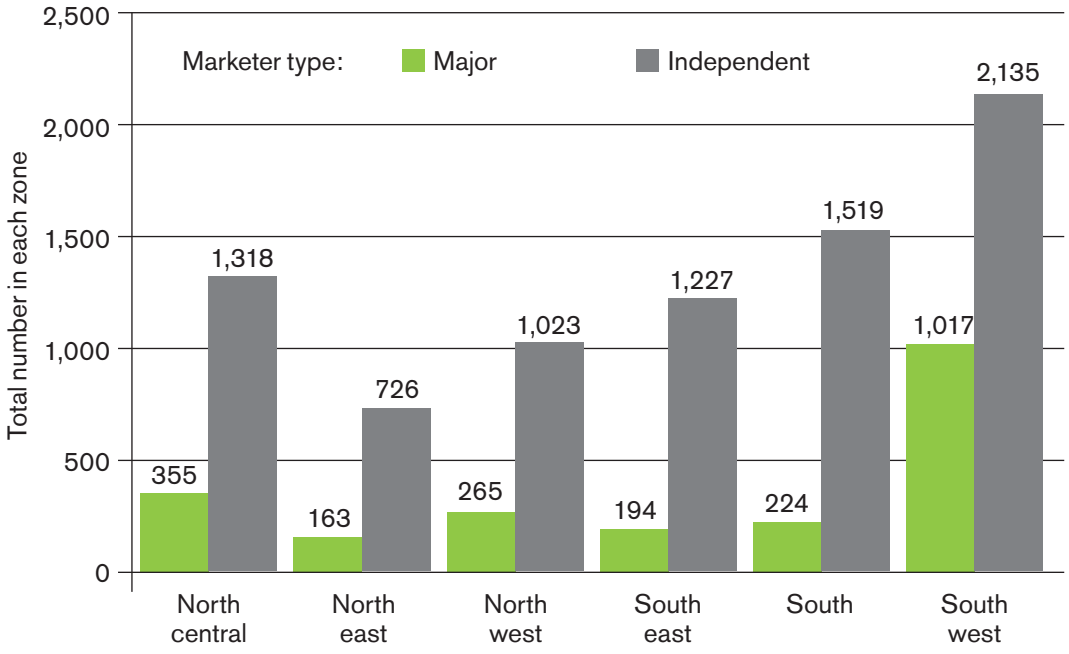
Furthermore, Lagos, Ogun and Oyo states in the southwest, and Rivers and Delta states in the south have large concentrations of industries that can justify these two regions having the largest shares of total fossil fuel distribution in the south. However, in the north, although the northwestern states of Kano and Kaduna have the highest concentration of industries, they receive lesser shares of the total supply of fossil fuels as compared to Lagos, Ogun, Oyo, Rivers and Delta states in the south.

Another factor that may affect the supply pattern of modern fuel is the concentration of oil-related activity in the south. While this is true, the refineries in the region are not fully functional, which is why Nigeria has to rely on imports of refined fossil fuel, while its crude is being exported (Siddig *et al*., 2014).

6.3.2.2 Deliberate sabotage and smuggling

As highlighted earlier, a high incidence of corruption has been endemic among Nigeria's regulators of petroleum products. For example, in a report in the *Daily Trust*, 'Why Nigerian marketers scramble for niger's petroleum products', Katsina (2014) quoted one marketer (petroleum retailers, see Figure 6.3) from the north saying that:

Figure 6.3
A summary of Nigerian petroleum retailers



Source: Ehinomen and Adeleke (2012: 235).
Note: There are six major oil marketers in Nigeria: Oando Nigeria Plc; Mobil Oil Nigeria Plc; Total Nigeria Plc; African Petroleum Nigeria Plc; Texaco Nigeria Plc and Conoil Nigeria Plc.

[P]aying for a product does not guarantee that one will get it, because there are people that have paid for LPG many years ago in Warri Depot and are yet to lift it. What baffles one is that products are being loaded every day at the depots but only to marketers favoured either by NNPC staff or powerful politicians.

However, even those that are able to load have to pay multiple 'facilitation fees' to the officials to smooth their operations. The process in Nigeria is so corrupt that at any given point a marketer can be expected ' to grease some palms'.

In a different development, Ehinomen and Adeleke (2012: 241) describe the entire distribution system of petroleum products in Nigeria as ineffective, due to the full control of the sector by the government. They therefore recommend the deregulation of the downstream sector of the petroleum industry, to allow private investors and entrepreneurs to fully participate in the sector, a situation that should lead to improved effectiveness in distribution. This can be inferred on the basis of similar situations in other countries. For example, Katsina (2014) quoted one northern Nigerian oil marketer who argued that:

If you buy from [the] Niger Republic, you are free from all troubles, because it is easy and straightforward. Politicians do not interfere in the business of the refinery, while the police and other relevant agencies do their jobs accordingly.

Similarly, allegations of smuggling represent another type of misconduct attributed to the country's petroleum-supplying sector (Katsina 2014; Siddig *et al*., 2014). For example, earlier researchers have reported smuggling as the key factor responsible for the product shortage in the country, particularly in the north (Odihi, 2003). However, no statistics have been provided to support claims that the north receives more than enough fossil fuel supply from the NNPC's allocation (refer to Table 6.1), which allows smuggling of part of the allocation to neighbouring countries. In this chapter, we take the view that such claims are exaggerated, because they are not supported by detailed evidence.

6.3.3 Early impact of fuel subsidy removal

In an attempt to address the country's troubed petroleum supply sector, the Nigerian government in January 2012 partially withdrew the fossil fuel subsidy. The government believed this would remove the financial incentives for smuggling and increase supplies. While the fossil fuel distribution to the various states has improved following the subsidy withdrawal (see Table 6.1), the country continues to witness shortages in fossil fuel supply (Alike, 2013). Similarly, the prices of all other household commodities have increased by about 70 per cent compared to their original price prior to the subsidy withdrawal. These sharp price increases are attributed to the increase in the cost of transportation (Nwaoga and Ani Casimir, 2013), which has risen by 100 per cent or more. In particular, the prevailing petrol price in the northeast rose to more than US$0.80 (144 Naira) per litre when the official price was US$0.60 (108 Naira) (Alike, 2013).

An important development following the subsidy removal was that both Niger and Chad, once considered the best places to sell northern Nigerian smuggled products, began refining their own petroleum products, while Cameroon (another claimed smugglers' destination, particularly in the north), is expected to follow suit shortly. However, to date, these recent positive developments in neighbouring countries do not seem to have produced any major change in the fossil fuel shortages in northern Nigeria.

Similarly, the view – popular among researchers – that the north receives far more fuel than they can afford to buy (or use), while the south receives far less fuel than they can buy (or

need) is now questionable. This is because, since 2012, the situation in the northern part of Nigeria suggests that northern Nigerian oil marketers now import from the refineries of the Niger Republic due to its high demand in the north (see for example, Kano (2012) and Katsina (2014)). For example, the 20,000 barrels-per-day Soraz Refinery located in Zinder in Niger is now patronised by marketers from the north for its diesel (automotive gas oil (AGO)) and cooking gas (LPG) products (Katsina, 2014). It is estimated that about 300 tonnes of cooking gas per week is imported to Kano alone from the refinery, and these products cost less in Niger Republic than in Nigeria (Uba, 2014). Katsina (2014) reports that the wholesale price of AGO is about US$0.80 (about 144 Naira) per litre in Niger while the NNPC wholesale price is US$0.85 (about 153 Naira) per litre. Similarly, while LPG is US$0.80 (about 144 Naira) per kilogram in Niger, it sells for around US$ 0.86 (about 155Naira) per kilogram in Nigeria. This means that there is an increasing preference to supply LPG from Niger by the marketers because of the high demand from households.

Other reasons given by some of the northern marketers as to why they now purchase their products from Niger include: the growing insecurity in Nigeria, the high level of corruption, and the costs of transporting the product from southern Nigeria to the north. Katsina (2014) noted that 'the Zinder Refinery in the Niger Republic is located about 300km from Kano, which means that a truck will consume less than 300 litres of AGO for a round trip. On the other hand, a round trip to Lagos, Calabar, Port Harcourt or any depot in the south will cost, at least, 1,200 litres of AGO to Kano'. It is therefore not surprising that more people are now using LPG for their cooking in Kano (Uba, 2014).

6.3.4 Electricity supply and its associated challenges following privatisation

Following the privitisation of PHCN in the last quarter of 2013, the national grid output fell from 3,563MW to 3,200MW in January 2014 (Izuora, 2014). The regulatory body, NERC, pointed to an inadequate gas flow to the generation companies, which was blamed on vandalisation of the oil and gas infrastructure in the oil-producing region of Nigeria. NERC's inability to provide an effective solution to its growing problems was further exposed when analysis by new investors of the power systems revealed that they had acquired a decaying system while delivery expectations remained high (Izuora, 2014).

Despite the poor state of electricity generation in the country, in the second quarter of 2014, the government announced an increase in the price of gas to the power sector from US$1.50 (around 270 Naira) to US$3.30 (around 594 Naira) per metric cubic foot. Alohan (2014) noted that this recent increase may push the price of the electricity tariff from around US$0.08 (14 Naira) to around US$0.22 (40 Naira) per kilowatt hour for domestic consumers in the next tariff review. This is a relatively high price for domestic consumers, the majority of whom struggle to afford their basic needs.

6.4 Policy implications and conclusions

From the above, it is clear that there are complex issues surrounding energy provision in Nigeria that are yet to be fully understood. However, this study has explained some important patterns of cooking fuel consumption and distribution in Nigeria. It has illustrated the high dependency on the use of fuelwood in some parts of the country, and has provided insights into the early impact of fuel subsidy removal as well as the privatisation of PHCN as part of the government's effort to transform the energy

sector. The results show that both modern and traditional cooking-fuel types are widely used across Nigeria, although to varying degrees. The supply of modern fuels to northern states, for example, is lower than to the southern states; the former are therefore more dependent upon traditional fuels for their cooking needs, with clear implications for energy poverty. However, population and industrial activities alone do not explain the distribution and supply of modern fuels across the country.

Recent efforts to remove the import subsidy on petroleum products have met with mixed success. The removal of the fuel subsidy, although good for the national economy, has negatively affected household incomes. Therefore, providing a viable policy intervention by the government to reduce the country's poverty level is emphasised here. This is important when considering the welfare implications of the government's intervention policy after the subsidy withdrawal (particularly the Subsidy Reinvestment and Empowerment Programme SURE-P), where much of the additional government spending, for example, on the provision of public goods, does not filter through to households (Siddig *et al*. 2014).

While it has long been recommended that the use of modern fuels by households in Nigeria should be encouraged instead of traditional fuels, this study concludes that the insufficient supply of fossil fuels in some parts of the country is causing most households to descend the 'energy ladder'. In other words, they are moving away from modern fuels back towards the use of traditional fuelwood. However, the recent changing patterns of gas supply in the north (i.e. imports from Niger to northern Nigeria) now means a steady and near-stable supply of this type of energy for some areas in the north, which is why some families are beginning to use it. This suggests that when alternative, modern fuels are in good supply, those families that can afford to will use them.

The current situation with modern fuels in Nigeria is expected to worsen for a number of reasons, including the continued shortage of modern cooking fuels, the partial subsidy withdrawal, and the recent rise in electricity tariffs. These factors will continue to make modern fuels more expensive for most families. Finally, as Balouga (2012: 34) noted, there is a lack of 'coherence and consistency in the enforcement of government policy in the household energy sector, which has resulted [in] the high demand for fuelwood in Nigeria in recent times.'

7
Mozambique's multifaceted energy access challenge

by Joshua Kirshner

7.1 Introduction

With the discovery of significant coal and gas resources in the past decade, Mozambique has gained attention as an emerging energy frontier. The impending coal and gas boom, however, presents a range of logistical and political challenges for the southern African nation, which emerged from colonial rule in 1975 and civil war in 1992. In particular, recent offshore gas discoveries in the Rovuma Basin, on the northern border with Tanzania, could make Mozambique one of the world's leading exporters of liquefied natural gas (LNG). Production is set for 2020, but by then analysts expect a glut on global gas markets, and infrastructural gaps are considerable. Nevertheless, the coal and gas rush has begun to spur investments in domestic power-generation projects.

Alongside the interest in Mozambique's fossil fuel resources, concerns are mounting over climate change. With one of Africa's longest coastlines, Mozambique is particularly vulnerable to the effects of climate change, despite having very low GHG emissions (Quan *et al*., 2013). These pressures have raised the profile of renewable energy technologies (RETs), with the Mozambique government actively seeking donor support and foreign investment in this area (Cuamba *et al*., 2013). But as in other African countries, the state's interest in RETs is complicated by the need to increase energy access more broadly, as a cornerstone of poverty eradication. Mozambique has among the lowest electrification rates in Africa, with the national grid reaching 21 per cent of the population by 2011 (EDM, 2011). A further 11 per cent of the country's 23 million inhabitants is estimated to have electricity access through off-grid sources (FUNAE, 2012), while some 80 per cent rely on biomass as their sole energy source for cooking and heating (Cuvilas *et al*., 2010).

In Mozambique, the Frelimo party-led state seeks to balance maximising the benefits of resource extraction for export-led growth while addressing domestic energy poverty. It aims to keep energy affordable for ordinary citizens and energy-intensive users alike. The latter consists of several megaprojects concentrated near the capital, Maputo, and in emerging extractive zones in the north. While grid-based electrification is increasing, the state sees promising potential for decentralised energy such as solar photovoltaics (PV) for dispersed rural populations.

Solar energy is playing a growing role in the country's push to boost electrification. An estimated 1.2MW of PV-system capacity was installed between 2000 and 2011, largely by FUNAE (Mozambique's National Energy Fund) with support from European, and recently Asian, donors. Some 1.5 million Mozambicans benefit from the installed systems, representing about 0.8Wp of solar PV per person (FUNAE, 2012). Although the quantity in wattage is small, its potential to improve rural health and educational services is significant (Cuamba *et al*., 2013). Solar is framed as an off-grid, decentralised technology and as an alternative to costly diesel generators.

Youth at a video club in Majaua-Maia, Zambézia province. Photo: Joshua Kirshner

Additionally, the Ministry of Energy estimates over 60 potential small-scale hydropower projects, with a capacity of up to 1,000MW. Mozambique's central interior, particularly Manica province, has apt hydrological conditions for off-grid applications. Despite growing interest from the government and donors, only a handful of small- and micro-hydro projects were implemented in recent years (Mika, 2014).

To explore the challenges and opportunities in pursuing an energy access agenda in Mozambique, this chapter begins by examining the country's system of electricity provision and identifies the main actors engaged in addressing energy poverty through on-grid and off-grid approaches. It then delves into a discussion of four decentralised energy projects spanning a range of technologies, developers and sources of finance. The chapter draws on over 75 interviews with a cross-section of government, donors, embassy personnel, small businesses and NGOs conducted in Maputo and Beira in 2013 and 2014. The discussion also builds on a series of site visits that I and consultants from the NGO Practical Action made to communities hosting energy services projects in August and September 2014, as part of a larger study supported by the UK's Economic and Social Research Council (ESRC).[13]

13 The Rising Powers, Clean Development and the Low Carbon Transition in sub-Saharan Africa (Ref: ES/J01270X/1). More details about the project are available at: www.dogweb.dur.ac.uk/the-rising-powers.

The chapter contributes to a growing literature that suggests decentralised, off-grid electricity systems offer encouraging potential for increasing access to energy services in an eco-friendly manner. Additionally, I contend that despite the need for public investments in energy by the state and donors for financial feasibility in the Mozambican context, fostering local enterprises that are responsive to the energy needs of local communities will be important if long-term sustainability is the goal. Such enterprises may initially rely on donor aid but could become more self-sufficient through local buy-in and relevance to people's needs and aspirations. As a result, demand-based community energy planning may be a better solution than the supply-based model currently pursued by state agencies.

7.2 Mozambique's system of electricity provision

Following a history of Portuguese colonial rule and three decades of anti-colonial struggle and civil war, Mozambique's electricity sector remains underdeveloped, reflected in limited grid infrastructure and low electrification rates. Yet the sector has expanded in recent years, paralleling broader economic growth. Established by the state in 1977, Mozambique Electricity (EDM) is the country's public utility, responsible for transmission, distribution and some generation. Before independence in 1975, thermal power plants using imported coal were the major source of electricity, with small contributions from hydropower supplying localised grids in rural areas (Cuamba *et al*., 2013).

This changed with the construction of the Cahora Bassa hydroelectric dam, completed in 1974, which reduced the share of thermal in favour of hydropower. Cahora Bassa is located on the Zambezi in Tete province, until then a remote outpost. One of the last major infrastructure projects constructed in Africa during the turbulent period of decolonisation, Cahora Bassa remains the largest hydroelectric scheme in southern Africa, with 2075MW of capacity (Cuamba *et al*., 2013). Cahora Bassa Hydropower (HCB), an independent power producer (IPP), began commercial operations in 1977, supplying power to the Mozambican, Zimbabwean and South African grids through power purchase agreements. But it was not until 2007 that HCB passed from Portuguese to majority Mozambican ownership.[14] Since then, the Frelimo party has invested Cahora Bassa with national symbolism and patriotic pride (Isaacman and Isaacman, 2013).

Mozambique produces a huge surplus of hydroelectricity at Cahora Bassa. But it must observe pre-independence agreements between Portugal, its former colonial ruler, and its powerful neighbour, South Africa, which committed over 85 per cent of Cahora Bassa's output to supply the South African power utility Eskom to finance the project (Sebitosi and da Graça, 2009). Around 65 per cent of HCB's production is currently exported to South Africa via a substation in Mpumalanga, with a portion re-imported into southern Mozambique on lines belonging to Eskom (KPMG, 2013). Very little infrastructure has been installed to distribute power to local people in Mozambique, especially outside major cities.

Amid these challenges, the state aims to build several large new hydropower facilities. These include the Mphanda Nkuwa (1,300MW), Boroma (444MW) and Lupata Gorge dams (654MW) on the Zambezi in Tete province. Mphanda Nkuwa is sited 60km downstream from Cahora Bassa, with an estimated cost of US$2.2 billion (KPMG, 2013). The

14 The government of Mozambique's ownership of HCB increased from 18 per cent to 85 per cent following a 2007 agreement with Portugal.

Mozambican government seeks foreign direct investment to catalyse these projects as a means to attract energy-intensive industries and boost regional electricity exports. A Chinese state-owned firm has expressed its intent to construct the Mphanda Nkuwa dam, but little transparency surrounds the awarding of these large hydro projects. Moreover, they are largely dependent on the proposed US$1.8 billion high-voltage direct current backbone transmission line between the Zambezi Valley and Maputo, which is in the planning stages (Furu, 2013). According to some analysts, climate change considerations were not incorporated in Mphanda Nkuwa's design (Beilfuss, 2012), which will displace 1400 households and indirectly affect the livelihoods of a further 200,000 Mozambicans (Morrissey, 2013; Isaacman and Sneddon, 2003).

To address soaring domestic energy demand, EDM has begun purchasing power from Gigawatt Mozambique, an IPP that is 40 per cent owned by the South African company Gigajoule. The company has invested US$320 million in a gas-fired 110MW plant in Ressano Garcia, which borders South Africa (KPMG, 2013). A further 300MW of gas-fired plants are envisioned for the southern region, reflecting Mozambique's newfound gas wealth and the state's intention to increase domestic use and beneficiation (Gqada, 2013). In parallel, EDM has invested in comprehensive grid expansion since 2009, aiming to reach all district capitals in the country (Cipriano *et al*., 2015). Along with upgrading Maputo's electricity infrastructure, the grid connected 121 of the 128 district capitals by 2013 (Ouchim, 2013).

Mozambique's electricity grid is expanding, but primarily to district centres and major towns. Given the scattered rural population, costs of grid extension and distances involved, low electrification rates prevail. Many rural communities are bypassed and effectively 'off the grid.' As a result, the state is increasingly supportive of decentralised energy, such as mini-grids supplied by solar PV or micro-hydropower, which can reach further into rural areas and reduce energy poverty. EDM lacks jurisdiction over smaller distribution networks, with some isolated grids managed by the Ministry of Energy through district governmental bodies (Hankins, 2009). Pragmatically, there is little expectation among stakeholders that solar and other RETs will achieve universal electricity access. It is rather viewed as a small-scale solution, but one that may have positive distributional and environmental effects (Ulsrud *et al*., 2015).

7.3 Key actors in Mozambique's renewable energy sector

Set up in 1997, FUNAE operates under the Ministry of Energy with the objective of extending energy access in rural areas of Mozambique. It initially supplied diesel generators and kerosene, but its focus has shifted to promoting, supplying and financing renewable sources of energy. FUNAE has some micro hydro and wind projects but its main focus is solar PV. FUNAE is funded through the state budget, with revenues from taxes and levies from petroleum and electricity concessions, along with donor support. Donors include the World Bank, European Union, and the governments of Belgium, Portugal, Spain, India and South Korea (Menezes, 2013).

Acting separately from FUNAE, the German International Cooperation, GIZ, is also developing RETs in Mozambique under the Energising Development (EnDev) initiative. EnDev is a partnership between the Netherlands, Germany, Norway, Australia, UK and Switzerland that cooperates in several African, Latin American and Asian countries. GIZ acts as the lead agency in implementing EnDev. In Mozambique, EnDev is called Access to Modern Energy Services Mozambique (AMES-M). It focuses on rehabilitating colonial-era micro-hydro mills, improving their efficiency and enabling electricity generation. GIZ's work with RETs in Mozambique pre-dates FUNAE's, beginning in the early 1990s (Mika, 2014).

Since the 2000s, FUNAE, international donors and development agencies have begun to include RETs in projects for provision of electricity for social uses in off-grid environments, such as school lighting, water pumping and vaccine refrigeration. The emphasis is solar energy, viewed as abundant in the country. These projects use localised mini-grids or stand-alone systems that supply electricity to *postos administrativos*[15], including clinics, schools and teachers' and nurses' residences. System capacity ranges from 250–500 watts (Mika, 2014), with systems tendered to pre-qualified companies and host communities selected based on feasibility and population size (Batsana, 2013). FUNAE has replicated this model across the country, an approach that extends its geographic reach but limits local involvement in project design. While not a panacea, local community involvement can enhance projects' economic sustainability by giving end-users more influence in deciding how electricity can best be used to benefit the village as a whole (Ulsrud *et al*., 2015; Tawney *et al*., 2015).

More recently, FUNAE has initiated projects focused on households, small businesses and village economies. These feature localised mini-grids or solar home systems (SHS) in homes and shops. FUNAE procures the systems, usually less than 100 watts peak, and families pay back the loans over a long period. FUNAE piloted this programme in Inhambane province, with 200 SHS installed in 2009 (Marinze, 2013). Beneficiaries view solar energy as apt for lighting, phone charging and refrigeration. In village shops, solar panels power freezers, radios, TVs and stereos, which attract customers and enhance social interactions. Previously, radios and TVs were often battery-powered, and some shopkeepers have complemented these with solar panels and wiring for recharging the batteries.

Some rural consumers have begun to acquire their own solar panels and SHS independently of FUNAE. Ownership of solar panels often occurs with other higher-end assets such as mobile phones and TVs, particularly in small shops. The technology has thus become part of the challenges and opportunities arising in the countryside, and often accompanies burning wood and charcoal for cooking and heating (Mavhunga, 2013). Penetration of SHS remains limited in urban areas, within reach of grid infrastructure.

FUNAE's centralised procurement of solar units has been criticised for impeding local private-sector capacity, insofar as it receives state subsidies and donor funds, crowding out competition (Atanassov, 2013; Hankins, 2009). No industry association for solar and other RETs exists in Mozambique. The University of Eduardo Mondlane in Maputo is active in studying RETs, with a masters' programme in renewable energies started in 2011. Government tenders appear to be spurring a small private market, however, particularly for pico solar. Fosera, a German firm, set up a small production line for portable solar lanterns and mobile phone chargers in Maputo in 2012, using German technology[16] (Cuamba, 2014). In 2013, Fosera won a tender from FUNAE to install pico solar systems (5 volts maximum) in schools and houses in Manica province, indicating FUNAE's interest in this technology (Pedro, 2013). Newer applications such as solar-powered base stations for mobile phone networks and PV in eco-tourism hotels are emerging, but remain limited.

Until recently, national capacity in solar manufacturing was lacking in Mozambique, and systems and components were imported. Much of it consisted of Chinese products, sourced from South Africa by cross-border traders and sold in market stalls and small

15 *Posto administrativo* is the territorial unit below district and province in Mozambique. It refers to the local authority's office and related administration buildings and staff houses.

16 Fosera assembles much of its equipment in Thailand.

electronics shops in urban centres, often without proper documentation. Chinese components are cheapest on the market, but widely viewed as unreliable. This equipment is used as 'do-it-yourself' (DIY) by rural dwellers but not in government-sponsored projects. FUNAE adheres to ISO quality standards for its equipment, but is faulted for lagging maintenance and repair, suggesting a lack of knowledge exchange in an industry with high import content. Theft and damage of solar panels is also a recurring problem.

The need to import solar PV equipment has decreased following FUNAE's tender to construct Mozambique's first solar module assembly plant, supported by a US$13 million concessional loan from India's Export-Import Bank. The FUNAE plant – which opened in Beluluane outside Maputo in November 2013 – aims to produce 5MW of capacity annually, reducing imports and lowering costs. Production inputs, including glass, wafers and aluminium frames, are sourced from Italy, South Africa and Taiwan (Namburete, 2014). FUNAE buys much of the plant's output directly, with little marketing to retailers or direct consumers thus far.

Grid-connected solar is unlikely to be available soon in Mozambique. Regulation enabling PV systems to feed into the EDM grid is largely undeveloped. The Ministry of Energy has taken exploratory steps in this direction (Saide, 2013), but the state appears focused on expanding gas, coal and hydropower for the grid (Cipriano *et al*., 2015). The uptake of solar thermal technologies and solar water heaters has also been limited (Mika, 2014; Batsana, 2013). The next section further examines the pursuit of an energy access agenda in Mozambique through a discussion of four energy projects that I visited with two Practical Action consultants and the director of the local NGO Kwaedza Simukai Manica (KSM).

7.4 Four off-grid energy projects

7.4.1 Chinhambuzi, Manica province

In March 2013, FUNAE inaugurated a solar PV mini-grid with financial support from Belgium in Chinhambuzi village. The Belgian Technical Cooperation (BTC), which has cooperated with FUNAE for several years, installed the village mini-grid system. The solar mini-grid supplies power to a primary school, clinic, police station, six teachers' houses, the local authority's residence and ten *bancas fixas*.[17] But ordinary residents in the main village, Chinhambuzi *sede*, and nearby settlements remain unconnected.

Many residents wish to be connected, but capacity constraints have prevented it. The system has 3.6kWp of capacity, or up to 5kW, insufficient for linking households to the network, which extends for three kilometres. The majority rely on burning wood or charcoal for cooking and heating. The teachers' houses have lamps and a refrigerator, with electricity normally provided until 8 pm.

The shopkeepers told us they pay MT70 per month (US$2.50) for electricity, a fee used to support a security guard to watch over the system at night. The tariff is symbolic and does not cover operational costs. Payments are issued to the village chief, who chairs an oversight committee. The teachers and local authority staff do not pay any tariff for their electricity while the shopkeepers' usage is unmetered.

Given their lack of access, some residents might try to spontaneously or illegally connect, causing stress to the system and possible outages for shopkeepers, who use deep freezers with large

17 A *banca fixa*, or permanent market stall ('fixed stall'), has been formalised or sanctioned by the local authorities. It differs from ambulatory vendors or informal *bancas*, which can be harassed by police on the basis of illegality (see Lindell, 2008).

Shopkeeper with solar-powered freezer in Chinhambuzi, Manica province. Photo: Joshua Kirshner

power demand. The load will likely increase, as shopkeepers acquire TVs, fans and other small appliances. The system is managed in the provincial capital, Chimoio, with no means to locally monitor the system's capacity or for demand-based community energy planning.

This research suggests the importance of conducting market research as a means to understand context-specific needs and expectations of energy users. The demand for solar energy in Chinhambuzi outpaces the system's capacity, and the village mini-grid system is unlikely to accommodate future growth. It will be important to consider the system's configuration and prices, so that energy services can become useful to a broader group of end users, while covering operational costs.

7.4.2 Mavonde, Manica province

Mavonde village is an hour-and-20-minute drive down an ungraded road from the district seat of Manica town, near the border with Zimbabwe. Many residents cross the border daily and have kinship ties on both sides. The area is affected by gold panning, involving domestic and Chinese operations, harming ecosystems in the Nhamacuara River, according to residents we consulted.

Mavonde hosts a FUNAE solar project, financed by the World Bank's Energy Reform and Access Programme (ERAP), initiated in 2009. FUNAE installed solar stand-alone systems at the primary school, clinic and administrative post and in eight shops and households in the main village, Mavonde sede, and Nhandiro, a village six kilometres further along the road.

Shopkeepers in Mavonde, Manica province. Photo: Joshua Kirshner

During our visit, most of the systems were non-functional. The end users agreed to repay their loans to FUNAE over a set period, but many of the systems were down for over a year, and users had stopped payments. FUNAE prepared contracts for the SHS end users, but eight months later the contracts were not being honoured by both parties.

In this project, FUNAE provided SHS to households through soft loans. If the equipment fails, there is some security in the investment, as users can request repairs, replacements or stop paying. Most trust the technology works, but many are frustrated by FUNAE's inadequate maintenance. Only two of 10 street lights were working, both close to the local authority's residence.

Within this project, FUNAE is in responsible for maintenance; it owns the systems in the school, clinic and administrative building. Repairs often face lengthy delays, possibly due to inadequate personnel or capacity constraints within FUNAE. We saw public notices for residents interested in SHS to register at the administrative building. The local authority told us they received 65 requests in one week. A female shopkeeper told us she prefers a loan from FUNAE rather than buying her own panels in Manica town, to avoid paying cash up front. At first she was sceptical of solar energy but now recognises its multiple benefits, such as freezing fish and meat, which otherwise cannot be stored except by drying. She views solar panels as a large investment and wants assurance of product quality.

Bancas fixas are vital social hubs in Mavonde and nearby settlements. The shopkeepers tend to be among the better-off, and many have worked seasonally in Chimoio, Beira or Johannesburg. FUNAE's systems have the (perhaps unintended) effect of increasing these shopkeepers' profitability. Much of the local population is scattered in smaller settlements, preferring to live near their fields. It is difficult for FUNAE to reach these residents and wire their homes with solar panels.

Along with several FUNAE systems, in Nhandiro we saw solar panels purchased by villagers, indicating a pre-existing demand for electricity. During our visit, a group of men sat round a table drinking beer beside a *banca fixa*; the shopkeeper's sound system, powered by a DIY solar panel, helped attract customers. In many ways, solar panels are a status symbol in Mavonde and other villages. The chief of the administrative post (*chefe do posto*) appeared proud of the FUNAE-installed solar systems, even if the majority of them do not work (Jones, 2014). Other villages in the region lack them.

7.4.3 Chua, Manica province

Chua village is located in Maridza administrative post, in Manica district. The village has had experience with micro-hydropower for over 50 years, with several hydraulic grinding wheels dating to the 1960s. GIZ's AMES-M programme, in collaboration with KSM, aims to rehabilitate eight sites with micro-hydro powered maize mills in and near Chua, improving milling and electricity generation for local economic development. Following a participatory survey, the project began in 2008 with a €64,000 budget (Zana, 2007).

We visited one of the micro-hydro schemes in Chua, owned by Lino Ndacada. The system has 22kW of capacity and connects to a mill and localised mini-grid that extends for thee kilometres. By day it powers the mill and by night it provides electricity. The mini-grid connects to 25 houses, with an additional 50 houses benefitting from battery charging, thus affecting some 450 people. It also connects to a business hub with three *bancas fixas*. Households pay a

Micro-hydro powered maize-grinding mill in Chua, Manica province.
Photo: Joshua Kirshner

fixed MT200–250 per month (US$7–8.50) and shops pay MT300 (US$10) for electricity.

Many of the systems use locally-made turbines, while the generators are imported from Germany. GIZ aims to improve the reliability of local turbines. The water canals and tanks are not lined with concrete, however, with some water lost or silted (Mika, 2014).

GIZ's experience in training local people to develop and operate micro-hydro schemes contrasts with FUNAE's more centralised approach. There have been productivity gains in milling and capacity building in operations, repairs and business management for systems owners (Zana, 2007). The micro-hydro schemes are individually owned, while the grid systems are owned by communities. GIZ and KSM have facilitated hybrid financing, with soft loans for hardware such as turbines and generators, and grants to support installing the decentralised grids.

In Chua, the micro-hydro scheme runs through the initiative of local people of very limited resources. End users pay for their electricity usage, which is run as a local enterprise. Lino Ndacada repaid his five-year loan and wants to build a second system. He has identified a suitable site on the Chua River and wants to employ local people to develop it, viewing it as a business opportunity. He told us he has purchased a motorcycle and paid school fees for his seven children with earnings from the micro-hydro scheme. Overall, the project builds on existing knowledge, uses relatively simple and locally adapted technology, and is based on proven demand for electricity generation. According to several villagers we consulted, the system's configuration and prices reflect end users' needs and expectations.

7.4.4 Majaua-Maia, Zambézia province

In Majaua-Maia, a village on the border with Malawi, FUNAE manages a project to rehabilitate a long-defunct mini-hydro plant. Inaugurated in 2013, the project is financed by the EU at a cost of €2.5 million. Canas, a Portuguese engineering firm, won the bid to install the system.

The project has rejuvenated a mini-hydro plant that powered a *fazenda* (farm and maize mill), owned by a Portuguese landowner named Maia since the 1960s (the nearby village is partly named for him). Mr Maia reportedly abandoned the *fazenda* in 1980 amid strife from Mozambique's civil war. The main house (*casa grande*) – a concrete and blue-tiled country villa – fell into ruin, and the mini-hydro system into disuse. FUNAE's project at Majaua-Maia aims to benefit 20,000 residents (5,000 households) in six surrounding villages, including three primary schools, one clinic and six grinding mills.

Majaua-Maia is a three-hour drive from the district capital, Milange, on rutted dirt roads. The new facility has a capacity of 767kW, and is situated on the Ruo River, a tributary of the Shire, forming a border with Malawi. Canas installed a German Ossberger crossflow turbine while the generator is made by Efacec of Portugal. The turbine sat idly in a customs terminal at the Beira port for almost a year before Canas was allowed to bring it into the country (Canas, 2013). The project's first phase set up a four kilometre high-voltage line, and the next phase, currently under construction, will extend it to 40 kilometres. The expected production is 3,500MWh/year. All houses, schools, a clinic and shops along the 4km line are connected. Each household has one light bulb and one power connection point. During our visit, however, households and shopkeepers were not paying for electricity, as the project is in its test phase (Quelhas, 2014).

During the construction phase, most of the inputs were sourced from Portugal with limited local involvement. Technically, the system features state-of-the-art equipment, and the powerhouse is an imposing concrete building, painted a bright orange. Apart from energy access as a technical 'fix', however, our research highlighted the importance of access to energy services that are adapted to communities' needs and social practices. In the Majaua-Maia project, a community-based needs assessment and local participation appeared lacking. Notably, the local grinding mills were not connected during our visit. Powering these mills for grinding cornmeal is a priority, especially for women (cornmeal is used for *xima*, a staple food). Local women must cross the river into Malawi to grind corn at a diesel generator-powered mill. As there is no bridge, they must wade across, often with children in tow. FUNAE intends to connect the local mills, but this had not yet happened.

Furthermore, the project *fiscal* (supervisor), Mr Sala, is from Beira, and his two young assistants are from provincial centres of Nampula and Quelimane. This suggests a missed opportunity to train local youth for such positions, fostering greater local involvement. Operators will likely be recruited from Maputo, Beira and Quelimane, but it might be difficult to attract skilled personnel to this isolated community with poor roads, or to encourage them to stay for long.

Regarding local uses of the electricity, we saw three video clubs in Majaua-Maia showing movies, mainly Jackie Chan films dubbed in Chichewa, the principal language in Malawi, also spoken locally. School-age children frequented these clubs, with no admission charged. We heard sound systems vying for attention from a cluster of *bancas fixas*. Only one had a refrigerator, and this shopkeeper also used a desktop computer to burn music CDs and videos.

As in other projects we observed, little capacity building has occurred around uses for electricity for first-time users. It seems important to consider potential economic opportunities created through electricity, such as milling, welding or food processing. One household was distilling liquor from corn and sugarcane, but this did not require any electricity. During the visit, we saw very small homes with just one incandescent light bulb. Our interviews suggested that most households continue to cook with charcoal and biomass, and some struggle to afford charcoal.

The electricity consumption in Majaua-Maia is unmetered, with residents and shopkeepers experiencing free electricity. It might be difficult for FUNAE to introduce a tariff system, raising questions of ability to pay and access to credit. FUNAE has not tested a payment or revenue-collection system, and it is unclear if it undertook market research or if non-payers will eventually be disconnected. When fully commissioned, the mini-hydro scheme at Majaua-Maia will be one of the largest decentralised mini grids in southern Africa (Quelhas, 2014). The project has much potential, but there are gaps in local involvement and adaptation to local needs.

7.5 Concluding comments

Mozambique's system of modern energy provision relies on large-scale hydro generation of electricity and fossil fuels for cooking and transport. The country's hydropower surplus at Cahora Bassa is largely exported, due to path dependencies from the colonial era. In the process, very little infrastructure has been installed for local distribution of power. Old and new technologies exist side by side, including burning wood and charcoal along with large-scale hydroelectricity. Attempting to fill the breach, solar PV and micro hydro have increasing presence in rural areas. The prospects for expanding or scaling up RETs, however, will be influenced by government policy, especially EDM's grid extension programme. This may limit the scope for off-grid solar and micro hydro in the longer term. Mozambique is increasing its electrification rate, but it remains among the lowest in sub-Saharan

Africa (Cuamba *et al*., 2013). RETs are thus framed in Mozambique within an energy access agenda, rather than as low-carbon development or climate change mitigation.

Our research suggests that FUNAE's supply-based model has had some success in rolling out energy service projects to expand coverage in far-flung rural areas. It is a centralised approach and is focused on connecting rural institutions, rather than providing direct access for rural dwellers. The approach is pro-poor, but relies heavily on state procurement and donor funding, including from Western donors and also from 'rising powers' such as India and South Korea. In the process, however, our findings suggest there has been limited commitment to capacity building and local needs. In Majaua-Maia, for instance, women's priorities appear side-lined, while free electricity may lead to unrealistic uses and aspirations, such as having three video clubs operating in the village.

The GIZ AMES-M approach, in contrast, is more demand focused. It involves adding new users and scaling up based on demand. While also reliant on donor financing and technical assistance, the approach prioritises local entrepreneurs, training and stakeholder engagement. GIZ is socially and technically innovative in its ownership model and bottom-up approach. Our site visits highlighted the value of community engagement in designing and developing projects through demand-based energy planning. Overall, fostering local ownership, long-term commitment and opportunities for learning and empowerment around these initiatives is an area for future improvement.

There is little expectation among key stakeholders that solar PV and other RETs will achieve universal electricity access in Mozambique. They are rather viewed as small-scale applications, limited to a few niches where innovation can emerge. Off-grid RETs have developed alongside EDM's grid extension programme; both aim to reduce energy poverty for socio-economic development. With high import content, little capacity building for local enterprises, and limited presence in the most isolated regions, some question whether FUNAE's approach to supplying renewable sources of energy is sustainable. Yet RETs have clearly entered into debates about Mozambique's energy future.

8
Reflections and recommendations

by Julia Tomei, Danielle Gent and Emma Wilson

8.1 Introduction

Worldwide momentum in addressing the energy trilemma is building. A number of key events will take place in 2015 that are likely to shape humanity's response to energy security, climate change mitigation and energy poverty, including the launch of the Sustainable Development Goals in September, and the United Nations Framework Convention on Climate Change (UNFCCC) Conference of Parties in Paris in December. It is critical that in the development of this post-2020 climate and development framework energy poverty is not lost or traded off. Rather, action on access to modern energy services must be ambitious, going beyond 'one light' solutions and top-down interventions that embed existing energy inequities. The IEA definition of basic energy access as 250kWh per rural household per annum is equivalent to around 2.3 per cent of the energy used by the average American or 6.4 per cent of the average UK household.[18] As the authors in this collection highlight, addressing these inequities will require challenging patterns of energy access planning that reinforce existing inequitable power structures.

8.2 The scale of the challenge

The provision of access to modern energy services to the 1.3 billion people who currently do not have access to electricity, and the 2.7 billion who rely on wood and other biomass for cooking, is a key global energy policy objective. Meeting the United Nations target of universal access by 2030 will, however, require a considerable scaling up of current efforts. As this collection demonstrates, it will also require a greater focus on the needs, expectations and aspirations of the energy poor. Focusing on different geographies, spatial scales and energy technologies and services, these interdisciplinary chapters have shed light on the multiple ways in which the broad challenges embodied in the global energy trilemma unfold and compete in different contexts. In this final discussion chapter, we draw out some of the key themes to emerge from the collection which include energy equity, the role of the end user and governance, before making some recommendations for practitioners, planners and policymakers involved in delivering sustainable energy for all.

8.3 The role of the end user

Many of the papers in this collection draw attention to the critical, but often overlooked, role of the end user. Taking as a starting point the very notion of 'sustainable energy for all', Kumar argues that the heterogeneity of 'all' and the multiple definitions of 'access' must be recognised to achieve this ambitious goal in an equitable manner. Kumar's three case studies demonstrate how each of the energy access tiers – from the provision of basic entry-level

18 In 2013, the average annual electricity consumption for a US household was 10,908kWh (EIA, 2014), while in the UK it was 3,900kWh (DECC, 2014).

lighting services to 'full' access to the central grid – are unable to meet the gamut of user needs for diverse reasons, including the lack of reliability, affordability and quality. Kirshner's paper, which focuses on energy transitions in Mozambique, reports similar outcomes. Here, the energy transition underway runs the risk that the needs of the poorest will be overlooked by government and other actors in favour of large-scale, fossil-fuel based electricity supply focused on the needs of energy-intensive users. His case studies highlight the multiplicity of actors involved in delivering electricity access, which have integrated end-user needs to varying degrees. Kirshner's research also highlights how community engagement in the design of the energy system is critical for identifying individual and community needs that go beyond the provision of lighting.

Both papers draw attention to the distribution of the costs and benefits of energy access within these diverse settings. Their research shows how, rather than emancipating women, the poor and landless, and other marginalised peoples, energy systems can serve to reinforce existing power structures and imbalances within and between communities. These findings hold important lessons for practitioners and policymakers, who, in tackling energy poverty, must not assume that users and their energy needs are predictable. Making such assumptions runs the risk of delivering energy systems that, at best, do not meet these diverse needs and, at worst, worsen the plight of already-marginalised peoples.

8.4 Governing energy at multiple scales

This collection also draws attention to the role of energy governance at multiple scales, and the critical issue of power. Gent and Tomei's chapter focuses on the impacts of shifts in global energy paradigms in one specific context, that of Central America. Raising questions about the relative importance of different energy policy drivers over time, the chapter highlights how, despite (rhetorical) support for energy access and renewable energy, energy policy in these countries continues to be driven by concerns for energy security and the dominance of the market – illustrating the pitfalls of path-dependent development. Focusing on the sugarcane-ethanol systems in three different countries, Tomei *et al*.'s chapter further draws attention to the critical role of governance in influencing the equity outcomes of sugarcane-ethanol systems. The chapter reveals how, even in those countries where the development of biofuels is motivated by social and rural development, benefits for all are far from guaranteed. Indeed, despite political economic differences, across all three cases the benefits of the sugarcane-ethanol systems accrue to more powerful actors, who have a vested interest in maintaining the status quo. Lopicich also highlights the many financial barriers for small players seeking to deliver sustainable energy access, and the constraints placed on their ambitions by institutions and regulations, which favour larger players. The role of vested interests and corruption is also raised by Kumar and by Naibbi and Healey. These chapters reveal that access to energy could be affordable if the system and infrastructure were better organised, less corrupt and designed to meet local people's needs.

Naibbi and Healey also reveal the unintended consequences of national policy decisions; in this instance, efforts to reduce energy subsidies in Nigeria have seen households move away from the use of modern cooking fuels to rely once more on traditional biomass. This policy shift has caused households to in effect step down the so-called 'energy ladder', and this sounds a cautionary note – it should not be assumed that access to modern energy services is permanent or even one way. Indeed, households are most likely to hold on to multiple rungs of the energy ladder, and energy usage will be affected by multiple factors of which policy is one (see for example Sovacool, 2012). The energy behaviours of households who are dependent on uncertain incomes will be

shaped by the wider shifts in governance. All of the papers in this collection therefore touch on the role of governance in influencing the equity outcomes of energy systems. While governance is unlikely to be the only factor, it is nonetheless significant and needs to be taken into account. Recognising this context-specificity, some factors for good governance nonetheless emerge from this collection, and these include the positive effects of good legislation to manage environmental and social impacts, and the importance of transparency, accountability and inclusivity in decision-making processes.

8.5 Energy equity

Finally, all of the papers in this collection share a concern for matters of energy equity. The different approaches adopted by the authors shed light on the complexity and multiple dimensions of equity, which is commonly limited in its conceptualisation to accessibility and affordability of energy supply (e.g. World Energy Council, 2013). These papers highlight four interrelated ways in which the equity dimension of energy access manifests itself.

Firstly, equity must encompass understandings of who wins and who loses from different configurations of energy technologies and systems, and how this distribution of wins and losses varies through space and time. Secondly, if initiatives to deliver sustainable energy for all are to meet the needs of the poorest, then those affected must be able to access and participate in decision making about the solutions being designed to address their needs. Thirdly, the uneven playing field created by unequal power structures, access to goods and services, and capabilities must be acknowledged if we are to address energy inequities. The underlying social, economic and political conditions will affect the outcomes of energy interventions, limiting or facilitating an individual's, community's or nation's capacity to benefit. A greater understanding of this contextual equity is therefore essential if we are to level the playing field (McDermott *et al*., 2012). Finally, efforts to promote energy access must go beyond the provision of 'one light' solutions. In particular, they must be more ambitious in the quality and quantity of energy provided to deliver solutions that address the needs, expectations and aspirations of the energy poor. This will require a shift in the way that access is currently conceived, as well as recognition of the tension between the scale of the challenge (i.e. technologies, financial flows and ambitions of key actors) and the localised, typically small-scale needs of the energy poor whether for household, productive or community uses.

8.6 Final reflections and recommendations

In this critical year, one which will determine the political and institutional landscape for how climate change mitigation, energy security and energy poverty issues are to be tackled, this collection provides a timely reminder of what is at stake: the opportunity to deliver sustainable energy solutions that enable the well-being of the poorest. In this endeavour, it is encouraging that the United Nations Sustainable Energy for All initiative has moved beyond binary measurements of access to a multi-tiered approach[19] (Bhatia and Angelou, 2014). This new approach to assessing the outcomes of energy access interventions acknowledges the different attributes of energy, many of which are raised in this collection, and which include capacity, availability, legality, reliability and affordability. However, at present this appears to be a top-down agenda, and one that is far removed from the lived realities of vast

19 See: www.se4all.org/wp-content/uploads/2013/09/7-gtf_ch2.pdf

populations in the global South. If we are to deliver sustainable energy for all, then we must seek to incorporate local learnings in order to deliver energy access that genuinely meets the needs of the energy poor.

Finally, drawing on the lessons learnt, we provide some recommendations for practitioners, governments and other institutions involved in the provision of sustainable energy for all, and identify some promising areas for future research.

- **A balanced approach:** governments need to balance support for centralised and decentralised off-grid energy, even with their inclination to promote large-scale, fossil fuel-based centralised energy production. Furthermore, fossil fuel exporters need to consider using export revenues to support decentralised energy access, rather than becoming tied in to high-carbon fossil-fuel pathways.
- **Assessing community needs:** practitioners and policymakers should apply community needs assessment approaches in the early stages of an energy access project or enterprise development to avoid making assumptions about the energy demands and livelihood aspirations of local communities. To take account of contextual equity factors, such approaches will also need to analyse the initial social conditions as part of the baseline.
- **Flexibility and dynamism:** energy access must be recognised as a dynamic process, one which changes over time with changes in governance and needs of end users. Practitioners and donors should ensure that this dynamism is reflected in methodologies to assess the outcomes and effectiveness of interventions to promote energy access.

8.6.1 Research priorities

- Political economy analysis of government decision making and how this influences equity outcomes in energy access, particularly in relation to the extent to which vested interests and existing energy pathways influence decisions (see also IIED, 2015).
- Analysis of the effects of institutions and policies that encourage good governance, including environmental and social impact regulation, transparency and accountability mechanisms, and inclusive decision-making processes.
- Analysis of the winners and losers of particular interventions, and the extent to which it is possible to ensure equity for lower-income end-users.
- Development of methodologies to monitor and evaluate the equity outcomes of energy access interventions and how local needs are met. These methodologies will need to take into account that household and individual behaviours will change over time in relation to shifts in policy, economic boom or crisis, or in personal circumstance, such as an increase or decrease in income.

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Knowledge Products

Research report

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Energy

Keywords:
Energy for all, energy access, equity, power relationships, Sustainable Energy for All (SE4ALL)

The issue of energy access for the poor is gaining momentum globally. This collection of papers by early-career researchers draws on in-depth field research in Latin America, Asia and Africa to explore the challenges of delivering access to modern energy services. The chapters document the ongoing inequities of energy landscapes across a range of geographies, scales and political economic contexts. The authors draw attention to the need to take local people's needs and livelihood aspirations into account in efforts to address the 'energy trilemma'. Highlighting the complexity and multiple dimensions of energy equity, the authors demonstrate the difficulties of disentangling energy poverty from the two other elements of the trilemma – climate change and energy security.

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