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Hanlin, Rebecca; Andersen, Margrethe Holm; Lema, Rasmus; Nzila, Charles

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RENEWABLE ELECTRIFICATION AND SUSTAINABLE INDUSTRIALISATION

Rebecca Hanlin, Margrethe Holm Andersen, Rasmus Lema, and Charles Nzila

Abstract

This book argues that debates about renewable electrification must move beyond their predominant focus on access to clean energy. Increased access to electricity makes important contributions to sustainable development but it does not produce the full range of co-benefits which can arise from green energy investments. The book argues that policy makers need to start focusing more heavily on questions of the development of local activities and capabilities in designing, constructing, and operating renewable electricity infrastructure. A key issue is the degree to which sustainable access to clean energy will be sustainable when these renewable energy supply mechanisms are often designed, constructed, operated, and maintained predominantly with foreign equipment, foreign financing, and foreign workers. This is what this book sets out to examine and discuss in the context of green industrialisation discourses. This chapter outlines the background to the sustainable industrialisation debate. It also specifies the objectives and provides an overview of the book and its key themes.

Introduction

There is a wealth of literature which has shown how access to electricity can create new business opportunities and increase economic activities in formerly non-electrified communities (e.g., Peters and Sievert, 2016). This is not the focus of this book. Rather, it is focused overall on the contribution which renewable electrification can make in meeting sustainable industrialisation goals. Renewable electrification includes both the creation of access to electricity to formerly non-electrified communities as well as transformation of existing energy systems with renewables.

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We argue that the debate about the benefits of renewable electrification needs a push. It must move beyond (a) the ability to create sustainable development benefits as a result of increased electricity access and (b) the ability to contribute to climate change mitigation. These are important goals in their own right, but there is a need to include (c) the local economic benefits that can potentially arise from the renewable electrification process itself. The debate needs to start focusing more heavily on questions about the localisation of economic activities and development of local capabilities for designing, constructing, and supplying renewable electrification infrastructure such as solar parks, windfarms, and hybrid grids.

The concern should be not only with distribution of economic activities but also with the learning gains that may arise in connection with these activities. The economic activities involved in renewable electrification are temporal in nature, but the learning gains can have a more lasting effect on the change of economic development paths. Accordingly, we argue that building up capabilities for economic change – or innovation capabilities – constitutes an important missing link in ensuring the transition to a more sustainable development in developing economies. The book brings together new insights on the development of local capabilities and suggests policy measures that can support and accelerate the development of capabilities required for sustainable industrialisation in Kenya and countries facing challenges similar to those of Kenya. Such capabilities are vital for the transformation required at a time when the need for access to electricity for development in low and lower middle-income countries continues to increase while warnings against the potentially disastrous effects of continued high emissions of CO_2 and the need to bring down CO_2 emissions dominate international and domestic debates.

The three main objectives of the book are therefore:

- To establish a new conceptual framework for analysing and understanding linkages between renewable electrification and sustainable industrialisation in developing economies.
- To contribute to the empirical understanding of how capabilities for sustainable industrialisation are being developed (or not) through renewable energy projects in low- and lower middle-income countries in Africa, based on in-depth studies mainly, but not only, from Kenya.
- To contribute to the development of transformative innovation policies, i.e., policies that support green transition in a manner that also takes into consideration aspects of distribution and directions of development.

This introductory chapter creates a backdrop and then sets the scene for the book. First, we introduce key discourses and debates about sustainable industrialisation. Second, we focus on renewable electrification processes and challenges. We then bring these together and outline the key focus of the book by highlighting how renewable electrification may produce 'co-benefits' that may contribute

to sustainable industrialisation processes. Finally, we outline the chapters and key themes of the book.

Sustainable industrialisation

Industrialisation is a process of structural change and traditionally, the term has referred to a shift in the sectoral composition of economies starting from agriculture, moving into manufacturing, and eventually into knowledge-intensive services (Kuznets, 1973; Gabardo, Pereima, and Einloft, 2017). Industrialisation as a result is synonymous with economic development driven by manufacturing and high-value services (Szirmai, Naudé, and Alcorta, 2013). These activities create pathways for developing countries to grow their economies because they provide employment and linkages to other parts of the economy, and they can boost consumption and generate more foreign currency through value-added exports (Opuku and Yan, 2019).

Indeed, it is often argued that African countries have no option but to industrialise through manufacturing (Oyelaran-Oyeyinka and Adesina, 2020) or at least that industry needs to play an essential role in economic development, for example with an increase in agro-industry (Lundvall and Lema 2014).[1] Yet, analysts have increasingly questioned whether current low- and lower middle-income countries can and should develop along pathways similar to those that were historically prevalent in the triad of North America, Europe, and East Asia. Rodrik (2018, p. 17) suggests Africa can only achieve development if it is based on 'a growth model that is different from earlier miracles based on industrialisation' and there is an increasing focus on the possibility for African countries to develop economically through the services sector, without having to go through a manufacturing phase of industrial development (Newfarmer, Page, and Tarp, 2018). As such, there is increasing agreement that economic development may involve some degree of traditional manufacturing activities and agricultural and commodity processing, but may also involve entirely new types of industry and services. The key question that we are concerned with in this book is whether green energy has a role to play in this respect.

Greening of industrial development

The prospects for a new economy are captured by terms such as 'green growth', 'green economy', and 'green industrialisation', which have all been advanced in policy circles. The various terms have been coined and promoted by different agencies, including the World Bank, the UN, and global think tanks as well as national governments.

A key notion in these concepts is that of 'low carbon development', which requires a decoupling of economic growth from environmental impact (United Nations Environment Programme, 2014; Jackson, 2017). In general, green growth concepts focus on the idea of an 'economic development that is based on

sustainable use of non-renewable resources and that fully internalizes environmental costs, including most critically those related to climate change' (Rodrik, 2014, p. 469). This involves the use of 'green technologies', i.e., technologies that have the least possible impact on the environment and are possible through an industrialisation process that is 'green' in process and outcome (UNIDO, 2009; Organisation for Economic Co-operation and Development, 2011; World Bank, 2012).

The term 'green industrialization' as defined by the United Nations Industrial Development Organization (UNIDO, 2009, 2011) is particularly relevant for this book. It defines 'green industrialisation' as having two main dimensions: (a) the greening of industries within themselves; and (b) the creation of green enterprises – i.e., enterprises which offer environmental goods and services. It is this latter dimension which most directly highlights the idea that greening of industrial development is associated with costs, but also with opportunities. But significant questions have remained about the distribution of costs and potential opportunities.

Combining greening and social inclusion

In recent years, the mainstream development discourses have been characterised by explicit attempts to bring environmental and social objectives together with economic development aims. For example, in the run up to the development of the Sustainable Development Goals (SDGs), UNIDO (2014) started using the term 'sustainable industrial development' and has since moved to the term 'inclusive and sustainable industrialisation' (UNIDO, 2017). UNIDO (2017) define this form of industrialisation as including three elements (UNIDO, 2017): (a) creating shared prosperity – offering equal opportunities and an equitable distribution of benefits to all, (b) advancing economic competitiveness, and (c) safeguarding the environment – addressing the need to decouple generated prosperity of industrial activities from excessive natural use and negative environmental impacts.

The discourse has thus shifted from 'green' to multifaceted 'sustainable' industrialisation. Focusing on sustainable industrialisation, according to UNIDO, can provide African countries a way of increasing employment, lowering energy costs, and reducing the pressure on infrastructure in cities as well as ensuring prosperity is shared across all those in society (UNIDO, 2020).

However, despite the widespread use of the term 'sustainable industrialisation' (e.g., Sampath, 2016) there is no agreed or readily available definition of what 'sustainable' means. Or put differently: the term 'sustainable' has been used to denote many different meanings, ranging from environmental sustainability (UN, 1987) to financial sustainability or more broadly the ability to sustain a certain type of production by a firm or existence of a company over a longer period of time. Whichever mode or combination of approaches are pursued, there is strong support for sustainable industrialisation at global level

through the introduction of SDG 9 focused on promoting inclusive and sustainable industrialisation and at a regional level through the African Union's Action Plan for the Accelerated Industrial Development of Africa (African Union, 2021).

In the next chapter we will specify how we take on board the relevant parts of these discourses and define sustainable industrialisation for operational use in our empirical work. Here it suffices to say that while we seek to incorporate the multi-criteria nature of the term, we use it in a more narrow way, which is tailored to our analysis of the process of renewable electrification.

In this book, the general use of the term 'sustainable industrialisation' can be defined broadly as having a double meaning. First, it is *environmentally friendly industrialisation*; or to be more precise, it gives rise to an increase in industrial activities (typically manufacturing and related services, but also e.g., agroindustry or high-value services associated with the digital economy) which do not conflict with the principles of sustainable development as they are commonly defined.[2] Second, it is a type of industrial development which can be *maintained in the long run*; industrial activities are enduring and rooted firmly in the local economy. This also implies contributing to social inclusiveness through creation of jobs and incomes in local communities. In the broad sense, 'sustainable industrialisation' is industrial development, which is sustainable in both the environmental, social, and general sense of the term. Although the book does not have an explicit focus on, e.g., justice and gender equality, it addresses key issues related to how renewable electrification processes may help reduce inequalities, e.g., through provision of local jobs, increased local capabilities, and other co-benefits from renewable energy projects.

Therefore, in this book, we are concerned with a defined subset of sustainable industrial development activities, namely those that contribute directly to the process of restructuring which contribute to green industrialisation (as defined by UNIDO) and to bringing the economy within the planetary boundaries (Rockstrom et al., 2009). Thus, the sustainable industrialisation activities discussed in this book align with low-carbon development objectives, as they are related to strategies that mitigate emissions to avoid dangerous climate change while at the same time achieving economic and social development (Lema, Iizuka and Walz, 2015).

Renewable electrification challenge(s)

We are concerned in this book with how to shape the process of renewable electrification in ways that maximise the contribution to sustainable industrialisation. Before we proceed to outline the research questions, contents, and main themes of the book, it is worthwhile to elaborate on the main drivers of renewable electrification, the context for empirical studies and some of the main capability challenges.

Access to electricity and climate change mitigation

There are currently 1.2 billion people – one in six people – in the world without access to electricity (Rivas Saiz, 2018). The problem is particularly severe in low- and middle-income countries in sub-Saharan Africa. The latest figures (Blimpo and Cosgrove-Davis, 2019) state that 43% of the population of sub-Saharan Africa have access to electricity (half the global access figure of 84%), with access in rural areas a staggeringly low 25%. Ensuring access to electricity thus remains one of the greatest development challenges of our time (Jacobson, 2007; Lay, Ondraczek, and Stoever, 2013).

National governments and multilateral agencies have put in place strategies for creating access to electricity, and today renewable electrification plays an increasingly prominent role. Many of these policy initiatives are framed within the context of the Sustainable Energy for All initiative (SEforALL, 2020) and activities related to SDG 7, which aims to 'Ensure access to affordable, reliable, sustainable and modern energy for all'. While aimed at increasing access, these strategies also have the associated aim of accelerating the transition towards increased use of renewable energy. Such a transition is important because it would help increase the number of people with access to electricity but also because it may help stabilise production and delivery of energy (IRENA, IEA and REN21, 2018) and last but not least because of the current warnings about the need to reduce worldwide CO_2 emissions (IPCC, 2018).

Context: East Africa and Kenya specifically

The East African Community (EAC) states are rich in renewable energy resources such as solar, wind, hydro, biomass, and geothermal energy. A large proportion of this potential remains untapped, yet it can be efficiently exploited to boost the generation of energy and cope with the strong load growth besides enhancing electrification of the partner states. All EAC partner states have adopted quite promising electricity access targets whereby the goals by Kenya and Uganda to achieve 100% access to grid-connected power by 2030 and 2040 respectively are regarded as the most ambitious in the East Africa region. These targets require a paradigm shift, since notwithstanding their impressive outlook, they do raise rather pertinent capability questions as well as whether achieving them is both realistic and possible considering the past trends.

Of all these East African countries, Kenya, with 90% of its energy mix sourced from renewable energies (Reuters, 2019), is clearly a country to watch: it is at the forefront of ensuring increased supply of electricity to a growing population using renewable energy. Meanwhile, the country still faces many of the same challenges faced by other low- and lower middle-income countries.

As with other countries in sub-Saharan Africa, Kenya faces the challenge of increasing demand for modern energy services in the face of its high population growth. In 2000 only 15% of the Kenyan population had access to electricity,

by 2013 this had raised considerably. Figures from 2018 indicate that access to energy in Kenya may have increased to 75% which places it well above average for sub-Saharan Africa which was 47.7% (World Bank, 2020).

The increased percentages in energy access relate to implementation of various national electrification projects undertaken by Kenya Power Authorities such as the Last Mile Connectivity Project and the Global Partnership on Output-Based Aid (GPOBA) slum electrification project. Many of the newly connected households have a low level of energy consumption, however (two units on average per month), and by March 2017 many newly connected households were reported as not yet having used the pre-loaded units that come with the meter when installed (Kenya Power and Lighting Company, 2017). This indicates that having access to electricity (being formally connected) and having the need for electricity and/or the resources to pay for electricity used from the national grid may not be the same.

Kenya Vision 2030 (2008) identifies energy as key in achieving its goals for economic development and poverty alleviation. The more recent Big Four Agenda of the Kenyan Government emphasises the importance of intensifying energy diversification, promoting transition from traditional fuels to modern sources of fuels, adopting energy efficiency technologies, promoting off-grid options, and attaining a more efficient energy mix with a reduced share of thermal power generation as critical ways forward (KIPPRA, 2018). Vision 2030 estimates that for Kenya to achieve its goal, its electricity generation must grow from the current level of 1,500 MW to 19,200 MW by 2030. In 2019, Kenya's installed electricity capacity was 2,818.9 MW (KNBS, 2020).

To increase electrification and adapt to climate changes, Kenya's Energy Act of 2019 (and the previous 2006 Act) strongly emphasises development of other renewable energy sources to diversify the national energy mix. Among the renewable energy sources given high priority are solar and wind, but these sources of energy still only represent a small fraction of installed capacity produced through renewable energy. The proportion of electricity generation by source in 2019 shows that geothermal remains the major source of electricity in Kenya accounting to 45% of total generation (hydro 28%, wind 13%, thermal oil 11%, and others 3%). Wind generation rose from 375.6 GWh in 2018 to 1,562.7 GWh in 2019 following full operationalisation of the Lake Turkana Wind Power Plant, becoming the third largest source of electricity generation in 2019. Solar generation increased from 13.7 GWh in 2018 to 92.3 GWh in 2019, attributed to the commissioning of the Garissa Solar Power Plant (KNBS, 2020).

The renewable electrification process, localisation, and capabilities

Traditionally, much of the physical technology, skills, knowledge, and companies involved in renewable energy projects in Africa have been bought from outside. While this has changed from always being from developed to developing

country (e.g., German solar panels to Kenya), the rise of manufacturing capabilities in the so-called BRICS (Brazil, Russia, India, China, and South Africa) implies there is now also increasing South-South technology transfer. In any case, 'technology transfer' is a complex issue (Ockwell and Mallett, 2013). It relates to a much bigger issue relating to the degree to which countries should rely on external technology or develop their own local innovation capabilities (Baker and Savacool, 2017). However, without local capabilities, there is a big risk that renewable electrification remains overly dependent on external actors and hence does not become sustainable – and a big risk that the possible benefits in terms of increased local employment, local content, and new business opportunities are not realised. This, of course, is a risk of missed economic opportunities in the short run, but also a risk of not gaining experience from engagement in these activities for the purpose of better local anchoring of future activities.

In fact, it is possible to see the capabilities that are needed and built through interaction of renewable energy plants at various stages of the production and deployment of renewable energy solutions. There are capabilities required in manufacturing core technology and parts for the plants themselves (whether these are wind turbine blades or solar panels, or the cement, nuts, and bolts needed to fix the turbines and panels). Then there are capabilities related to the construction, operation, and maintenance of a renewable electrification plant. These are not just construction level capabilities, but also important planning and financing capabilities. The operation and maintenance of the plants once commissioned also require particular capabilities as does the distribution of the power to the consumer for their consumption.

More concretely, capabilities can be built in the design, build, and operation (DBO) of solar, wind, and other renewable energy plants. The capabilities that are built are not just those for individuals and firms directly involved in the DBO of renewable energy plants but include allied supplier firms and their individuals as well. This is because firms directly involved in renewable energy plant DBO activities rely on others, for example to provide supplies and transport of those supplies, to conduct outsourced work, such as initial ground clearance, and to provide support facilities.

The renewable electrification process and potential co-benefits

This book discusses the potential of using renewable electricity expansion and transition efforts to contribute to future and wider sustainable industrial development aims. We are interested in sustainable industrialisation through electrification that is not only green but is also more durable and more inclusive (see above). A key element of inclusivity is around who is involved and how they are involved in the electrification process, and durability relates to the nature of capabilities i.e., whether they are sufficiently rooted and relevant for subsequent activities in the sustainable development process.

In order to dissect and specify these aims, we draw on vocabulary from the multilateral policy arena and focus on 'co-benefits'. In the broadest sense, these are the positive benefits related to the reduction of greenhouse gases (IPCC 201?). More concretely, mitigation with green energy, such as renewable electrification, can have a range of additional benefits. For example, a key environmental co-benefit is the reduction of air pollution. Economic co-benefits are manifold and include, for instance, the reduction of costly energy imports. However, we limit our focus to what we see as the most important co-benefits when it comes to sustainable industrialisation: localised economic activity and capability-building. As mentioned above, in key policy discussions these benefits tend to be overshadowed by the emphasis on local benefits that arise from access to clean energy.

As such, the argument and focus of this book can be illustrated through Figure 1.1. The figure shows that renewable electrification, in addition to the reduction of carbon emissions, creates the primary benefit of increased electricity production. In turn, this allows for the development of new businesses and improved productivity, potentially in high productivity growth industries such as manufacturing and high-value services. It creates new access in formerly non-electrified communities, which can enable various forms of production and services. These outcomes are illustrated by arrows at the top of the diagram in Figure 1.1. We seek to emphasise the potential industrial gains available through the *process* of renewable electrification. This is essentially a process of creating and installing new green energy infrastructure. We argue that this process provides important opportunities to derive activities and capabilities that are highly relevant to sustainable industrialisation. These are the arrows at the bottom of the diagram in Figure 1.1.

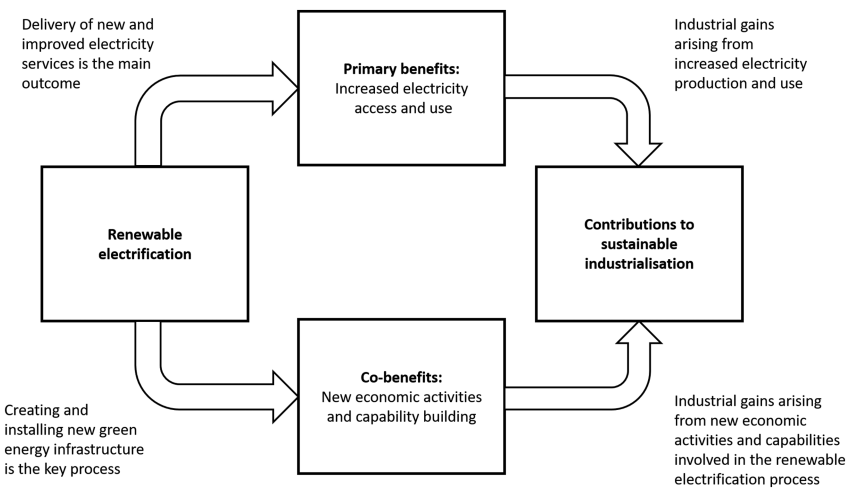

FIGURE 1.1 The importance of co-benefits. *Source: authors.*

This book focuses on how renewable electrification processes can be shaped in ways that maximise their contribution to sustainable industrialisation. It does this by analysing the technological capability-building in the wind and solar renewable energy sub-sectors in Kenya with the inclusion of some cases from other countries in East Africa.

Outline of the book

The book starts by presenting a conceptual framework for understanding and analysing renewable electrification processes with specific emphasis on learning processes at different levels, development of (technological) capabilities, and outcomes in the form of capabilities that enable increased employment, local content, and business opportunities (Andersen and Lema, 2022; this volume).

The book subsequently presents a number of case studies and insights into how the systems of production and learning of solar and wind energy in Kenya (and a few other African countries, i.e., Tanzania and Ethiopia) are developing and how capabilities for renewable electrification are being built (or not). It includes examples of how international linkages influence such processes and presents insights on how policies for renewable electrification and green transformation in Kenya may be shaped to help foster the desired development.

Drawing on selected case studies, including a number of projects in Kenya, using transition theory, the book discusses the successes and failures of diffusion of renewable energy for rural transformation (Mbeo et al., 2022; this volume).

Disaggregating sectoral systems of production and innovation in renewable electrification pathways, Hansen et al. (2022; this volume) argue that 'size' is an important determinant of the appropriateness of renewable energy technological trajectories in sub-Saharan Africa. Distinguishing between small-scale (mini-grids) and large-scale (grid-connected) deployment paths in renewable energy, they find that innovation and diffusion dynamics differ more between small and large than between wind and solar.

In the following chapter the use and application of the Technological Innovation Systems (TIS) framework to analyse the Small Wind Turbine (SWT) innovation system in Kenya is presented (Wandera, 2022; this volume). While many studies have been conducted on the diffusion of SWT in developed countries, relatively fewer studies on this topic have been conducted in developing countries, especially in East Africa.

Based on a survey of existing renewable electrification projects in Kenya (Nzila and Korir, 2022; this volume) and on research into a selected number of renewable energy projects deemed critical for the understanding of how the project level (design and processes) influences the up-take of renewable energy (Hanlin and Okemwa, 2022; this volume), the book presents insights into the current status of capabilities for renewable electrification in Kenya.

The book further investigates how 'learning from importing' of renewable energy products and services may help build local capabilities for renewable

electrification, placing particular emphasis on governance structures and knowledge-exchanges between buyers (in Kenya) and lead firm suppliers in more advanced economies. Lessons on the creation of 'learning spaces' in the Lake Turkana Wind Project (Kenya) and the Adama Wind Project (Ethiopia) (Gregersen and Gregersen, 2022; this volume) are presented along with lessons on capability development and accumulation of innovative capabilities in off-grid solar energy companies in Kenya and Tanzania (Karjalainen and Byrne, 2022; this volume).

The role of South-South technology collaboration in renewable energy is investigated with the purpose to explore to what extent and under what conditions renewable investments have economic co-benefits in terms of spill-overs and linkage development effects. One peculiarity of African renewable energy sectors is the rapid increase and likely future growth of Chinese involvement in large-scale renewable energy projects. We investigate to what extent economic co-benefits arise when Chinese investors develop renewable energy projects (Bhamidipati et al., 2022; this volume).

The book includes a chapter focused on Kenyan energy policies and legislation, including the increasing attention to local content issues that are closely linked to discussions regarding development of local capabilities. In light of current discussions about the need for building capabilities to ensure a green and sustainable development path in developing economies and the need for more emphasis on transformative innovation policies, we look at stakeholders' perspectives on local content requirements (Kingiri and Okemwa, 2022; this volume).

Finally, the book concludes by providing an overall assessment of successes and challenges in developing capabilities required for renewable electrification in Kenya and other countries with similar characteristics regarding electrification and/or engineering, design, and project management capabilities. Based on this assessment, the book offers suggestions for key stakeholders, such as universities, private sector actors, and policy makers (both domestic and foreign) in how to capitalise on the opportunities available for capability-building and industrial development through renewable electrification. Implications for pathways to transition to a green and low-carbon development are a key focus area of this chapter. Furthermore, the chapter suggests a number of outstanding questions and issues that would warrant future research (Lema et al., 2022; this volume).

Key themes in the book

As mentioned, the key overriding topic throughout the book is how to shape the development of renewable energy pathways to maximise co-benefits in terms of sustainable industrialisation through development of a broad range of (industrial) capabilities. In considering the role of learning and capabilities in supporting innovation in the renewable electrification sector in Africa, this book highlights three key themes or future research areas that need more attention. We come back to these in the final chapter.

Project design, organisation, and linkages

Renewable electrification activities – their design and construction – are most often conducted as 'projects'. These projects may have highly differentiated 'anatomies' which in turn may create different types and degrees of co-benefits. In this book we ask questions about the degree to which local actors are involved in renewable electrification projects. How much 'local content' is provided and where in the project is it located? Are local actors providing mission critical inputs, or inputs which are strategically less important? We also ask questions such as which linkages are involved, what is the nature of linkages between local and foreign actors, and to what extent do they include elements of knowledge transfer and capacity-building? To what extent (if at all) are issues of local content and capability-building reflected in upfront project planning, and are policies in place to facilitate their realisation?

Deployment model and choice of technology

The different natures that projects take may reflect wider 'modes' of renewable electrification. With regards to the type or shape of the technology, it is about whether renewable energy is produced in a centralised manner for 'the grid' (i.e., is used to power a set of households or businesses, often through a national power provider) or whether renewable energy is being used to power homes and businesses 'off-grid', i.e., in a decentralised and independent manner. It also relates to the importance of the type and size of the technology being used. Size of technology relates to small or large-scale projects or plants.

Predominantly, in the countries we look at in this book, small scale tends to be more off-grid in technology choice while on-grid tends to be more large scale.[3] In this book, we investigate how such characteristics matter for the associated (potential) opportunities for local industrial activity and capability-building in and around the project. We attempt to answer the following questions around the location of learning and capabilities building: what are the patterns of learning, capabilities, and outcomes across large and small-scale deployment models? How do such patterns differ between different renewable energy technologies such as wind and solar PV?

Policies and political actors at the national and global level

We consider in this book the degree to which global policies and schemes may influence renewable electrification at the local level, e.g., as development banks, donor agencies, and other political actors get involved in financing. Energy policies at the national and local level are obviously important, but the nature of the electrification process is also influenced by industrial and trade policy, educational policy, etc. A key broad proposition for this book is that deliberate and active policies are required for renewable electrification to contribute

to sustainable industrialisation. Such benefits do not (necessarily) emerge as a fortunate by-product of renewable electrification; they are likely to be absent or very constrained unless they are specifically planned for in local or global policies. Thus, the chapters in this book look at the following questions: what are the main policy areas which influence learning and capability development for sustainable industrialisation (e.g., energy, industry, trade policy, etc.)? To what extent are deliberate policies implemented to facilitate capability development in this field? What opportunities and obstacles are important for ensuring optimal learning and capability development in renewable energy projects?

In summary

Through the key themes outlined above, this book engages substantially with debates about directions of development by examining distinct pathways of electrification with differing transformative potentials when it comes to wider benefits (beyond electricity) from electrification processes. We are particularly focused on looking at the processes of change – how pathways evolve over time (Leach et al., 2010). The case studies and chapters in this book investigate how the system of actors and technologies changes and adapts over time in response to events, new actors' entry, changes in policy, and technology. We focus, more specifically, on how policies on electrification and related policies on local content, certification of electrical contractors, etc. lead to specific dynamics in the system that lead to particular technological pathways and/or lock-in to certain types of actors and processes. We also focus on the relationship between different technologies and how the actors interact with them as well as how system dynamics are changed by these interactions. Many of the chapters consider how inclusion in these systems leads to greater or lesser opportunities for inclusion of local actors in 'the system' – whether this is at an infrastructure project level; at the level of 'renewable electrification' as a sectoral system of innovation; or at the level of 'industrialisation debates' nationally, at county level, or at community level. They discuss to different extents what this inclusion means in terms of skills development, employability, and long-term opportunities for business. We are interested therefore in both 'green and just transformations' (Scoones, Leach, and Newell, 2015).

The book thus addresses local sustainable industrialisation 'outcomes' arising from renewable electrification processes and examines underlying explanatory factors such as the 'social choice' underlying particular directionalities in techno-economic progress and associated circumstances such as unequal distribution of technological capability and economic power between different actors and change agents.

To ensure increased integration of renewable energy in the electrification processes in Kenya and other developing economies, the development of local capabilities of various kinds are key. This book focuses on innovation capabilities – by which we mean both technological and other types of capabilities related, e.g., to

evaluating the social, financial, and technical feasibility of different projects as well as planning, implementation, operation, and maintenance. In terms of technological capabilities, both capabilities to use and operate given forms of technologies in a specific context and capabilities to create and implement innovations in production to change the forms and configurations of current technologies are important.

By explicitly focusing on the early experience gained regarding capability-building in renewable energy projects in an African context and the provision of new primary data collected through both quantitative surveys and qualitative studies of selected renewable energy projects, the book contributes to setting a new direction of future innovation and industrialisation policies and practices, while taking into consideration issues of diversity and distribution of benefits in the renewable electrification processes.

Theoretically, we combine research fields (notably development studies, business and strategic management studies, innovation studies, and global value chain thinking) that are rarely combined. As many of the green technology value chains are highly globalised, we find that this unique combination contributes to a better understanding of ongoing renewable electrification processes and better opportunities for identification of policies that can effectively support development of capabilities for sustainable industrialisation.

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Notes

1 As such, Naudé (2019) argues that African countries have three different options for industrialisation. First, '*acquiring traditional manufacturing capabilities*', i.e., classical movement from agriculture to manufacturing over time. Second, '*fostering sectors with the characteristics of manufacturing*' or movement towards industrialisation through service sector (ICT, finance, tourism, etc.). Third, '*resurgent entrepreneurship-led industrialisation*' which is about development of niche high-productivity growth businesses, e.g., manufacturing parts of 3D printers or the aviation industry.
2 Sustainable development meets the needs of the present without compromising the needs of future (WCED, 1987).
3 This may be changing as more companies, for example in Kenya, are now installing their own medium-sized solar PV systems to reduce their dependency on the national grid.

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