SUSTAINABLE ENERGY FOR ALL

Innovation, technology and pro-poor green transformations

David Ockwell and Rob Byrne

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CHAPTER 1

INTRODUCTION

Beyond hardware financing and private sector entrepreneurship

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INTRODUCTION

Beyond hardware financing and private sector entrepreneurship

Low carbon Africa?

An unimaginable number of people on the planet today lack access to electricity, something that is now fundamental to many aspects of human and economic development. For some, it is so important that we 'might even … consider access to electricity as a human right' (Winther 2008, p. 224). Globally, the number of people lacking electricity access sits at 1.1 billion (SE4All 2015, p. 2). In Africa, this translates to an average of two out of every three people, but this disguises huge variations across and within countries. In Kenya, the focus of much of this book, for example, the figure rises to almost four in every five people lacking access to electricity, and more than nine in ten in rural areas (SE4All 2015, p. 41). Nevertheless, examination of Kenya's highly dynamic market in off-grid photovoltaic technologies (hereafter, solar PV) suggests ways in which to significantly improve these electricity access numbers and, hopefully, the prospects for human and economic development. Based on detailed empirical analysis of this promising Kenyan example – and supported by examples from research in Tanzania, India and China – it is the aim of this book to introduce a systemic conceptual framework through which to understand how research, policy and practice can provide more effective analyses and interventions to address the electricity access problem.

The statistics quoted above are abstractions that perhaps make it difficult to comprehend the enormous impact on everyday life they are meant to represent. Instead, for those of us living in the rich world or those who have long had access to plentiful electricity, it may be more helpful to reflect on how electricity is involved in our daily routines. Stop for a moment and look around you. Most likely, everywhere you look there will be electrical appliances (you may even be reading this on one). Think through your average day, from getting up in the morning through to going to bed at night, and note every time you rely on

electricity: from boiling the kettle, to washing and ironing clothes, to lighting and heating your home, or simply turning on a television or radio, or charging a mobile phone. So many aspects of our lives, many of them basic human needs – lighting, heating, cooling, cooking, washing and communication – are made easier or, indeed, possible because of our access to electricity. Furthermore, many of the goods and services we consume, and many of the jobs we do to earn money, are also only possible because we have access to reliable electricity.

No wonder then, in the year 2015, such a stark difference between the lives of the world's rich and the world's poor has driven ambitious policy commitments to try to rectify the issue of electricity access. In 2011, under the leadership of Ban Ki-moon, the United Nations (UN) announced a commitment to providing 'sustainable energy for all' (SE4All) by 2030. Note the inclusion here of 'sustainable' energy, connoting the nexus between energy access and climate change, and environmental sustainability more broadly. It also raises the possibility of using renewable energy sources, often off-grid, to provide electricity to many of the people currently lacking access; certainly for those who live in rural areas where grid extension is prohibitively expensive, but also for those in slum urban areas where expense prevents connection to the existing electricity grid.

Africa's[1] economy and accompanying energy demands have almost doubled in size since the turn of the century and it is estimated it will see further increases in energy demand of up to 80 per cent by 2030 (IEA 2014). If initiatives such as SE4All succeed in getting large numbers of renewable energy technologies into use, then the prospect of Sub-Saharan Africa (SSA) locking into lower carbon development trajectories is a powerful one, although we should note that this is not without controversy. After all, most SSA countries are already 'low carbon' from a per capita or aggregate greenhouse gas (GHG) emissions perspective. Considering that the energy needs of the poor are (currently) small, some analysts and practitioners argue that the poor should not be constrained to using low carbon technologies, as their GHG emissions will not significantly increase the global total even if they were to meet all their energy needs with fossil energy sources (e.g. see Sanchez 2010). This argument is linked to questions regarding the extent to which renewable energy technologies, particularly solar PV, can support economically productive activities, or anything beyond basic services such as lighting, mobile phone charging and social connectivity through television and radio.

On the face of it, these two points present challenges to the argument for promoting pro-poor low carbon development. But there are counter-arguments. First, while the poor may be surviving on small quantities of energy at present, projections that they will not increase their energy consumption much into the future could merely reflect limited ambition – or contestable modelling assumptions – on the part of analysts (e.g. see Bazilian and Pielke 2013). Building on this observation, Bazilian and Pielke (2013, p. 75) caution:

> The lower the assumed scale of the challenge, the more likely it is that the focus will turn to incremental change that amounts to 'poverty management,'

> rather than the transformational changes that will be necessary if we are to help billions climb out of poverty.

In other words, the point of addressing energy access is to enable the poor to escape poverty, not to be a little less poor. As they become wealthier, we can expect them to increase their energy consumption and, as Wolfram *et al.* (2012) argue, this increase could be highly significant over the long term. In the meantime, if there are no carbon constraints, the establishment of the supporting energy infrastructure, social and technical practices, political and economic interests, sunk investments, laws and regulations, and so on, associated with fossil-based provision of energy would mean the poor becoming locked into high carbon development pathways (see Unruh 2000 for an explanation of the lock-in idea). That is, promoting fossil-based energy access would be promoting development pathways that just store up problems for developing countries that they will have to address later.

The second point, which questions whether renewable energy technologies can support economically productive activities, is in some ways more difficult to challenge. Technically, there are few reasons why renewable energy technologies could not support the entire range of productive activities. Such activities, as we implied earlier, require energy in the form of electricity, or heat, mechanical power, etc. (Modi *et al.* 2005). But electricity generated from a solar PV module is still electricity; heat generated from burning biogas is heat; mechanical power generated from a windmill is mechanical power, and so on. When it comes to renewable energy technologies, the main technical challenge for supporting productive activities is not so much the kind of energy generated by a specific technology; it is, instead, about whether the energy can be delivered fast enough for the activity in question. That is, the challenge is whether the specific technology can generate enough power, and whether this power can be maintained as needed or whether there is an intermittency issue. The other main 'technical' challenge is whether the cost of generating power from a specific technology is cheap enough to ensure that productive activities are economically viable, especially when compared with other available options.

The power, intermittency and cost of renewable energy technologies are all dynamic characteristics rather than fixed quantities, and they are changing in favourable ways. Both power and intermittency issues could be addressed through energy storage and management technologies, such as better batteries and 'smart' grids, or a combination of both. While there is still a long way to go in this regard, an interesting development in battery technology – batteries that are designed to work on the grid as well as off-grid – was announced by the firm Tesla[2] in 2015, but there is also plenty of other research into batteries that could yield important benefits (e.g. see Van Noorden 2014). And the evidence of favourable changes in the cost of renewable energy technologies is now strong and clear. For example, the costs of generating grid-connected electricity from renewable energies are falling rapidly and are already competitive with fossil fuel options, even after accounting for the costs of addressing intermittency (IRENA 2015).

These favourable changes in technical characteristics provide some of the reasons why the global deployment of renewable energy technologies has been accelerating. According to REN21 (2015, p. 17), in 2014, there were more additions of renewables to global power capacity than coal and gas combined, and renewables were able to supply almost a quarter of global electricity. Although these increases are not yet happening fast enough to meet the goals of policy initiatives such as SE4All, these kinds of changes are inspiring some analysts to investigate the feasibility of a rapid and complete worldwide replacement of fossil-based energy systems with renewables. One example is the work done by Mark Jacobson at Stanford University and Mark Delucchi at the University of California who, together, have published peer-reviewed work modelling the feasibility of providing energy for all global purposes by 2030 using only water, wind and solar power (see Delucchi and Jacobson 2011; and Jacobson and Delucchi 2011). Although their modelling has been critiqued (see Trainer 2012), they have strongly defended both it and their findings (Delucchi and Jacobson 2012).

But, returning to the policy commitment of sustainable energy for all, we can further interrogate the word 'sustainable' in relation to another aspect, going beyond the technical or physical that a focus on environmental sustainability privileges. That is, we can think about it in its fullest sense, drawing on the widely used definition of sustainable development as first articulated in the World Commission on Environment and Development (WCED) report, *Our Common Future*. The familiar definition given in the report is, of course, 'Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED 1987, p. 43). The report then expands on this definition and, in particular, emphasises that sustainability is not just about the environment. On the same page, it goes on to say:

> Development involves a progressive transformation of economy and society. A development path that is sustainable in a physical sense could theoretically be pursued even in a rigid social and political setting. But physical sustainability cannot be secured unless development policies pay attention to such considerations as changes in access to resources and in their distribution of costs and benefits. Even the narrow notion of physical sustainability implies a concern for social equity between generations, a concern that must logically be extended to equity within each generation.

There are deeply political implications arising from this elaborated definition, not least of which is the concern for social equity. The expression used may be timid – 'concern for social equity' rather than, say, 'commitment to achieving social equality' – but it nevertheless points to an essential characteristic of sustainability: that development will not be sustainable if it ignores – or worsens – social justice outcomes. It follows, then, that a commitment to 'sustainable' energy for all must incorporate not just a commitment to environmentally and economically sustainable energy but also a commitment to its social dimensions as well. This has implications

for the kinds of interventions that policies might drive. But it also has implications for the ways in which we might understand, analyse and recommend interventions, all of which arise to a large extent – although not exclusively – from academic debate.

Sustainable energy access and the scholarly deficit

We wrote this book in 2015 and the numbers above give some idea of the level of ambition that policy commitments like SE4All imply. 'Transformation' is an overused word in academic discussions on issues of sustainability these days, but providing sustainable electricity access to more than one billion people over the next 15 years (the UN's 2030 target) implies nothing less than a transformation. The notion of 'transformation' is understood here to mean change that is both rapid and wide-reaching, in terms of the number of additional poor people gaining access to sustainable energy, but also change that works for social justice. Echoing the WCED sustainable development definition, we could accept the possibility of all poor people getting access to economically and environmentally sustainable energy (cf. physical sustainability) while achieving minimal social justice outcomes. For example, we could imagine a scenario in which every off-grid household gets a solar PV system without having any transformative impact on gendered power relations regarding intra-household access to clean lighting services (see Jacobson 2004 for some evidence of unequal access to electricity in solar-powered households in Kenya). We might describe this as a shallow transformation.

In some ways, mainstream 'development' interventions of the kind traditionally associated with institutions such as the World Bank and the International Monetary Fund (IMF) could, in this regard, suffice to achieve the SE4All transformation. These interventions have been concerned with economic growth, defining their 'one-size-fits-all' policy prescriptions primarily from a neo-classical economics perspective. Critiqued by many, this kind of approach is blind to contexts and different views on what constitutes 'the good life', and subordinates the social to the logic of markets (e.g. see Escobar 2012 for perhaps the most elaborated critique of this approach). However, if we are serious about realising social equity, which we have argued above is essential to sustainability, then we must also work for fairer social relations – what we might call a deep transformation. Such a deep transformation might be catalysed by initially shallow transformative action – perhaps through technical improvements in access to energy that mean more households gain solar PV systems or grid connections – that enable deeper changes to happen over time.

But we cannot assume that these will happen automatically. Rather, achieving sustainable energy for all, in its fullest sense (including social justice and social equity), will require political work, not just technical action (Scoones *et al.* 2015b) at all levels from local to international and among powerful actors well beyond the SE4All initiative. For example, sustainable energy access also forms a core pillar of efforts under the Africa-EU Energy Partnership (AEEP n.d.); the African

Development Bank's 2013–2022 strategy is predicated on driving industrialisation across Africa through Green Growth, maximising opportunities for low carbon energy technology markets (AfDB 2013); multiple international donors have reframed their strategic approaches around widely used, but ill-defined, concepts such as 'green growth', 'low carbon development' and 'climate-compatible development' (see Mulugetta and Urban 2010 for a discussion of the various interpretations of low carbon development); and, at the level of international climate policy negotiations under the UN Framework Convention on Climate Change (UNFCCC), the transfer of low carbon energy technologies to developing countries remains central to achieving both GHG emissions reductions and national development goals (UNFCCC 2015).

Importantly, these policy ambitions implicitly assume that such a transformation can be driven by the deliberate interventions of key actors. These actors could be individuals or organisations, intervening through policy and practice at a range of possible scales, from international to local. But deliberate interventions to achieve transformative change in energy access are unprecedented. Doing this with low carbon energy technologies is even more challenging, given that they are marginalised (economically, politically and socially) relative to high carbon energy technologies. Furthermore, much of Africa lacks the infrastructure, technological capabilities and functioning innovation systems for even these mainstream technologies. But, while this presents an unprecedented challenge (and notwithstanding the potential controversy noted above), it also represents an unprecedented opportunity. Sub-Saharan Africa's lack of existing infrastructure offers the region, more than any other, the potential to develop along lower carbon pathways, rather than locking-in (Unruh 2000) to the high carbon, fossil fuel-based infrastructure that is now so difficult for other nations and continents to decarbonise in the bid to tackle climate change.

Myriad actors (individuals and institutions) are currently operating across Africa trying to drive sustainable energy access; from small, local non-governmental organisations (NGOs), to national governments, international donors, multinational companies, regional governmental organisations and multi-billion dollar programmes coordinated by intergovernmental organisations such as the UN and the World Bank. But what do interventions that transform sustainable energy access in low-income countries look like? Why have so many past interventions failed to drive change on a wider scale or at a more rapid rate? In the handful of examples where transformative changes in sustainable energy access have occurred, what drove them? What made them transformative as opposed to narrow, slow and incremental? Who was involved? What did they do?

These are all questions with which we seek to engage in this book. We do not pretend to be able to answer all of them. We do argue, however, that the conceptual framework we develop in this book is better equipped to inform the transformative policy ambitions mentioned above than the two-dimensional approach of the majority of existing literature on energy access in Sub-Saharan Africa. That literature is dominated by a focus on finance and technological hardware and an accompanying dominance of economics and engineering-based analyses

(Watson *et al.* 2012). Notwithstanding a handful of recent contributions (e.g. Jacobson 2007; van Eijck and Romijn 2008; Romijn and Caniëls 2011; Sovacool and Drupady 2012; Byrne 2013b; Baker *et al.* 2014; Rolffs *et al.* 2015; Naess *et al.* 2015), there are few academic contributions that go beyond technical and economic analyses, and almost none that consider the socio-cultural and political dimensions of energy access in SSA. A recent systematic review demonstrated that the literature is characterised by a range of disparate and uncoordinated efforts. Studies consist of project-by-project, or policy-by-policy, analyses of 'barriers' and few are of high enough quality to contribute to more systematic learning (Watson *et al.* 2012). In many of these analyses, there is an increasing use of the term 'enabling environment' to describe the context that facilitates change. This tends to be a catch-all term for anything beyond financial or technical challenges. There is little in the way of any comprehensive articulation or explicit theorising of what constitutes such enabling environments.

Therefore, the argument we make in this book begins with the observation that scholarship has not kept up with policy ambitions in this field. The existing literature lacks both the necessary conceptual tools and the empirical basis to answer the questions posed above and to inform policy approaches that might be fit for purpose in realising current transformative ambitions. Only a handful of real-world, empirical examples exist that look anything like a transformation in access to sustainable energy technologies for poor people in Africa. No attempt has yet been made to systematically analyse these examples and act upon the lessons that might be learned. Doing so requires new conceptual thinking and comparative empirical analysis that bridges traditional boundaries between hitherto unconnected fields of scholarship. Extending from this, we also need an action-oriented focus that is able to both advance scholarly understandings and inform contemporary policy and practice. It is this lacuna that we seek to address in this book by introducing a systemic analytic perspective based on empirical analyses of the solar PV market in Kenya – one of the few examples of more transformative change in sustainable energy access that do exist in Africa. Of course, this one empirical example could easily be dismissed as an insufficient basis upon which to construct a conceptual framework. This is debatable but, nevertheless, we seek to address this criticism by supporting the insights this one example offers with those from low carbon research in Tanzania, India and China, as well as the innovation studies literature more generally.

The problem with hardware financing and private sector entrepreneurship

Scholarly work in the climate policy literature, particularly drawing on environmental economics, offers a more generic perspective on the problem of low carbon energy technologies and developing countries than is seen in the more specific literature on energy access in Sub-Saharan Africa. The generic perspective is one that has gained significant international policy traction. In this literature, the

problem is theorised as the standard economic explanation of market failure in relation to the transfer of low carbon technologies[3] to developing countries. Little attempt is made to engage with ideas of how poor people might gain access to low carbon technologies, once they are present in a country. The implicit assumption is that transfer equates with access: fix the market and the energy access problem is solved.

The core focus of this environmental economics approach is the fact that markets for low carbon technologies do not capture the associated positive externality of reduced future carbon emissions. This means that there is no incentive for developing countries to invest in low carbon technologies, and hence a lack of developing country markets to attract investment from international technology-owning companies. Market-based policy mechanisms are therefore prescribed to meet the incrementally higher costs of low carbon energy technologies.

The classic example of the operationalisation of this perspective in practice is the Clean Development Mechanism (CDM), an instrument introduced under the Kyoto Protocol and hailed at the time as a 'win-win' agreement between the industrialised and developing countries that would promote both climate mitigation and sustainable development goals (Matsuo 2003; Lecocq and Ambrosi 2007). But, as Figure 1.1 shows, the CDM has led to an uneven distribution of investment, with Africa as a whole hardly benefiting at all (with just 3 per cent of cumulative

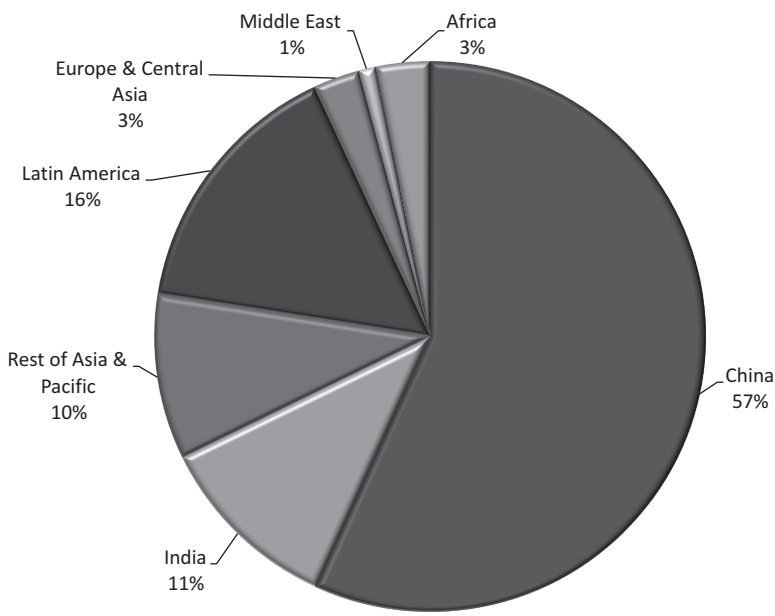

FIGURE 1.1 Distribution of cumulative investment under the CDM
Note: Figures are the percentage of total accumulated investment by the end of November 2015.
Source: Based on analysis of the CDM pipeline (www.cdmpipeline.org).

investment under the CDM to date). Essentially, the CDM can be characterised as a 'hardware financing mechanism' (Byrne *et al.* 2012b), emphasising its focus on finance for technology hardware. Other more targeted examples of hardware financing approaches also exist; in particular, efforts under some forms of intervention through the Global Environment Facility (GEF) that target low-income countries. However, these efforts have led to similar results. For example, as we discuss in more detail in Chapter 6, the GEF-financed Photovoltaic Market Transformation Initiative, implemented through the International Finance Corporation (IFC) and trialled in three countries, including Kenya, did not lead to 'market transformation'. Despite making USD 5 million in finance available, the initiative managed to add just 170 solar home systems (SHSs) to the market in Kenya (Byrne 2011, p. 129) – a market with annual sales of around 20,000–25,000 (Ondraczek 2013, p. 409). Clearly something is being missed by these 'hardware financing' approaches.

The other dominant approach that has emerged in this field more recently is a focus on private sector entrepreneurship. The classic example of this in relation to low carbon energy technologies is the establishment of Climate Innovation Centres (CICs) under the Climate Technology Programme directed by infoDev (the World Bank) with the UK Department for International Development (DFID) and their Danish counterparts (Danida). The CICs essentially operate as venture capital mechanisms, providing finance and business incubation support to early stage innovators in the countries where they operate (as of 2015, CICs are operational or under development in Kenya, Ethiopia, Ghana, South Africa, Morocco, the Caribbean, India and Vietnam) (infoDev 2015).

The idea of private sector entrepreneurs driving innovation and technological change in developing countries seems to have captured the imagination of international policy-makers and donors. It fits in neatly with normative commitments to neo-liberal ways of doing development. But it is ill-conceived for the specific circumstances that exist in a wide range of different contexts: differences in relation to types of technologies; differences in social practices facilitated by technologies; differences in socio-cultural variations of these practices; differences in levels of technological capabilities existing in different countries, regions or communities; differences in politics and political economies, and so on (Ockwell and Mallett 2012). Rather, it represents a renewed commitment to development approaches characterised by mono-economic assumptions, i.e. that economic 'laws' are applicable across time and space (Selwyn 2014, p. 8) and are not contingent on any of the context-specificities mentioned above. However, there is little evidence that financing early stage innovators is likely to translate into widespread systemic low carbon technical change in developing countries, let alone more transformative change that facilitates access to electricity for the world's poorest people.

As we discuss in Chapter 2, this is not surprising once we understand the insights gained from decades of research in the field of Innovation Studies, including recent contributions that focus specifically on low carbon energy technologies. This body of research, often focussed on the adoption and development of new technologies in developing countries, clearly demonstrates that widespread technological change

occurs over time, via processes of developing technological capabilities and well-functioning innovation systems. It implies that the kind of private sector entrepreneurship supported by the CICs and others is likely to lead to a number of isolated businesses promoting new technological hardware, as opposed to making a contribution to systemic long-term change. Indeed, the academic paper by Sagar *et al.* (2009), upon which the CIC idea is based, pitches CICs as a means of strengthening and building innovation systems in developing countries, with activities that go well beyond the financing of entrepreneurship. The way in which CICs have been operationalised therefore falls well short of the original proposition made by Sagar *et al.*

Building innovation systems forms a core pillar of the conceptual framework that we develop in this book, albeit one that we argue needs to be extended beyond that introduced by Sagar *et al.* (2009). This extension needs to encompass a socio-technical understanding of change, and be embedded in more localised governance structures than are implied by Sagar *et al.*'s international focus. This is not to say that the CIC will not produce any pro-poor energy technologies or important pro-poor benefits. There is at least one example of the Kenyan CIC supporting a solar-powered irrigation technology that may well be of benefit to poor farmers. Rather, the point is that this kind of isolated investment is unlikely to result in widespread transformative change unless it is part of a more systemic approach to understanding – and seeking to effect – socio-technical change. It is this systemic approach to understanding and action that this book articulates.

As we argue in more detail in Chapter 2 and Chapter 3, these 'Hardware Financing' and 'Private Sector Entrepreneurship' framings, whether applied to the specific problem of sustainable energy access or the broader issue of low carbon technology transfer and development, miss a fundamental understanding of how technological change, technology adoption, innovation and development occur.[4] It is the aim of this book to develop a more sophisticated, systemic conceptual framework that is better able to explain examples of transformative change in sustainable energy access and, hence, inform future governance and interventions in practice. But, before summarising the details of this conceptual framework, let us first spend some time articulating why the current dominance of 'Hardware Financing' and 'Private Sector Entrepreneurship' framings of the problem matter so much.

A pathways perspective on why framings matter

We adopt the Pathways Approach (Leach *et al.* 2010a) as the normative starting point for our analysis in this book, building on its operationalisation in Byrne *et al.* (2014b) and Marshall *et al.* (in press). In simple terms, this approach casts aside the idea of a single, incontestable and normatively 'good' pathway of development, instead emphasising the need to remain open to multiple alternative development pathways that might be pursued. This is vital in the context of the complex, interrelated challenges resulting from the need to address poverty while simultaneously dealing with other (sometimes competing) priorities such as addressing climate change, environmental integrity, job creation, economic growth and social

justice. It demands explicit recognition that there is no single, universally applicable, pathway towards achieving sustainable energy access, nor is there any single outcome or development trajectory that such pathways might unquestioningly support. Rather, multiple possible pathways and multiple potential 'destinations' exist, all of which have material consequences for the distribution of benefits that result along the way: who wins, who loses, whose interests are represented and whose are marginalised. The societal services and functions that sustainable energy technologies facilitate – such as providing light and connectivity to poor people in remote rural or slum urban settings, or the industrial energy needs of large businesses, etc. – are realised dynamically out of the interplay of various co-evolving complex systems (socio-cultural, technological, environmental, political, economic) and any particular unfolding of these dynamics constitutes a specific development pathway among multiple possibilities (Leach *et al.* 2010a).

Each of these complex systems themselves, and their combination, can be framed in different ways. Fundamentally, the Pathways Approach recognises that who you are shapes how you 'frame' – or understand – a problem or opportunity, and that this understanding tends to focus on a specific development pathway to the neglect of alternative perspectives. Or it might simply represent the received wisdom (Leach and Mearns 1996) of donors or government agencies, or other powerful actors, who fail to appreciate the realities of a problem from different perspectives, such as a farmer, shopkeeper or mother.

Each framing informs – and is informed by – a narrative that interprets the world in a particular way, reflecting and reinforcing the perspective of the narrator, justifying particular actions, strategies and interventions in order to achieve certain goals. As understood here, a narrative is used to 'suggest and justify particular kinds of action, strategy and intervention' Leach *et al.* (2010b, p. 371) and so a narrative attempts to enrol actors and their resources into particular ways to achieve development goals. If this enrolment is successful, then a particular direction of development is privileged, the result of which is an unfolding pathway co-evolving contingently and uncertainly in the interplay between these privileging forces and the various complex systems noted above.

As narratives orientate actors and resources towards particular goals, employing particular strategies, so a pathway of development evolves. All actors are operating with incomplete knowledge, and so any particular perspective underdetermines what might constitute material reality. The Pathways Approach therefore proposes that it is vital to create opportunities for multiple pathways to evolve in order to meet the priorities and needs of different groups. However, narratives that resonate with the perspectives of powerful actors – those who are able to mobilise sufficient resources to support their strategies – may become institutionalised, whereas other narratives, such as those of the already marginalised, may fail to materialise, thereby perpetuating unequal distributions of power. Furthermore, once certain narratives dominate policy, the framings of issues therein can serve to further exclude alternative framings and further marginalise those actors who promote these alternatives. In this way, policy narratives and associated problem framings have material

consequences, influencing the extent to which particular identities and power relations are either reinforced or redressed.

Thus, multiple framings, narratives and pathways are possible. Different groups of actors will interpret the world in different ways, interpretations arising from their own experiences, situations, understandings, values and interests. Favouring certain framings over others, they will seek to promote narratives that would help to create their preferred development pathways. Some narratives will be more dominant than others, perhaps because they are promoted by powerful actors, and are likely to become manifested in interventions. Other narratives remain marginalised, perhaps because they are promoted by groups who are themselves marginalised or powerless (Byrne *et al.* 2012b, Forsyth 2008).

The ways in which problems are framed – in the case of this book, the problem of sustainable energy access and related issues of low carbon energy technology transfer, low carbon development, green growth, and so on – and the ways in which narratives are used to justify these framings – thus become a critical focus for analysis. Our argument is that the existing framings of the sustainable energy access problem (both in the majority of the academic literature and in dominant policy approaches) as one constituted and solvable through a focus on hardware financing and private sector entrepreneurship, are such that the needs of poor countries and the poor people therein are unlikely to ever be met. We argue for a fundamental reframing of the problem to one constituted by the need to build well-functioning, pro-poor socio-technical innovation systems in developing (and, particularly, low-income) countries. We base this systemic perspective on a synthesis of core aspects of Innovation Studies and Socio-Technical Transitions theory – a synthesis developed to a large extent from in-depth empirical analysis of the success of the solar PV market in Kenya, but bolstered by insights we have gained from related empirical work in Tanzania, India and China, along with reference to decades of work by many others in Innovation Studies. But, before summarising the main elements of this new theoretical framework, and the core arguments on which it is based, we should acknowledge that we too are engaged in framing and narrative construction.

Our normative position and the aims of this book

It would be remiss of us, having acknowledged the importance of framings, not to acknowledge our own normative positions in relation to both this field of enquiry and our professional and personal perspectives more broadly, both as researchers and as private individuals. Both of us are white and male academics based in a Northern university (the University of Sussex in the UK), having grown up and been educated in the Global North. And we have both spent extended periods of time living and working in various countries in the Global South. Byrne, in particular, has an intimate knowledge of sustainable energy access issues in East Africa, having worked as an engineer installing solar home systems in Tanzania. Ockwell originally trained in Economics and Ecology, and later Political

Science, working for several years as a policy consultant in the UK. His academic life emerged from an original approach that combined insights from Political Science with work in the natural sciences, culminating in a focus on the politics of scientific knowledge and its (mis)use in policy. Byrne originally trained in and practised engineering before retraining in the fields of Innovation Studies and Science and Technology Studies. Both have gravitated towards a more Science and Technology Studies-oriented perspective on science and development policy. Both continue to engage with, and act as consultants to, national and international policy-makers on climate change and development, maintaining a particular interest in sustainable energy access in Africa and working closely with development partners based in Nairobi. A normative commitment to pro-poor social justice and environmental sustainability is definitive of both authors' perspectives on their research and ideas pertaining to any kind of meaning in relation to life and human well-being more generally.

We should also acknowledge that the alternative framing of sustainable energy access that we espouse in this book is open to – indeed, welcomes – critique and questioning just as much as those framings we portray as being limited in their ability to serve the needs of poor people (i.e. the Hardware Financing and Private Sector Entrepreneurship framings we characterise above). Our hope is not so much that the alternative framing we articulate in this book be taken as a panacea for tackling the problem of sustainable energy access. Rather, it is that this alternative framing, with its systemic perspective and focus on the needs and practices of poor people, will provide a very different perspective on the governance of sustainable energy access and low carbon development more broadly, including related ideas such as green growth. This alternative framing is one that privileges a situated perspective, rooted in local institutions that fundamentally demand that democracy – in all its messy, unpredictable, subversive and creative possibilities – be foregrounded in the ways in which pathways to sustainable energy access and low carbon development are imagined, navigated and practised (Stirling 2014; 2015a).

In this way, our hope is that the politics of sustainable energy access are moved to the foreground of both analysis and practice. Far from sustainable energy access being a neutral concern that might be addressed by technocratic engineering and finance interventions, it becomes an explicitly political problem with solutions that are themselves political as much as they are financial, technical or social. Indeed, we expect that politics feature in the lived experiences of all actors involved in the field – even the supposedly 'neutral' engineers and economists – albeit in ways that those actors do not always explicitly acknowledge. The conceptual framework and approaches to policy and practice, and governance more broadly, proposed in this book are therefore intended to facilitate a more political and democratic approach to the sustainable energy access problem – one that is cognisant of the systemic nature of innovation and socio-technical change. Finance, engineering and private sector entrepreneurship each play a role in these dynamics but they do not, either in and of themselves or in combination, constitute the entirety of a socio-technical innovation system.

A socio-technical innovation systems perspective

Thus, our argument is that fundamental problems exist with the current framings of the problem of sustainable energy access, in both the majority of academic literature and in policy and practice. We seek to demonstrate through the empirical analysis in this book that neither the two-dimensional Economics–Engineering framing that dominates the academic literature on energy access in Sub-Saharan Africa nor the Hardware Financing–Private Sector Entrepreneurship framings that dominate policy (and much contemporary practice) can explain examples of transformative change in low carbon energy technology adoption in developing countries. Therefore, solutions based on these underdetermined framings are unlikely to meet the sustainable energy access needs of developing (particularly low-income) countries or the poor people therein. This, we argue, is primarily due to a failure to understand three key things:

1. The systemic nature of innovation and its role in relation to broader technological change, particularly regarding the adoption and development of new technologies in developing countries.
2. The socially situated and co-evolutionary nature of new technology adoption in specific social contexts, particularly in relation to new technologies that must compete with existing, dominant technologies. In the case of low carbon energy access, dominant technologies include – among others – kerosene lanterns, biomass-based cooking stoves, and diesel generators and batteries for electrical equipment (whether for domestic or productive use).
3. The role that key actors (individuals or organisations) might play in driving transformative socio-technical change by attending to issues 1 and 2. After all, any deliberate attempt to address the problem of sustainable energy access implicitly assumes that some kind of actor can and will intervene to achieve such an outcome. This third point is directly and inextricably linked to governance.

It should be noted that by attending to these three elements we are not arguing that technological hardware and finance are unimportant, nor are we saying there is no role for hardware financing and private sector entrepreneurship – they are and there is. Any interpretation of this book as an attempt to create a position that dismisses the importance of hardware, finance and entrepreneurship would fundamentally misunderstand the point we seek to make. Our argument is that these aspects of the energy access problematic need to be understood from a systemic perspective: they are component parts – not the sole constituents – of a broader system. Moreover, we argue, by ignoring other systemic, socially situated and political considerations, a narrow focus on hardware and finance will never lead to transformative change in sustainable energy access.

Insights from Innovation Studies

The first step the book makes towards a systemic conceptual framework centres around insights from the field of Innovation Studies and linked fields such as

Innovation Management (explored in more detail in Chapter 2). In particular, this builds on recent scholarly efforts to connect insights from Innovation Studies with issues of international climate policy and climate technology transfer (e.g. Sagar and Bloomberg New Energy Finance 2010; Ockwell and Mallett 2012; Hansen and Ockwell 2014; de Coninck and Puig 2015; Watson *et al.* 2015). This work has sought to move beyond the dominant Hardware Financing framing by wrestling insights from the Innovation Studies literature into a framework that can deal with the context of often less mature low carbon technologies (Ockwell *et al.* 2008), new patterns of technology flows (Lema and Lema 2013), including South–South (Brewer 2008), and the conditions of policy urgency that characterise climate change (as opposed to temporally neutral accounts of conventional technology transfer) (Ockwell and Mallett 2012). This literature is helpful in focussing attention on the insight that technology is essentially constituted by knowledge, with technological hardware representing the artefact of applied knowledge. It draws attention to how firms and industries develop their technological capabilities over time as they access new technologies, progressing from new productive capabilities 'up' to more complex innovative capabilities (e.g. see Hobday 1995a; Bell 1997; Bell 2012). This process leads to capabilities to manage and drive technological change, underpinning broader processes of (potentially low carbon) economic development and industrial change in developing countries. It is through the accumulation and advancement of these technological capabilities across firms and industries in different country contexts that technological change and economic development occur.

The literature in this field provides a further valuable insight, situating technological change in the context of countries' 'innovation systems', emphasising the network of actors (e.g. firms, universities, research institutes, government departments, NGOs) within which technological change occurs and the strength and nature of the relationships between them (Ockwell and Byrne 2015). Taking this insight seriously, we are offering an explanation of why hardware financing policy mechanisms like the CDM fail to deliver to low-income countries. Such supposedly technology- and country-neutral market mechanisms are likely to attract foreign investment in countries where internationally competitive technological capabilities already exist among domestic firms and industries to some extent, and where national systems of innovation are conducive to such investment. Therefore, these market mechanisms reinforce the comparative advantages of countries with well-developed capabilities in relation to low carbon technologies (such as China, India and Brazil), but fail to effect change in countries where existing technological capabilities and innovation systems are weak or absent.

But, despite the value of the recent Innovation Studies-inspired scholarship on international climate policy and low carbon technology transfer, these perspectives suffer from some critical limitations in being able to deal with sustainable energy access in Africa. First, they have principally been developed and applied in the context of OECD and Asian Tiger economies and, in the subsequent focus on climate technologies, rapidly emerging developing economies, particularly India and China (e.g. Ockwell *et al.* 2010a; Lema and Lema 2013; Hansen and Ockwell

2014; Watson *et al.* 2015). This makes 'traditional' Innovation Studies ill-equipped to deal with low-income country contexts that lack modern energy (or other) infrastructure in many areas, or basic levels of technological capabilities and innovation systems (this is discussed in more detail in relation to the Socio-Technical Transitions scholarship below). Second, and perhaps more importantly, Innovation Studies fails to engage with the crucial role of technology users and the social practices that co-evolve with technologies – particularly with access to new technologies that afford such transformative social, economic and political potential as those that facilitate electricity-based services. With a problem such as sustainable energy access in Africa, any useful conceptual framework must enable us to pay attention to the social practices of the poor people whom we hope will gain access to such technologies. To address this need, we look to the field of Socio-Technical Transitions.

Insights from Socio-Technical Transitions

The burgeoning field of Socio-Technical Transitions is far better equipped than traditional Innovation Studies to facilitate attention to technology users (Byrne 2011), focussing as it does on the co-evolutionary relationship between social practices, technology and innovation. Its interest in societal 'transitions' also looks like something closer to the notion of 'transformations' that pertain to this book's focus on sustainable energy. Societal transitions are understood in this literature to be society-wide changes from one set of stable social and technical configurations that perform a 'function' in that society to a new set that could perform that function more sustainably (e.g. see Geels and Schot 2007). A relevant example for us here is the global effort to 'transition' from a fossil fuel-dominated energy system to one based on renewable energies. As energy is fundamental to all processes, there are many 'societal functions' associated with energy systems, e.g. mobility, communications, entertainment, and so on. Each has its own social and technical configuration, and each configuration will vary across different contexts. So, for example, home entertainment could involve television, social media, conversation and music-making in various configurations with context-specific cultural practices, social norms and group or personal identities. In one context it may be normal practice to watch television during social gatherings; in another, watching television at such times may be considered insulting to one's guests. Whatever the specific social (taken as shorthand for social, cultural and political dimensions) and technical (together, socio-technical) configuration – and the co-evolution of the various social and technical elements – in any given time or place, it performs its function within a broader context that includes supply chains, government regulations, related functions, socio-technical configurations, and so on.

The Socio-Technical Transitions literature tries to incorporate these multiple dimensions and their interdependent dynamics into a coherent conceptual framework. As a result, it has much to say about how change occurs. It conceptualises existing society-wide socio-technical configurations as stable 'socio-technical

regimes', understood as rules shared by actors in functional domains (e.g. shared knowledge base, belief systems, mission, strategic orientation, etc., within a particular society's transport system) (Geels 2004). In the case of energy, as we noted above, regimes would currently refer to fossil fuel-dominated energy production and consumption. But renewable energy alternatives exist, of course, and attempts are well underway to substitute them for fossil fuels. Nevertheless, renewable energy technologies are still relatively marginal compared to fossil fuel-based technologies and so the Socio-Technical Transitions literature conceptualises them as 'niche' technologies. In this case, the literature is interested in how to 'manage' such niches to effect widespread change (e.g. Kemp *et al.* 1998; Raven 2005). That is, it is interested in how fossil fuel-dominated regimes might change as a result of either successful management of niches of sustainable energy technologies to the extent that they compete with dominant fossil fuel-based regimes; or of landscape-level (the broader context) changes such as rising social and political demands for low carbon energy; or, addressed more recently in the literature, through the destabilisation of socio-technical regimes (Turnheim and Geels 2013). However, despite the promise of the Socio-Technical Transitions field, it too suffers from a number of critical limitations in its ability to deal with the sustainable energy access problem in Africa.

The first limitation, to a greater extent even than the Innovation Studies literature, is that the field has been developed using a rich range of historical case studies based on transitions in mostly post-war European contexts. An emerging strand of the literature is beginning to engage more explicitly with the contexts of developing countries, but this has mostly focussed to date on rapidly emerging economies, especially India (e.g. Berkhout *et al.* 2010) and South Africa (e.g. Baker *et al.* 2014; Swilling *et al.* 2015). Only a few peer-reviewed journal papers have attempted to deal explicitly with issues related to energy access in low-income countries (van Eijck and Romijn 2008; Ulsrud *et al.* 2011; Ahlborg and Sjöstedt 2015; Rolffs *et al.* 2015; Ulsrud *et al.* 2015;). This leaves the Socio-Technical Transitions literature wanting in going beyond what Furlong (2014) refers to as the 'modern infrastructure ideal'. It is unable to account for the stark differences between the well-established energy infrastructures in European and other Northern contexts, and the complete lack of established energy (or other) infrastructures in the majority of low-income countries across Africa. What infrastructure does exist in these contexts mostly serves a minority of urban elites. Access to grid-based electricity is not an imminent prospect for the majority of poor people in either the rapidly expanding urban fringes or the remote rural areas of most low-income countries.

Moreover, there are other challenges for transitions approaches when trying to apply them in the contexts of low-income countries. For example, based on rich empirical case studies in SSA countries, Keeley and Scoones (2003, p. 6) argue that attending to the historical relationships between science, local knowledges and political styles – influenced, as they are in Africa, by different (current and past) experiences with colonialism, post-independence development efforts and international science, technology and innovation – demonstrates 'multiple variegated and located forms of "modernity"' that defy universalist description and prognosis. This

implies much more than simply the assertion that context matters; rather, it begs fundamental questions of Transitions theory and galvanises a call to extend the thinking to (particularly low-income) developing country contexts that resist easy categorisation within the usual niche–regime–landscape typology of Socio-Technical Transitions terminology. In relation to sustainable energy access, it begs a number of questions such as: What constitutes the regime of energy provision for poor people in Africa? Is reliance on wood fuel for heat and cooking, kerosene for lighting and occasional diesel generators for electricity enough to constitute what might be referred to as regimes with which niches of low carbon alternatives (e.g. solar home systems) have to compete and broader landscape dynamics intersect? Are these regimes established enough to constrain or enable the agency of actors and their potential to effect, or even drive, the widespread adoption of sustainable alternatives? Or are they more open, less stable and amenable to change in ways not yet properly considered in the Transitions literature – ways that might render both analytical purchase and insights for action in seeking to galvanise pro-poor, low carbon development pathways?

In this book, we develop the idea of 'socio-technical innovation systems', as opposed to simply 'innovation systems', allowing for the adoption of what we argue are the most promising strands (in relation to sustainable energy access in Africa) of both the Innovation Studies and Socio-Technical Transitions literatures described above. This goes beyond the limits of the Innovation Studies literature by attending explicitly to the role of technology users and the co-evolutionary nature of technological change, innovation and social practice. Critically, however, it allows us to test the limits of these literatures in the contexts of low-income countries and energy access for poor people. Concerns regarding space and spatio-cultural contingencies, including Geography-inspired critiques of Transitions scholarship (e.g. Lawhon and Murphy 2012), are thus explicitly introduced into the analysis.

For our purposes in this book, a final limitation of both the Transitions and Innovation Studies literatures is their failure to deal with the political nature of socio-technical change. The Transitions field has been repeatedly criticised for its failure to explicitly deal with politics and the often political nature of processes of change in sustainable directions (e.g. Smith and Stirling 2007; Smith and Stirling 2010; Kern 2011; Meadowcroft 2011; Lawhon and Murphy 2012). Despite these repeated calls for more attention to the politics of change, and even a contribution by one of the literature's key proponents seeking to extend one of its core conceptual frameworks to attend to politics (Geels 2014), there is only a handful of examples in the Transitions literature where empirical analysis has tried to deal with politics, political economy or power (some examples include: Avelino and Rotmans 2009; Grin 2010; Kern 2011; Normann 2015). In a developing country context, the literature is practically brand new: Baker *et al.* (2014) analyse the political economy of South Africa's energy transition, and this may be the only example of a peer-reviewed journal paper within the Transitions field to date. Low-income countries also tend to exhibit extreme asymmetries in the distribution of power and of knowledge, both often being the privilege of a centralised political and scientific

elite, thus further emphasising the need to attend to politics and power in understanding socio-technical change.

The analysis in this book shows why the ignorance of politics in multiple forms is a fundamental weakness that requires much more attention in future research – and action – in this field. However, rather than seeking to provide the definitive answer to this weakness, we instead use our analysis to emphasise, first, the importance of politics, by showing how it is relevant to explaining the ongoing development of the solar PV market in Kenya. We do this through a close examination of the work done over several decades by key actors who have helped to build a 'socio-technical innovation system' around PV systems, work that is often political as well as technical. In revealing the often political nature of this work, we can take a second step, one that reflects on the implications for both the analysis and governance of action to achieve transformations in sustainable energy access. Important in this regard is this notion of 'key actors', whether they are individuals or organisations. So, to be clear, our aim is to extend the contribution of this book beyond just the articulation and demonstration of a socio-technical innovation system perspective on sustainable energy access. We also want to articulate the importance and implications of attending to the interventions of key actors seeking to realise or build socio-technical innovation systems. However, we are fully cognisant of the fact that our conceptual framework requires further work in this direction. It is here that we begin to make our third step, by outlining what we think a future research agenda could be that would enable us to strengthen the political and governance dimensions of a socio-technical innovation systems framework, both as an analytical and an action-oriented perspective.

Our action-oriented motivation is important because a focus on the work of key actors is of direct relevance to the ambitions of international policy commitments like the UN's Sustainable Energy for All initiative. These commitments imply a need to understand how actors might deliberately intervene to drive 'broad' transformations in sustainable energy access, as opposed to understanding how 'narrow' transitions might evolve (or have evolved) over time (see Stirling 2014, or Stirling 2015a, for a discussion of the distinction). Placing these actors within a systemic perspective on change – one that is assisted by drawing on the Socio-Technical Transitions and Innovation Studies literatures – we refer to such actors as socio-technical innovation system builders. This facilitates close attention to the many international and national actors who seem to play key roles in promoting sustainable energy access in low-income countries, e.g. intergovernmental organisations (IGOs), non-governmental organisations (NGOs), researchers (including us, the authors), private sector actors, technology users, and so on. In myriad ways, they (we) all participate in processes of 'development', change and knowledge co-production and many of them (us) 'move easily between Washington and Addis Ababa, Rome and Bamako' (Keeley and Scoones 2003, p. 163). This raises classic questions of power, legitimacy and distribution: Whose knowledge counts? Who has control over resources? Whose agenda drives change? Who wins? Who loses? Once again, we cannot answer all these questions but we do aim to show that the framework

we develop in this book at least provides a way to analyse these questions and to think about how to address the huge asymmetries in power, knowledge and distribution we have noted.

While we have argued that both the Innovation Studies and Socio-Technical Transitions literatures are lacking in their treatment of politics, there is a handful of papers that make reference to relevant ideas through the notion of systemic intermediaries. In general, intermediaries are actors who work across the boundaries between firms or sectors (Howells 2006; Kivimaa 2014) or between supply-side and demand-side actors (Stewart and Hyysalo 2008), providing a wide range of services to clients in primarily bilateral relationships. For example, an intermediary may be employed by a client organisation to conduct a market survey or technology foresight exercise. Systemic intermediaries differ from this general type in that they 'function primarily in networks and systems … and focus on support at a strategic level' (van Lente *et al.* 2011, p. 39). This systemic function, or strategic focus, resonates with our notion of system builders in the sense that they have the potential to transform socio-technical systems (Marvin *et al.* 2011). But similar notions appear under different terms in other, more specifically Socio-Technical Transitions-oriented, work. Here, they are described as actors who play a role in driving cumulative causation (often borrowing from Political Science ideas such as 'advocacy coalitions' and 'policy entrepreneurs') (Kern 2011); as 'technology advocates' who do socio-political work to empower socio-technical niches, including by constructing actor-networks (Smith and Raven 2012); and 'cosmopolitan actors' who do socio-cognitive work to render technologies more widely applicable and lead to their being used beyond sustainable niches (Deuten 2003). However, so far, only Kivimaa (2014) acknowledges the work of systemic intermediaries as political; indeed, she even argues that it is necessarily so. Significant work, then, needs to be done to develop these threads into a comprehensive theory that explicitly deals with the role of such actors and the political nature of their actions. Moreover, this needs to be clearly situated within a systemic and active perspective of how transformations derive from such actions. It is beyond the scope of this book to complete such work. However, our hope is that at the very least the analysis articulated herein goes some way to bringing the significance of the idea of socio-technical innovation system builders to the foreground of analysis, and also articulates their importance to thinking on policy, practice and governance more broadly.

The structure of this book

We develop our 'Socio-Technical Innovation System' conceptual framework and related concept of 'Socio-Technical Innovation System builders' in subsequent chapters. Chapter 2 focuses on relevant insights from Innovation Studies while Chapter 3 focusses on Socio-Technical Transitions. In Chapter 4 and Chapter 5, we move on to demonstrate how a socio-technical innovation system perspective has more explanatory power in understanding one of the most widely hailed examples

of low carbon energy technology uptake in Africa, namely, the solar PV market in Kenya. This is achieved by analysing an in-depth reconstruction of the history of solar PV in Kenya, based on a combination of over one hundred hours of recorded interview testimony, stakeholder workshops and extended time spent by the authors in the field, both as researchers and practitioners. In Chapter 6, we focus on two classic examples of alternative solar PV policy approaches that have been implemented in Kenya, which respectively rehearse the Hardware Financing and Socio-Technical Innovation System Building framings we characterise in this book. This analysis demonstrates the stark difference in the transformative impact between the two, where the latter has had significantly greater and more rapid impacts than the former.

The analysis in Chapters 4–6 is focussed specifically on solar PV in Kenya and the findings suggest there is an urgent need to conduct more comparative future research across different scales and types of sustainable energy technologies, and different socio-cultural and political contexts. While this research is yet to be done in a way that builds on the analysis in this book, in Chapter 7 we draw on insights from several other pieces of original empirical analysis in Tanzania, India and China – work with which the authors have been involved. This shows how a systemic perspective resonates across these different contexts and, indeed, across other technologies and different points of enquiry across a range from consumer access to technologies (in Kenya and Tanzania) to industrial activity in relation to sustainable energy technologies (in India and China).

Before giving some final thoughts in this Introduction, we should explain the use of capitalisation for some terms that the reader may already have noticed. Building on Hulme (2009), we adopt the convention of using upper-case letters to denote when we are referring to framings and the associated narratives that support them. So, Private Sector Entrepreneurship in upper case denotes the dominant policy framing and associated narratives that portray private sector entrepreneurship as the key to achieving sustainable energy access, whereas private sector entrepreneurship in lower case simply refers to, or describes, an instance of entrepreneurship observed in the private sector. In keeping with this, we also use upper-case letters to denote broad areas of scholarship, which could be considered themselves to be 'frames' in that they each include and exclude different elements according to their particular perspective. So, the use of Socio-Technical Transitions refers to the corresponding literature and scholarship while socio-technical transitions would refer to specific processes of socio-technical change. We hope this provides some clarity in regard to whether we are speaking at any particular point about framings (or area of scholarship) or whether it is in reference to a specific instance of a particular practice or process. Likewise, we use this convention for our own framings in the hope that it creates transparency in regard to our own position.

Towards pro-poor governance of sustainable energy access

The analysis and theoretical approach in this book, as well as the insights for policy and practice, leave as much to be researched and articulated as they provide any

concrete answers to the problem of sustainable energy access. The enormity of the sustainable energy access problem in the Global South is not one that can be solved in one book, nor by any singular prescription for policy and practice. Indeed, even in pursuing the research agenda articulated herein, it is neither our aim nor our desire to achieve any such prescription. Instead, what we hope this book does is to point us in the direction of an approach to the governance of sustainable energy access that embraces the fullest understanding of the notion of sustainability.

Centre stage in this is a concern with social justice and democracy (c.f. Forsyth 2008). If we accept the promise of a systemic perspective on socio-technical change and its relevance for catalysing development that meets the needs of poor countries and poor people, then we also need to consider how we create and nurture supportive institutions and governance structures. For us, this is a call for governance structures and institutions that help to build capabilities, from those at the individual level, such as the kinds of capabilities advocated by Sen (e.g. Sen 1999); to those that are technical and systemic in nature, such as the kinds of capabilities that facilitate technological innovation (e.g. Bell 2012). Simultaneously, these structures and institutions need to foster networks that meaningfully connect different individuals, groups and constituencies at multiple levels (Forsyth 2005; 2007) – connections that enable flourishing and inclusive partnerships in project and programme design, implementation and evaluation (Sovacool and Drupady 2012, p. 295). We offer our concept of Socio-Technical Innovation System Building as a way to realise these goals, an approach that can catalyse change by seeking to understand – across specific but widely varying socio-cultural, political and economic contexts – existing practices, and existing technological strengths and weaknesses, and to build on these through inclusive and reflexive projects, programmes and other interventions.

Of course, even if our approach is accepted in some form, there is still plenty of work to do in order to develop it. We conclude the book, therefore, by offering an agenda for future research, policy and practice in this field. Before doing so – notwithstanding the critiques raised above regarding policy prescription – we do attempt to articulate a concrete policy proposal for how to implement our approach in relation to climate technology interventions; a proposal we have articulated elsewhere (see Ockwell and Byrne 2015), and which we have called Climate Relevant Innovation System Builders (CRIBs). We reiterate the proposal here in order to demonstrate at least one way to operationalise the concepts we develop through the book. It also raises the possibility of thinking about our approach as one that is applicable beyond the specific challenge of sustainable energy access. That is, Socio-Technical Innovation System Building may be relevant to a whole range of sustainability challenges, not just those in the realms of energy access or climate change. Whether our approach has wider applicability or not, it is our hope that the suggestion of a step change in the way we understand sustainable energy access – and the processes of change that will accompany (indeed, are accompanying) the many interventions aimed at driving lower carbon pathways of development – will form the basis for governance processes more directly focussed on, and preoccupied by, empowering and enabling plural voices – in particular, the voices of the poor and marginalised countries and the people therein.

Notes

1 In this book, we are specifically interested in low-income countries, with a particular focus on Sub-Saharan Africa. For ease of reading, the term 'Africa' is sometimes used. In no way is this intended to portray 'Africa' – or indeed 'Sub-Saharan Africa' – as a homogeneous entity. The critical importance of the myriad cultural, historical, political, etc., heterogeneities that characterise different national and sub-national contexts across Africa is central to our perspective. The fact of these heterogeneities forms a key part of our analytical foci and a core component of our argument for the need for a new theoretical framework, based on detailed, comparative analysis within specific contexts in Africa.
2 See www.teslamotors.com/en_GB/presskit
3 For a more detailed treatment of the issue of low carbon technology transfer, see the various contributions in Ockwell and Mallett (2012).
4 Elsewhere we have explored the gender implications of the emerging focus on entrepreneurship for delivering low carbon technological change in terms of reinforcing existing gendered power relations, see Marshall *et al.* (in press).