



Policy mixes for business model innovation: The case of off-grid energy for sustainable development in sub-Saharan Africa

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ABSTRACT

Business model innovation (BMI) is often complementary to technological innovation and offers novel and sustainable value creation opportunities. Enabling BMI through policy is difficult, however, and not yet well understood in practice or theory. We build on the quickly evolving literature on policy mixes to develop a theoretical model which explains how policy strategies and instruments shape the conditions for BMI. We derive the model inductively by studying the emergence of an off-grid renewable energy BMI in sub-Saharan Africa which proposes to actively create sustainable development in rural areas as opposed to merely increase energy access, drawing from 61 interviews with companies and industry experts as well as policy documents across six African countries. Our model has three core theoretical implications. First, focusing on policy strategies, policy instruments and their respective interactions, we uncover a set of mechanisms that explain how policy mix elements combine to create conducive conditions for BMI. Second, we shed light on the role of multiple objectives and goals within a policy mix for fostering BMI, which, if balanced appropriately, can create a productive tension between support and constraints. Third, we suggest the distinction between sector-specific and society-wide policy mixes as an analytical tool to study these tensions in policy mix research.

1. Introduction

Business model innovation (BMI) is often complementary to technological innovation (Baden-Fuller and Haefliger, 2013), and is capable of supporting disruption across sectors through connecting multiple technologies in ways that create value (Johnstone et al., 2020). Complex forms of BMI, where substantial change is evident across the business model's (BM) value proposition, value capture approach and value networks (Foss and Saebi, 2017), are becoming prevalent in different systems change and sustainability transition contexts, but often struggle to diffuse widely. For example, new BMs for energy and mobility services have emerged but have struggled to disrupt incumbent models of value creation (Bohnsack et al., 2014; Cohen and Kietzmann, 2014; Hall et al., 2020). This challenge has led to a growing focus on understanding the role of policy in supporting BMI. Several contributions demonstrate that policy is important in influencing whether BMI is able to disrupt incumbent BMs (Bidmon and Knab, 2018; Wainstein and Bumpus, 2016; Wesseling et al., 2020), and that specific policy instruments can be

important in supporting or hindering BMI (Huijben et al., 2016).

To our knowledge, however, this connection between policy and BMI remains underdeveloped, both in the transitions literature (Bidmon and Knab, 2018) as well as in the wider management literature (Foss and Saebi, 2017). Specifically, no study has analysed the mechanisms through which policies support BMI. Our main research question is thus how the combination of policy strategies and instruments can create conducive conditions for complex BMI. We argue that the concept of policy mixes (Flanagan et al., 2011; Rogge and Reichardt, 2016) can help to provide a much-needed theoretical foundation to understand the structural conditions for complex BMI. The policy mix literature, which identifies policy strategies and instruments as two key elements, has provided rich empirical and theoretical insights for other forms of innovation (Flanagan et al., 2011; Rogge, 2019; Rogge and Reichardt, 2016). At the same time, due to the nature of BMI as a form of innovation that has the potential to embed new technologies in complex systems, we argue that studying BMI can help to address two key limitations of the extant policy mix literature. First, although the policy mix concept

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emerged as a means of understanding the interactions between policies, there has been limited empirical research on how the presence of multiple policy objectives affects innovation. Second, and relatedly, the empirical policy mix literature has mostly focused attention on the interactions and potential tensions within instrument mixes, and not on the interactions between policy strategies and instruments.

Our empirical setting of off-grid energy in sub-Saharan Africa (SSA) allows us to study a complex BMI as it simultaneously emerges in some policy contexts and does not in others. This enables us to develop a theoretical model explaining how policy mixes shape the structural conditions for complex BMI. The complex BMI we focus on in SSA challenges existing approaches to value creation by opening new opportunities beyond a single sector. We observe companies in certain countries expanding their value propositions from merely providing energy access to offering multiple electricity-enabled services which simultaneously tackle several UN Sustainable Development Goals (SDGs) (Fuso Nerini et al., 2018; Trotter, 2021). Doing so changed the way value was captured and deepened the value networks required to deliver different types of value to rural communities. By analysing BMI across policy contexts, we contribute to theory in three ways. First, we identify the mechanisms that connect policy mixes with BMI. Second, by arguing that maintaining a productive tension between sector-specific and society-wide policy mixes generally, and different policy objectives specifically, enables complex BMI, we expand the conception of balance beyond instrument mixes. Third, we posit that the distinction between sector-specific and society-wide policy mixes enables the explicit analysis of multiple types of policy objectives, supporting recent calls for more research in this area (Edmondson et al., 2019; Kanger et al., 2020; Mayer, 2021).

2. Background

To our knowledge, the connection between policy mixes and BMI has not yet been explored. In order to address our research question of how policy mixes shape the conditions for BMI, we first review the literature on policy mixes and innovation. We focus on the connections between policy strategies and instruments because these connections are particularly important in guiding innovation towards systems change and have received limited empirical attention to date (Kanger et al., 2020). We then introduce BMI as a complementary but distinct form of innovation and develop initial insights on how policy mixes might affect the conditions particularly for complex BMI given these characteristics. We adopt a holistic perspective that investigates the impact of policy mixes on all dimensions of a BM from value proposition to value capture and value networks.

2.1. Policy mixes and innovation

It is increasingly understood that a mix of policies is required to support innovation outcomes that encourage sustainability transitions and benefit society (Edmondson et al., 2019; Kanger et al., 2020; Schot and Steinmueller, 2018). The policy mix concept emerged in the context of economic policy in the 1960s, where the mix referred to the combination of fiscal and monetary policies required to maximise a country's growth and minimise unemployment (Flanagan et al., 2011). Up to the end of the 1990s innovation policy was mostly concentrated on pushing supply for new technologies largely through supporting R&D (Anadón, 2012; Schot and Steinmueller, 2018). But since the early 2000s, many governments have expanded their focus to accelerate the deployment of new sustainable technologies through the use of demand-pull policies including technology and product standards, and feed-in tariffs (Anadón, 2012). The expansion of innovation policy typologies, the broadening of purpose beyond innovation per se, and examining the role of different policies in pursuit of sustainability, have spawned rich theoretical and empirical conversations about the effects of interactions within policy mixes (Flanagan et al., 2011; Kivimaa and Kern, 2016; Rogge and Reichardt, 2016). A central part of these conversations has

been the development of conceptions of policy mixes that go beyond mixes of instruments. Flanagan et al. (Flanagan et al., 2011) for example argue that it is the way in which instruments are embedded and connected to overarching "policy rationales" that often lead to tensions or conflicts in a policy mix. This distinction between instrument mixes and overarching objectives is developed further by Rogge and Reichardt (2016) who identify three main building blocks for the policy mix concept: elements, policy processes and characteristics. We focus on the two main elements of a policy mix: first, the policy strategy which is the "combination of policy objectives and the principal plans for achieving them"; and second, the instrument mix which constitutes "the concrete tools to achieve overarching objectives" (Rogge and Reichardt, 2016). Although the literature is not entirely consistent on the use of different terms, we have chosen to follow Rogge and Reichardt (2016) who refer to objectives as being connected with a policy strategy, whereas goals relate to specific instruments¹.

Despite the conceptual prominence of combining policy strategy and instrument analyses in the policy mix literature, we identify two associated knowledge gaps on how policy mixes influence innovation, namely the effects of (1) the presence of multiple policy objectives, and (2) the tensions that arise from interactions between policy strategies and instruments.

Firstly, we argue that there is a limited understanding of the implications of interactions between multiple and at times conflicting policy objectives for innovation. While the empirical literature has focused explicitly on instrument mixes, particularly in the context of environmental policy and sustainable technologies (Kemp and Pontoglio, 2011; Rosenow et al., 2017), policy strategies are particularly important in contexts with multiple policy objectives and for types of innovation such as BMI that embed new technologies within systems, where the overarching purpose guiding innovation is critical (Schot and Steinmueller, 2018). Policy strategies provide a vision for the future within which different technologies or combinations of technologies and practices can be imagined. For innovation, this creation of space and possibility stimulates a long-term perspective by encouraging a search for new solutions (Kivimaa and Kern, 2016; Schmidt et al., 2012). For example, Rogge et al. (2011) highlight the role of climate targets, an example of a policy strategy, in providing visions of the future. Although these visions are not always connected to individual decisions, they are critical in providing a foundation for changing mindsets and hence influencing the space within which corporate innovation strategies are developed. They also set expectations for example about the stringency and enduring nature of regulations, factors that have been found to be particularly important for RD&D where there is high uncertainty about outcomes compared to decisions around technology adoption (Schmidt et al., 2012).

Policy strategies often address multiple policy objectives at different levels of abstraction (Howlett, 2009). For example, long-term targets for climate policy, renewables and specific technologies interact and can reinforce each other by providing signs of a growing market (Reichardt and Rogge, 2016). These interactions embody tensions, however, which are not yet well understood and at the same time are particularly relevant for innovation at the intersection of multiple sectors. For example,

¹ We made a pragmatic choice for this paper to align our use of terminology with Rogge and Reichardt 2016 to simplify and clarify the boundaries of our empirical analysis. We thank one of our anonymous reviewers for pushing us to engage deeply with the different use of terms such as goals, objectives, rationales in the literature and would like to encourage continued reflection on the use of these terms. Specifically, there are recent examples where the term 'goals' represents a more abstract concept than objectives, e.g. Kanger et al. 2020. Goal in this case refers to the direction of socio-technical change. We would argue that there is an opportunity to develop conceptual clarity on the different levels of abstraction for terms that go to the heart of guiding policy mixes towards their destination.

innovation related to the transition to a bioeconomy involves both energy and manufacturing sectors and has been addressed in different ways by policy strategies across countries in Europe. Connecting these policy strategies can be advantageous, however diversity across countries has been found to encourage experimentation (Imbert et al., 2017). In the context of zero-carbon homes, Edmondson et al., (2020) identify the dual nature of the policy strategy as “stretch and conform”, combining the tension inherent within policy strategies, namely the need to provide space for opportunity but at the same time clearly delineate the direction of travel. These recent examples demonstrate the potential for policy strategies to provide bridges across sectors and systems. The empirical policy mix literature has however largely been confined to single policy domains, paying little attention to broader objectives of social welfare, economic growth or equity of development (Rogge and Schleich, 2018; Uyarra et al., 2016), or has focused on specific niches within regimes using the language of transitions (Edmondson et al., 2019; Kanger et al., 2020).

Secondly, the implications of interactions between policy strategies and instruments for innovation have received limited attention empirically, despite the potential for tensions to emerge at this intersection. The instruments within a policy mix, often studied in isolation, target the different problems preventing innovation. Technology-push instruments such as R&D grants attempt to reduce the costs of innovation and enable learning by doing (Guerzoni and Raiteri, 2015). Demand-pull instruments aim to enhance expectations about new markets to emerge and grow, for example by increasing profits through providing feed-in tariffs or public procurement contracts that change the relative profitability of different technologies (Costantini et al., 2017; Hoppmann et al., 2013; Kivimaa and Kern, 2016). Systemic instruments ensure that an infrastructure is in place within which demand-pull and technology-push instruments can be reinforced (Costantini et al., 2017; Rogge and Reichardt, 2016; Smits and Kuhlmann, 2004), and provide incentives for collaboration (Cantner et al., 2016; Falcone et al., 2019). Combining these instruments in ways that enable innovation can be difficult to implement in practice and to study empirically. The concept of balance between technology-push and demand-pull instruments has been highlighted by several authors as a way of conceptualising and measuring interactions between instruments (Borrás and Edquist, 2013; Costantini et al., 2017; Guerzoni and Raiteri, 2015; Schmidt and Sewerin, 2019), building on extensive case study research on instrument mixes for environmental policy (OECD, 2007). A balance measured in terms of the similarity of demand-pull and technology-push instrument intensity has been found to positively impact energy efficiency innovations (Costantini et al., 2017).

Policy strategies, by their nature, are usually translated into instruments. The consistency between strategies and supporting instruments is important for innovation and is key to the credibility of policy strategies (Schmidt et al., 2012). However, the literature has produced mixed results with respect to this consistency. Its effects may depend on the technology and type of innovation, but the underlying mechanisms are not well understood. For example, in the case of biogas, there is evidence of positive effects stemming from policy inconsistency for entrepreneurial experimentation but not for diffusion (Makkonen et al., 2015). The authors find that the presence of a policy strategy with a lack of supporting instruments can sometimes encourage broad search. On the other hand, mismatches between the objectives of a policy strategy and respective instruments can lead to negative outcomes for innovation activities. For example, in the case of zero-carbon homes the credibility of long-term targets fell due to changes in the stringency of standards for demonstration projects (Edmondson et al., 2020). Finally, in the context of climate policy, even though there have been weaknesses in individual instruments such as the EU ETS, it is the combination of the EU ETS with long-term targets that has supported structural changes in the electricity industry (Rogge et al., 2011; Schmidt et al., 2012).

In summary, while there is a growing understanding for how policy

mixes foster innovation, we argue that there has been limited explicit analysis of a broad set of policy objectives, as well as the nature and effect of the interactions between policy strategies and instruments informed by these objectives. As policy mix researchers grapple with ways to study effects not only for individual technologies but for systems as a whole (Kanger et al., 2020), we argue in the subsequent section that BMI offers an underutilised opportunity to analyse structural conditions for innovation in the presence of multiple overarching objectives.

2.2. Policy mixes and business model innovation

BMI is complementary to but distinct from product, process and organisational innovation (Baden-Fuller and Haefliger, 2013; Zott et al., 2011), and offers potential to connect across different sectors and systems by reconceptualising value (Bolton and Hannon, 2016; Johnstone et al., 2020). Connections between BM and technological innovation are relevant at different stages of the innovation process from invention through to diffusion and adoption. The BM forms the architecture around product and process innovations because it deals with fundamental questions about value creation (Markides, 2006). At both early and late technology development and diffusion stages, focusing on BMI can inform the role of users for developing technologies (Baden-Fuller and Haefliger, 2013) and help guide technologies towards addressing their needs. A focus on BMI can also help to identify systems of complementary technologies, activities and actors required to create value and to transform systems such as energy, mobility or food (Foray et al., 2012; Weber and Rohracher, 2012).

Two key systemic BM characteristics thus lend themselves to supporting technological innovation and, we argue, are likely to shape the policy mixes required. First, the concept of value is core to the BM, encouraging a focus on stakeholder needs. Ultimately, the three core components of a BM - the value proposition, value capture and value networks - combine to create value (Bocken et al., 2014; Bohnsack et al., 2014; Foss and Saebi, 2017; Teece, 2010; Wesseling et al., 2020; Zott et al., 2011). The value proposition defines the type of value being created and the purpose of the BM, value capture describes how customer needs are translated into profitable opportunities, and the value network comprises the interactions with actors beyond the firm required for delivering value. Different approaches to value creation offer opportunities for stakeholder needs to be integrated in novel ways. Second, BMs allow for value creation activities to be studied holistically, placing focal firms within a system of customers, suppliers and public or private partners. Changes in value creation have implications for the connections between actors within the system. Re-thinking the architecture of these connections offers opportunities for embedding the products and services of a focal firm, thereby creating a foundation for sustainable competitive advantage (Zott and Amit, 2010) and for expanding value creation beyond its economic form (Massa and Tucci, 2014).

As with other forms of innovation, there are different degrees of BMI ranging from incremental changes in a single BM component to radical changes in the entire architecture of the BM. In the case of mobility for example, BMs that focus on delivering functionality rather than ownership require a new value proposition that refocuses on services rather than ownership, new arrangements for customers to pay for service use, and new types of networks to connect different users of shared physical resources (Bocken et al., 2014). While some authors have focused on changes in one or two BM components (Huijben et al., 2016), there is a growing understanding that changes across all three BM components, termed ‘complex’ BMI by Foss and Saebi (2017), are required to support sustainable innovation by addressing the core challenges new technologies pose to existing ways of doing business (Anderson and Kupp, 2008; Bidmon and Knab, 2018; Bocken et al., 2014; Sanchez and Ricart, 2010; Schaltegger et al., 2016).

To study how policy mixes shape the conditions for BMI, we contribute to the literature by focusing specifically on complex BMI. The two systemic characteristics of (1) focusing on needs and (2) embedding

technologies in wider systems are easily observable in complex BMIs. They also provide insights on why it is important to consider value proposition, value capture and value networks holistically, why policy intervention is required and how policy mixes operate. First, considering the needs of users and other stakeholders is likely to require transcending individual systems or sectors and connecting with underlying societal objectives. Complex BMI offers opportunities for engaging with customers in novel ways, but without policy intervention, the most vulnerable customers are at risk of being excluded (Hall et al., 2021), and there can be delays in engaging with local actors in the process of BMI development (Bolton and Hannon, 2016). Second, complex BMI often involves connections between complementary technologies and serves as a means of creating value through changes in value proposition, value capture and value networks. These connections between technologies are not new, but they have become more intense due to the proliferation of advanced information, communication, and platform technologies (Baden-Fuller and Haefliger, 2013). Policy mixes that build connections between sectors and between actors can address this complexity, both via policy strategies that frame the problems to be addressed by new technologies, and via instruments, for instance supporting collaborative initiatives to accelerate changes in value networks. In summary, policy mixes for complex BMI are likely to require careful consideration of the interactions between policy objectives and how these are translated into policy strategies and instruments. Studying the conditions for complex BMI thus allows us to shed light on the mechanisms required to foster innovation in ways that meet multiple objectives.

3. Methods and data

3.1. Empirical setting and sample

Due to the limited theory and empirical evidence on the relationship between policy and BMI, we conduct a theory-building, multiple-case study (Eisenhardt and Graebner, 2007). Our empirical context of off-grid energy in different countries in SSA is particularly well suited to studying how policies create conducive conditions for BMI for three reasons, namely (1) its greatly understudied nature despite a strong salience of multiple policy objectives, (2) the ability to observe a complex BMI while it is emerging, and (3) the simultaneous (non-)emergence of aspects of this complex BMI in different countries with different policy mixes. Firstly, the African context has been largely neglected in empirical studies of both policy mixes and BMI, yet it offers rich empirical grounds to generalise to value propositions that address multiple salient policy objectives as companies operate in a context defined by the pressing need for and policy focus on rapid socio-economic development. The majority of countries in SSA, and among them the six countries Ghana, Nigeria, Uganda, Sierra Leone, Tanzania and Zambia we study in this paper, have considerable electricity access and sustainable development gaps (Table 1) which implies a strong pressure on policy makers to meet urgent sustainable development objectives.

Secondly, the context in our chosen countries has considerable room for innovation in how off-grid energy technologies are implemented to meet customer needs and adhere to their constraints. Off-grid energy comprises all electricity generation which is not connected to a centralised grid, either as an autonomous stand-alone system or as a mini-

grid where several customers utilise the same generation source. Off-grid energy provides opportunities to accelerate energy access and increase the penetration of renewable energy (Alova et al., 2021; Alstone et al., 2015), especially where centralised grid coverage is (Trotter et al., 2017) low. SSA has been responsible for the largest global growth rates in off-grid solar energy. Total off-grid capacity in SSA tripled from 400 MW in 2012 to 1.2 GW in 2017 (IRENA, 2018a), solar accounting for almost 70% of this total, growing by an average of 29% annually since 2009. The large influx of off-grid companies in the past decade have led to the recent emergence of a complex BMI in different contexts, albeit not existing at scale anywhere yet (see Table 2 for an overview): In addition to mere electricity provision, off-grid companies invest into electric appliances for productive use (such as, depending on case-specific opportunities, maize and rice milling equipment, irrigation systems, cold storage or brick making). They power them using parts of their generated electricity and charge customers for these services by the hour or by kilograms of products produced instead of charging by the kWh (Haney et al. 2019). These energy-enabled productivity gains increase the return per unit of electricity generated when compared to selling electricity to households due to the associated economic value added, which in turn enables the cross-subsidisation of less financially lucrative but sustainable development-critical electricity consumption in households, health centres and schools. The underlying value proposition broadens towards providing sustainable rural development with the company's offerings targeting multiple SDGs such as poverty reduction (SDG1), improved healthcare (SDG3), economic growth and provision of decent jobs (SDG8) and sustainable production (SDG12), in addition to energy access provision (SDG7). The required value networks deepen so companies can navigate different areas of expertise, for instance managing agricultural service provision in addition to generating and selling electricity. This complex BMI furthermore implies a multitude of new connections to policy making as it propels off-grid energy companies from mere energy providers into potential agents for broader rural development. Finally, as all companies with this complex BMI in our sample have been transitioning from an established off-grid BM (Table 2), our setting enables us to observe the formation of

Table 2

Summary of established business model versus the business model innovation in Africa's off-grid energy sector studied in this paper.

Business model components	Established off-grid business model	Complex business model innovation
Value proposition	Increase energy access in underserved areas	Actively create and drive sustainable economic development in underserved areas
Value capture	Sale of units of energy (in kWh) paid for by usage, or sales of entire systems (in kW) paid for either upfront or through leasing model	Sale of units of energy (sales in kWh), and of productive services/goods as part of rural productive value chains (sales in agro-processing time, kg of processed goods, ...)
Value networks	Large share of in-house value creation, limited (if any) core partnerships	Heavy partnership requirements across rural productive value chains

Note: Following Foss and Saebi (2017), complex business model innovation entails a simultaneous innovation in all three of these business model components. See also Haney et al. (2019).

Table 1

Selected country-level socio-economic indicators of country cases studied (Source: The World Bank, 2019)).

	Zambia	Uganda	Ghana	Nigeria	Sierra Leone	Tanzania
GDP per capita (2019 USD)	1305	794	2202	2229	527	1122
Population (2018, in million)	17	43	30	196	8	56
Rural electrification rate (2017, in %)	14	11	65	23	5	17
Human development index rank (out of 189, 2017)	143	159	142	158	181	159
Share of renewables in generation mix (2015, in %)	97	93	51	18	61	34

these BMIs and their drivers as they happen rather than having to rely on reported accounts.

Thirdly, as aspects of this complex BMI are emerging in several different countries in SSA with distinct policy mixes, our context allows us to study the role of different policy mixes for the same type of complex BMI. By studying six different countries, we can place its onset (or lack thereof) into the context of the different policy mixes present in these cases, allowing us to develop a theoretical model explaining how policy mixes shape the conditions for BMI (Eisenhardt and Graebner, 2007). Our theoretical sampling of case countries is based on the differences we observed in the extent to which this complex BMI model was prevalent compared to traditional off-grid BMs.

3.2. Data collection

We collect data on policy mixes and BMI using semi-structured interviews and policy documents. Interviews with off-grid energy companies in different policy contexts formed the basis for our identification of BMI. We focused on Uganda and Zambia initially because of the presence and absence of BMI in these cases respectively. Using snowball sampling, we added four further country cases, namely Nigeria, Tanzania, Sierra Leone and Ghana. As complex BMI was particularly prevalent in Uganda, we interviewed additional companies active in Uganda to substantiate our findings.

To collect data on policy mixes, we combined a bottom-up with a top-down approach. Using the interviews with off-grid energy companies to guide us in the identification of policy mixes that were relevant to BMI, our initial approach was bottom-up as it was informed by the impact domain of off-grid energy rather than choosing a priori policy mixes we deemed relevant. We then added a top-down approach by collecting data on relevant policies via a combination of interviews with industry experts (from national Energy Ministries, international donors and off-grid energy associations) and policy documents for each of the six country cases. This combined bottom-up and top-down approach, although time-consuming, is methodologically the most comprehensive approach to delineate elements of policy mixes (Ossenbrink et al., 2019).

Table 3

Overview of interviews and policy documents by country, including type of business model innovation for interviewed companies.

	Zambia	Uganda	Ghana	Nigeria	Sierra Leone	Tanzania	Total
Off-grid energy company interviews							33 ¹
No business model innovation (BMI)	C1, C2, C3, C4, C5, C6, C7, C8	C2, C3, C4, C10, C11, C12, C14, C15, C16, C17, C18, C19, C21, C22	C3, C4, C7, C28	C2, C3, C4, C7	C3, C4, C8	C3, C4, C11, C32, C20	
Limited BMI ²	C9	C13, C20		C29, C30		C33	
Complex BMI ²		C7, C23, C24, C25, C26, C27		C31	C7, C28		
Industry expert interviews	E1, E2, E3, E4, E5, E6	E1, E2, E3, E7, E8, E9, E10, E11, E12, E13, E14	E2	E1, E2, E3, E7, E15	E2, E3, E7	E1, E2, E3	15
Policy documents	5	4	5	7	7	4	32

¹ 33 energy companies were interviewed in total. Thirteen of the energy companies were interviewed twice, resulting in 46 total interviews with companies. *Italics* indicates companies that are active in multiple countries. **Bold** font indicates where companies adopt different business models by country. For each company and country, Appendix A classifies their value proposition, value capture and value network approach as either “established” or “innovative” according to Table 2, deriving whether the business model is no BMI, a limited BMI or a complex BMI.

² The minimum requirement for a company to be classified as pursuing complex BMI is the company implementing at least one pilot electrification project in a given country in which it is simultaneously expanding its value proposition, value capture approach and value network to resemble the respective definitions of complex BMI provided in Table 1. By contrast, and in line with Foss and Saebi (2017), a company having limited their BM changes to one or two components is classified as pursuing limited BMI.

Table 4

Data overview.

Construct	Data type	Description	Average length	Total
Business model innovation	Interviews	• Interviews with 33 energy companies, 13 of which were interviewed twice	• 1:24:14 hours	• 64:34:44 hours
Policy mixes	Interviews	• Interviews with 15 off-grid sector experts, all of which interviewed once	• 1:27:41 hours	• 21:55:21 hours
	Policy and regulatory documents	• 22 documents from African governments	• 48.1 pages	• 1057 pages
		• 10 documents from donors	• 71.6 pages	• 716 pages

Between January and October 2019, we interviewed 33 off-grid energy companies and 15 industry experts. Table 3 lists the interviewees (C = energy company, E = industry expert) by country. Notably, three out of four companies in our sample active in several countries use different BMs depending on the country context (Table 3). While this finding may point to the importance of different structural conditions in these countries for BMI, it is crucial to point out that such an approach also requires the capacity of companies to localise and implement their BM according to country-specific conditions. Classifying companies by type of BMI is described in Footnote 1 of Table 3, and further detailed in Appendix A. Thirteen of the 33 energy companies were interviewed twice to obtain additional insights, resulting in 61 total interviews. Table 4 summarises the extent of interview and policy document data collected. Finally, where possible we triangulated interviewee accounts with the companies’ publicly available company reports, image videos and web presences.

3.3. Data analysis

The analysis involved the main processes of data reduction, data display and conclusion verification (Miles, M.B. and Huberman, A.M., 1994).

3.3.1. Data reduction

We used existing frameworks for BMI and policy mixes to reduce the data, focusing specifically at this stage on the company interviews and company archival data. We started by coding each BM (of a company in a particular country) according to the three main BM components: value proposition, value capture and value networks. Following Foss and Saebi’s (2017) BMI definition, we categorised each company-country pair as having no BMI, limited BMI (changes in one or two components) or complex BMI (changes in all three) (see Appendix A). To do this, the first author and a research assistant initially coded changes in value proposition, value capture, and value networks, and stopped iterating once they reached an inter-coder reliability of 90%. We recorded and transcribed segments of the interviews relevant for the

connection between policy and BMI. We then used Microsoft Excel to systematically assign codes, developing a database of multiple instances of BMI for each company-country pair. At the same time, we coded instances of policies mentioned in each company interview, as well as specific mentions of policies affecting each BM component. The first author led the policy coding using first-cycle coding to identify the main policy-related drivers and barriers for BMI. The initial first-cycle coding is summarised in Table 5. Both authors discussed a sub-sample of BMI codes connected to policy during this process. We observed a distinction

Table 5

Policy coding.

First cycle	Second cycle
Top-down drive	Policy strategy
Forcing mechanisms	
Ease of planning and implementation	
Tax and customs incentives	Policy instruments
Technical and regulatory support	
Domestic finance	
International finance	

Table 6Overview of policy strategy and instrument coding by country¹.

Domain	Element	Description	Present and applicable to interviewees in examined country cases? ²					
			Ghana	Nigeria	Sierra Leone	Tanzania	Uganda	Zambia
Sector-specific	Policy strategy	Long-term plan to increase off-grid energy deployments	Yes	Yes	Yes	Yes/No ³	Yes	Yes
		Long-term plan to create a private sector-led off-grid energy market	No	Yes	Yes	Yes/No ³	Yes	Yes
	Systemic instruments	Regulatory instruments (e.g. framework for off-grid energy companies)	No	Yes/No ⁴	Yes	Yes	Yes	No
		Information instruments (e.g. rural community engagement)	No	No	Yes	No	Yes	Yes
	Technology-push instruments	Economic instruments (e.g. grants)	No	Yes	Yes	Yes	Yes	No
		Information instruments (e.g. building capacities)	No	Yes	Yes	Yes	Yes	No
Society-wide	Demand-pull instruments	Economic instruments (e.g. household connection subsidies)	No	Yes/No ⁴	Yes	Yes/No ³	Yes	No
	Policy strategy	Strategy to ensure affordability of public services applied to off-grid energy	Yes	No	Yes	No	Yes	Yes
		Strategy to foster holistic development through off-grid energy	No	No	Yes	No	Yes/No ⁵	No
		Local industry growth objectives applied to off-grid energy sector	No	Yes	No	No	Yes	Yes
	Systemic instruments	Regulatory instruments (e.g. local standards, local content requirements)	No	No	Yes	No	Yes	Yes
		Regulatory instruments (e.g. legally binding electricity tariff limits)	Yes	No	Yes	No	Yes	Yes
	Demand-pull instruments	Economic instruments (e.g. property taxes, import taxes)	Yes	Yes	Yes	Yes	Yes	Yes

¹ Sources: Interviews with industry experts E1 - E15 and policy documents (Ghanaian Ministry of Power, 2016; Ghanaian Ministry of Power, Energy Commission of Ghana, & National Development Planning Commission, 2019; African Climate Technology Finance Centre and Network (ACTFCN), African Development Bank Group & Energy Commission of Ghana, 2015; ESMAP, 2017, 2019; Federal Government of Nigeria, 2005; Rural Electrification Agency Nigeria, 2016; World Bank & Electricity Regulatory Authority (ERA), 2019; Energy Regulation Board Zambia, 2018a, 2018b; Energy Regulation Board Zambia, 2019; Energy Regulation Board Zambia, 2018b; ESMAP, 2017; Government of Tanzania, 2008; Government of Uganda, 2016; Government of Uganda, 2017; Government of Zambia, 2003; International Renewable Energy Agency, 2016; JICA, 2008; NERC, 2016; REA, 2012; Republic of Sierra Leone, 2009; Republic of Sierra Leone, 2016; Republic of Sierra Leone, 2017a, 2017b; Republic of Sierra Leone, 2011; SE4All, 2015; Sierra Leone Electricity and Water Regulatory Commission, 2018; The Energy and Water Utilities Regulatory Authority, 2009; United Republic of Tanzania, 2019; World Bank, 2018) – see also Appendix B

² We did not observe significant within-case variation in the policy mixes in Ghana, Zambia and Sierra Leone, but did observe within-case variation in Nigeria, Tanzania and Uganda. For our purpose, within-case variation means that certain strategies or instruments have been both present and absent in the same country case. This happens if certain policy elements which did not exist before get introduced at a certain time, or where existing policy strategies and instruments temporarily change, for instance where international donor organisations implement their own instruments within countries in SSA. Hence, in some cases, countries can be governed by different sets of strategies and instruments. See Appendix B for a more detailed narrative. The main cases of within-country variations are discussed in the footnotes 3 – 4 below.

³ In Tanzania, the political regime change in 2015/16 meant several off-grid energy instruments were being scaled back as the new government implemented significantly less supportive structures to the sector.

⁴ In Nigeria, the World Bank implemented the Nigerian Electrification Programme. They introduce societal affordability objectives and associated instruments, but provide high levels of demand-pull subsidies and performance-based finance to enable them

⁵ In Uganda, German development agency GIZ ran a pilot mini-grid tender that greatly limited firms to innovate their value proposition and value capture. The World Bank has also set up a similar, albeit smaller initiative as the one in Nigeria governed by a similar policy mix.

policy mix elements relevant for our paper for the six countries, with footnotes explaining the main within-case variations in the policy mixes we observed. Following Rogge and Reichardt (2016), policy instruments were coded by their primary effect (systemic, technology-push, demand-pull) and their type (economic, regulatory, information).

3.3.2. Data display and conclusion verification

We displayed the data in different ways, combining our coding of BMI and policy mixes by comparing patterns across countries, identifying where the connections between policy mixes and BMI were similar (replication logic) and where patterns were not confirmed (contrary replication) (Eisenhardt and Graebner, 2007). We also compared the connections between different policy elements and BMI, interrogating how they worked and why. We discovered during this stage that the effects were similar across BM components but that there were critical differences in how sector-specific and society-wide policy mixes affected BMI. We also discovered that there were different sub-mechanisms within sector-specific and society-wide instruments which mapped onto the different effects of instruments (rather than the instrument types). We coded the mechanisms using a combination of first-cycle and second-cycle coding as illustrated in Table 7. We used these mechanisms as the basis for our third process of drawing conclusions, where we examined similar and contrasting examples to verify the relationships between policy mixes and BMI.

Being aware that our structural focus is unable to capture every nuance of why a given company adopts a new BM, we focused on identifying salient patterns in the data. The outcomes of this stage are visualised in a theoretical framework introduced in the discussion which explains the conditions for complex BMI as a combination of sector-specific and society-wide policy mixes. Our understanding of mechanisms is critical to the explanatory power of our model. We focus on identifying how policy mixes produce different conditions for BMI and in doing so we draw on the sociological tradition of mechanism-based explanation. A mechanism in this tradition unpacks how two constructs are linked by explaining the process through which they are connected (Ylikoski, 2019).

Table 7

Overview of mechanisms and sub-mechanisms of policy mixes influencing BMI identified in this paper.

Policy element	Main mechanisms influencing BMI (second-cycle codes)	Associated sub-mechanisms influencing BMI (first-cycle codes)
Sector-specific policy strategies (Section 4.1.1)	Create a long-term foundation	<ul style="list-style-type: none"> • Providing long-term market access • Providing scale • Promoting partnerships and competition
Sector-specific policy instruments (Section 4.1.2)	Implement supportive conditions	<ul style="list-style-type: none"> • Easing operations (<i>systemic</i>) • Providing legal security (<i>systemic</i>) • Ensuring effective flow of information (<i>systemic</i>) • Supporting innovative entrepreneurs (<i>technology-push</i>) • Building innovation-relevant capacities (<i>technology-push</i>) • Improving the business case (<i>demand-pull</i>)
Society-wide policy strategies (Section 4.2.1)	Integrate societal objectives	<ul style="list-style-type: none"> • Integrating pricing guidelines • Integrating type of service guidelines • Integrating local industry growth guidelines
Society-wide policy instruments (Section 4.2.2)	Implement societal constraints	<ul style="list-style-type: none"> • Mandating additional value creation (<i>systemic</i>) • Adding financial pressure to innovate (<i>demand-pull</i>)
Sector-specific and society-wide policy mix interactions (Section 4.3)	Maintain productive tensions	<ul style="list-style-type: none"> • Keeping adequate level of financial pressure to innovate (<i>demand-pull</i>) • Ensuring operative flexibility (<i>demand-pull</i>) • Ensuring broad inclusion of companies (<i>demand-pull / technology-push</i>)

4. Results

The first two subsections of this section discuss how sector-specific and society-wide policy mixes shape the conditions for complex BMI in the off-grid energy sector of the six countries in SSA in turn, each devoting a separate subsection to policy strategies and to policy instruments. A third subsection focuses on the interactions and feedback between both policy mix elements and identifies the critical mechanism of maintaining productive tensions between sector-specific and society-wide policy mixes. Each of these five subsections identifies and analyses a set of overarching and associated sub-mechanisms how the different policy elements in the six country cases (Table 6) shape conditions for BMI (see summary in Table 7). The respective overviews of exemplary detailed interviewee evidence are presented in Tables 8–12 where each quote is given an individual number for easy referencing purposes.

4.1. Impact of sector-specific policy mixes on BMI

4.1.1. Sector-specific policy strategies

We find that sector-specific policy strategies, most notably governmental development plans for establishing a commercial off-grid energy sector market and their underlying objective to increase the electrification rate, have helped to enable BMI to occur in our sample via the key mechanism of **creating a long-term foundation** for companies to establish themselves and innovate their BM. Specifically, we find three associated sub-mechanisms how sector-specific policy strategies create a long-term foundation, namely by (1) providing long-term market access, (2) providing scale and (3) promoting strategic partnerships and competition in the market (Table 8).

First, the private sector off-grid energy sector development plans in Nigeria, Uganda, Sierra Leone, Zambia, and in early-2010s Tanzania have been critical in signalling the governments' willingness to provide long-term access to the electrification market, key to lower perceived risks for companies entering into these relatively nascent markets ([Quote 1] – [Quote 4]). The strategic plans in these cases all set out targets for off-grid energy connections, and all explicitly aim to draw the private sector into the market (E1 – E3, E5 – E9, E11, Appendix B).

Table 8

The impact of sector-specific policy strategies on business model innovation: Exemplary empirical evidence for the “create a long-term foundation” mechanism.

Sub- mechanism	Exemplary quote	Country context / source
Providing long-term market access	<ul style="list-style-type: none"> • [Quote 1]: “Sierra Leone is a great country for us to be present in. We only recently got there, ... and chose it because the government is pushing for mini-grids unlike a lot of things I have seen in Africa. ... Their commitment means we have security, at least more than what we usually have. It allows to try out different innovations, different things we are trying to do with how we serve communities.” 	Sierra Leone (C28)
Providing long-term market access	<ul style="list-style-type: none"> • [Quote 2]: “Sierra Leone is a very interesting case. Their access rate is super low, and they have now implemented a really great and conducive plan for really scaling up energy access and mini-grids. ... It was much easier than we thought, being part of the market there – and we see a lot of potential with everything they have going on.” 	Sierra Leone (C7)
Providing long-term market access	<ul style="list-style-type: none"> • [Quote 3]: “Government is supporting us ... for the long term so we can uniquely design our solar project to service the needs of variety of agricultural based development, ensuring local produce in the region are prioritized, preserved and processed for in-country and international distribution. ... There will be job creation, improved agricultural productivity through irrigation and agro-processing, increased electricity services that will provide incentives to attract more qualified health personnel, teachers and other essential service providers” 	Nigeria (C31)
Providing long-term market access	<ul style="list-style-type: none"> • [Quote 4]: “In Nigeria’s power sector, the government has its renewable energy masterplan. The Nigerian Government has put in place policies in order to ensure accelerated electrification in off-grid communities, and is following this plan closely. ... We have benefitted hugely from this policy as it gave us a chance to establish ourselves in the market with different ways how we market our mini-grids.” 	Nigeria (C30)
Providing long-term market access	<ul style="list-style-type: none"> • [Quote 5]: “[Because of the government’s off-grid strategy] we will be here for decades. ... It’s important for us to keep the [local] economy running. ... We have integrated, to a certain degree, the need for energy, that meets the demand for the key activity which is fishing. We want to add value to another community, which is fish drying and also target the health sector, portable water and reducing the use of fuel wood [...]. The other aspect is the construction of school, free sanitation systems.” 	Uganda (C27)
Lack of providing long-term market access	<ul style="list-style-type: none"> • [Quote 6]: “Since [the new Tanzanian government] has come in and changed its policies and dropped most of its support, we and a lot of other mini-grid companies have been kind of left in limbo. We wanted to provide affordable and reliable electricity to ... the poor. Now, we have to struggle to deliver on this promise. We try to adjust, but the outlook in the country is not very good right now.” 	Tanzania (C33)
Lack of providing long-term market access	<ul style="list-style-type: none"> • [Quote 7]: “Our license was suspended, ... and [the policy makers said] ‘you should keep operating, you just cannot expand.’ Unfortunately, expanding our systems is the core part of our model. We tend to build [mini-grids] tight to what their expected demand is, and expand on that basis. ... This killed our freezer programme because lights are going off at 10 o’ clock at night so it doesn’t make that much sense to own a freezer if it doesn’t keep things cold.” [Quote2Cit] 	Ghana (C28)
Providing scale	<ul style="list-style-type: none"> • [Quote 8]: “One of the big components is scale. In Ghana, we were going one project by one project, three years working we had 900 connections. In Sierra Leone, we are going to have 10,000 connections by the end of next year. It gives us a big enough marketplace that you can test an idea ‘what’s our rice milling strategy?’ Among 10,000 connections, you are going to have at least 50 rice millers. ... The scale is a foundation for a lot of innovation.” [Quote1] 	Sierra Leone, Ghana (C28)
Providing scale	<ul style="list-style-type: none"> • [Quote 9]: “Policy makers are ensuring we have some scale [by bundling mini-grids together]. Then we can easily scale up our team, train our people that are needed and can handle things like the productive use of energy, which is what is our focus of this arrangement.” 	Uganda (C25)
Lack of providing scale	<ul style="list-style-type: none"> • [Quote 10]: “From the early 2010s, the dedication of the government in Tanzania drove lots of mini-grid developers in. The market opportunity was huge elsewhere also, but we felt confident that things would be made easy for us [in Tanzania]. We were able to electrify a lot of people and quickly scale in these years, learning quickly, keeping on improving our business model. ... When the new government came and started changing things in 2015, 2016, it scaled back massively on mini-grids. There is no drive, and suspicion regarding foreign companies coming in. The regulations are still there, but the drive is gone. Without the support, we have to work a lot harder to develop these projects, it’s all a lot slower.” 	Tanzania (C33)
Promoting partnerships and competition	<ul style="list-style-type: none"> • [Quote 11]: “The government knows it needs the private sector [for development]. ... I wouldn’t say they actively build networks, but they are building opportunities ... bringing people together. And Uganda has a ton of local entrepreneurs ready to scale. ... They are involved in project development, but also some key services surrounding mini-grids. Training, demand creation, even finance.” 	Uganda (C24)
Promoting partnerships and competition	<ul style="list-style-type: none"> • [Quote 12]: “Ultimately, where there’s competition, where there’s challenge and where there’s an environment that is conducive of creativity, you’re more likely to end up with interesting solutions coming up and really putting the end customer at the core. Surely that’s just good business in the long run” 	Uganda (C25)
Lack of promoting partnerships and competition	<ul style="list-style-type: none"> • [Quote 13]: “How can you even try to partner with others if there are restrictions that say the entire off-grid sector is designed for the public sector alone?” 	Ghana (C28)
Lack of promoting partnerships and competition	<ul style="list-style-type: none"> • [Quote 14]: “Partnerships are key, but if the government just pulls out, a lot of potential partners, especially foreign ones, become weary. ... It used to be easier when Tanzania was a frontrunner in the sector.” 	Tanzania (C33)

Table 9

The impact of sector-specific policy instruments on business model innovation: Exemplary empirical evidence for the “implement supportive conditions” mechanism

Primary effect	Sub- mechanism	Instrument type	Exemplary quote	Country context / source
Systemic	Providing legal security	Regulatory	• [Quote 15]: “[Tanzania] were the first who had useful and easy regulations in the mini-grid sector. That was the original reason why we targeted the country with our mini-grid model. It gave us the security to [proceed with] our business idea.”	Tanzania (C33)
	Providing legal security	Regulatory	• [Quote 16]: “Before the regulation, there was no external funding. ... The [mini-grid] regulation was developed in conjunction with GIZ. That helped catalyse the industry, the funders now got interested ... everybody has come in to Nigeria because there is a regulation.”	Nigeria (C29)
	Providing legal security	Regulatory	• [Quote 17]: “The fact that Uganda has a consistent legal framework is very important. ... There are some things ... that are inefficiencies, but in general, the regulations are good, regulations are key, they organise the market. As much as there is bottlenecks within the regulatory process, I feel that the industry itself is an organised market.”	Uganda (C26)
	Providing legal security	Regulatory	• [Quote 18]: “One issue is ... that [as of] yet we are not having full policy support to give confidence to mini-grid project developers for when the grid arrives. ... Once [updated mini-grid regulations by the Nigerian Energy Regulation Commission] comes to effect, I believe it’s going to change a lot of issues ... In some cases [now], ... [mini-grid developers] are not really designing the system for long term. I believe that when the policy comes in place that yes, ... there will be a business model that supports long-term mini-grid projects.”	Nigeria (C30)
	Lack of providing legal security	Regulatory	• [Quote 19]: “The Japanese (JICA) came in and [developed] a rural electrification master plan, which is a very well written master plan. After they left, nothing much happened, even though we are still referred to it. The problem with that is that they weren’t able to deliver the plan because it wasn’t financed, but also really, they did the whole thing with mainly the Japanese experts and then just left. Unless you do that type of thing with Zambians then the level of ownership is going to be very low.”	Zambia (C9)
	Lack of providing legal security	Regulatory	• [Quote 20]: “Mini-grids [in Zambia] is risky. ... There is no procurement of mini-grids. ... We would like to change because technology’s moving faster [but] regulation is always behind”	Zambia (C5)
	Easing operations	Regulatory	• [Quote 21]: “[The drive in Sierra Leone for off-grid energy] has really translated into good regulations. Compared to other places we found it easy to get things done, quite hustle-free. This has really allowed us to invest more time and resources into what we offer to customers, what our value proposition can be.”	Sierra Leone (C4)
	Easing operations	Regulatory	• [Quote 22]: “In Nigeria, ... if I were to build a fast project without any license, without any permit now, if I have money I can go and design my project, build it, as long as it doesn’t exceed 100kW... Most of the projects that you see would be developed before even the approval from the regulator.”	Nigeria (C29)
	Easing operations	Regulatory	• [Quote 23]: “If you are starting a new company, you must have filed accounts for at least a year [in order to apply for a mini-grid license]. If you don’t have an account for at least a year, you must have a partner who has an account, like a joint venture partner or something. That’s a requirement. ... It has helped a lot in the beginning. Do I still need that partner now? No. ... But other partnerships we have now are very important.”	Uganda (C26)
	Easing operations	Regulatory	• [Quote 24]: “[Regarding the tender of several mini-grids bundled together], it would be more of a collaborative arrangement because they [the international partner company] have their modular units, containerised solar solutions, whereas we got the ground team that can run power plants. ... It makes sense for everybody.”	Uganda (C18)
	Lack of easing operations	Regulatory	• [Quote 25]: “The regulation has been missing for the mini-grid. It’s completely missing, so the regulators were taking it on a case-by-case basis, and using light-handed approach to actually regulate the mini-grids space, and that is one huge observation that we made. ... [B]ecause of the lack of regulation we spend a lot of time [going] from one institution to the next, getting permits and just getting all documentations to get the project off the ground. Things like delays of 8 months in one single institution, that happened to us.”	Zambia (C5)
	Ensuring effective flow of information	Information	• [Quote 26]: “The district did a lot of quality checks, a number of times we had stakeholder meetings where the communities would share experiences. ... Those meetings served as a platform for the private sector to improve. So if you look at the first systems the private sector put in, they are very different from what they are now in Kasese [West Ugandan district].”	Uganda (C20)
	Ensuring effective flow of information	Information	• [Quote 27]: “It is great to see all these familiar faces when we have our sector-wide meetings. ... This [the other mini-grid company CEOs and myself] is the class of 2012. Back then, it was our first sector meeting. ... We are still grappling with the same issues, so knowing what they are doing, what ERA [the regulator] is doing, what the Rural Electrification Agency is doing, all of that is crucial for what we do and how we do it.”	Uganda (C25)
	Ensuring effective flow of information	Information	• [Quote 28]: “We have known each other since 2012. There was a big sector meeting, and we stayed in touch ever since. Many of us have worked on projects together, remember it’s a small sector. ... We have all learned from each other, and the fact we have survived this long speaks to that.”	Uganda (C26)

(continued on next page)

Table 9 (continued)

	Ensuring effective flow of information	Information	• [Quote 29]: “The regulator and policy makers, they need to inform us as early as they can about any changes to their regulatory framework or their strategic priorities. Not knowing what the guidelines will be is worse than what any actual guidelines could be.”	Uganda (C25)
	Lack of ensuring effective flow of information	Information	• [Quote 30]: “No, [the industry] is not properly aligned, not at all. That’s one of the gaps [the Zambian government] needs to try and be more definitive about. ... If we [off-grid developers] knew how much money they likely to have in the next ten years, you could say ‘well, the grid is going to come to this area so let’s focus on the other areas’ but ... we haven’t got that [transparency].”	Zambia (C6)
	Lack of ensuring effective flow of information	Information	• [Quote 31]: “With a lot of regulations, there is a lot of uncertainty. ... There is a new sales tax coming for the industry. But what is the sales tax? Nobody knows. ... And what is the rate? Nobody knows. ... If you don’t like uncertainty, then definitely don’t do a business here.”	Zambia (C2)
Technology-push	Supporting innovative entrepreneurs	Economic	• [Quote 32]: “I have received a grant from Power Africa to start [my company]. ... Over the last one and a half years, we’ve gained some knowledge and experiences on producing ice. Now, we are not a power company, we are a cold chain company. ... I’ve built my career on pioneering things. Some have worked, some have been headaches, but for me, that’s what really drives me.”	Uganda (C26)
	Supporting innovative entrepreneurs	Economic	• [Quote 33]: “The Nigerian Government put in funding into Bank of Industry to lend to local entrepreneurs and mini-grid project developers. That was in 2010, about 9 years ago. From that timeline, I can tell you that this initiative actually made about 4 or 5 project developers come online. ... The primary reason [for us to start looking at additional revenue streams] was a need assessment. We are looking at what the community needs. When we say we have a lack of access to energy, it’s not really the lack of access to energy that is the issue, it’s the lack of energy services in these communities. Before our electricity project arrived, we had issues [with] criminals exploiting the dark to rob the community. ... With our street lighting, we reduce the security challenges, it becomes challenging for thieves and criminals to come and exploit the darkness.”	Nigeria (C30)
	Lack of supporting innovative entrepreneurs	Economic	• [Quote 34]: “We have never received any external finance from anyone. It’s all private. Little by little. ... We cannot finance equipment, or do pay-as-you-go. No credit. ... It is really a challenge for us, because when you go to [see] people in the village, they cannot afford the initial investment of a typical solar system. If someone [other companies capable of lease-based business models] gives out a solar system at a payment plan that is so affordable, we cannot compete.”	Uganda (C13)
	Building innovation-relevant capacities	Information	• [Quote 35]: “Not only that they [Energy Ministry in Sierra Leone and DFID] invested in developing mini-grid assets, but they also invested heavily in capacity building for the government [to improve governance of the industry]. ... There are also capacity building programmes for technicians which is helping to implement projects better, more quickly, on the ground.”	Sierra Leone (C28)
	Building innovation-relevant capacities	Information	• [Quote 36]: “In Uganda you can get some technical training. There are trainings at Makerere University, sponsored by government, they do a lot of outreach and train people to work in off-grid energy. ... They mostly build technical capacity, and more could happen on the business side, but this technical training is critical of course.”	Uganda (C21)
	Lack of building innovation-relevant capacities	Information	• [Quote 37]: “For most Zambians, [the biggest challenge] would be the lack of entrepreneurs, the ability to run the company. It’s hard anywhere and it’s extra hard here. Schools don’t teach it properly. ... I really feel for Zambian entrepreneurs.”	Zambia (C6)
	Lack of building innovation-relevant capacities	Information	• [Quote 38]: “We need to grow the industry by putting policies towards capacity building in place, within individual [small to medium sized energy providers], because that is one thing that’s not been looked at. Incentives have been introduced to the industry but I think incentives are one aspect of improving companies, but if there’s no capacity then I think they will still not grow. ... Vocational training would be good.”	Zambia (C1)
Demand-pull	Improving business case	Economic	• [Quote 39]: “[The public tender of] 15 [mini-grids at once] is a big number considering how small and new the mini-grid space is ... It reduces the risk [because] ... until we can resolve the question of the source of income and on-going income [in rural communities], there will still be a question mark around liability of mini-grids.”	Uganda (C25)
	Improving business case	Economic	• [Quote 40]: “[To develop mini-grids in Zambia], energy has to be subsidised one way or another. The figures just don’t work out otherwise, given the costs we have and the type of revenue we can achieve from selling electricity units.”	Zambia (C6)
	Improving business case	Economic	• [Quote 41]: “The World Bank will take the risk on mini-grids.”	Nigeria (C31)
	Improving business case	Economic	• [Quote 42]: “We know if we don’t have subsidies we will not be profitable.”	Uganda (C19)

Nigerian company C30 explains that “[t]he Nigerian Government has put in place policies in order to ensure accelerated electrification in off-grid communities ... We have benefitted hugely from this policy as it gave us a chance to establish ourselves in the market with different ways how we market our mini-grids” [Quote 4]. Thus, firm governmental commitments to establishing a private sector-friendly off-grid market with long-term access to business opportunities can increase companies’ willingness of spending resources on BMI early on (see also [Quote 5], E12, E15, Appendix B.2, B.3). By contrast, our interviewees point out that where this sub-mechanism of market access provision is absent, BMI is severely hindered or even made impossible to achieve. The Ghanaian government’s decision to grant only a negligible role to the private sector in off-grid energy (E2, Appendix B.1) has been responsible for attempts at BMI

failing in Ghana, as C28 is alluding to with respect to its planned lease-to-own model for refrigerators [Quote 7]. Similarly, since the new government in Tanzania has signalled sufficiently less commitment to the sector (Appendix B.5), mini-grid companies were left with considerable levels of uncertainty, leading to a loss of its momentum for BMI across value proposition, value capture and value networks [Quote 6].

Second, sector-specific strategies can create a long-term foundation for BMI by providing opportunities for off-grid energy companies to scale. The opportunity to scale quickly has been important in attracting innovative companies looking to experiment with their BMs. Comparing a case where the government has put in place a development plan targeted at private sector development with the explicit objective of rapid energy access scale-up (Sierra Leone) with one where the government

Table 10

The impact of society-wide policy strategies on business model innovation: Exemplary empirical evidence for the “integrate societal objectives” mechanism.

Sub- mechanism	Exemplary quote	Country context / source
Integrating pricing priorities	<ul style="list-style-type: none"> [Quote 43]: “Due to [Uganda’s affordability and development policies], our value proposition now is to deliver an integrated community development project: It integrates meet[ing] the demand for fishing, ... fish drying, involves the health aspect, portable water and reducing the use of fuel wood, ... the construction of a school, free sanitation systems and so on. ... We could just devote the system to households and wait for revenue from electricity. It would be easier because the capital structure is lower. If I could adjust my tariff depending on the costs, why would I waste time into building a fish drying or a cooling plant, hiring new staff? That it another risk altogether. If my tariff reflects the costs, I would rather focus on that because I would be making actual money from that instead of trying to go into other businesses. But this is not possible. Now of course if you do the evaluation, these other businesses, actually, they make more money than electricity, so as a developer they become of interest to you. Like when I look at the RoI from the ice plant and the other businesses it is much higher than that of electricity, and without the productive use of energy you really cannot implement mini-grids here.” 	Uganda (C27)
Integrating pricing priorities	<ul style="list-style-type: none"> [Quote 44]: “REA [Rural Electrification Agency in Uganda] is increasingly looking at mini-grids. It’s not been decided really what off-grid electrification will look like, but everybody there knows it certainly does not make sense to have a solution that people can’t afford. ... [For us], the more products we sell, the more they [farmers] earn. The more they earn, ultimately the more money they will have in their pocket to buy our electricity, which means we can then at that stage scale the power distribution site of the business and [it] ends up being an overall more sustainable approach. ... It’s a win-win on both sides. It’s not just us as a developer going off raising funds and doing really well and having electricity users whose quality of life stays flat. Having a win-win setup [allows us to] still charge the same amount [without subsidies] as anybody else when it comes to the limits [on tariffs] ERA [Electricity Regulatory Agency in Uganda] is setting.” 	Uganda (C25)
Integrating pricing priorities	<ul style="list-style-type: none"> [Quote 45]: “If I were to set the tariffs on what we know now, I would target three times the tariff [compared to what strategic plans in Ghana foresee]. But we believe that there is a virtuous cycle and we have seen it that if you charge lower tariffs people consume more, and if you think about mini-grids as a large fixed asset, so the more volume you pump through the system, the more cost-effective you can be. We have taken that at heart and we do lot of value engineering.” 	Ghana and Sierra Leone (C28)
Lack of integrating pricing priorities	<ul style="list-style-type: none"> [Quote 46]: “When Tanzania first put an emphasis on mini-grids, it wanted to draw companies into Africa which had never been there before. ... It wanted people from the US, from Europe, from all these places, to found companies in Tanzania and build mini-grids. They cared about energy [access]. ... We could move in, set up quickly and charge customers the tariffs we felt were fair and allowed us to do business.” 	Tanzania (C33)
Lack of integrating pricing priorities	<ul style="list-style-type: none"> [Quote 47]: “In Nigeria, in the villages, I can charge a tariff I want, I just have to clear with the local community. ... I suggest a price, the villagers say yes or no, and if its yes, then we sign an agreement, and that’s all I have to present to government to be allowed and start selling.” 	Nigeria (C29)
Integrating type of service priorities	<ul style="list-style-type: none"> [Quote 48]: “The local [district-level] government in Kasese [a district in Uganda] ... were the first to develop a District Renewable Energy Strategy in Uganda. They came up with a vision for development, what should we do as a district and convince the private sector to work towards that vision. ... On the solar part we had several companies come in to provide affordable access for as many people as possible.” 	Uganda (C20)
Integrating type of service priorities	<ul style="list-style-type: none"> [Quote 49]: “[T]he Rural Electrification Agency, they are pushing us to connect all households in the village. All of them! They tell us to come up with innovative solutions to make it happen.” 	Uganda (C7)
Lack of integrating type of service priorities	<ul style="list-style-type: none"> [Quote 50]: “Government has talked too much about development for everyone in the last decades. But there is no actual plan, they have really failed the people with their promises. ... We take it into our own hands, we want to drive development in rural areas. ... We need to think a bit like the government, and act like [it]. ... It really is a win-win situation for us and the communities we serve.” 	Nigeria (C31)
Integrating local industry growth priorities	<ul style="list-style-type: none"> [Quote 51]: “It’s enough to put a local constraint, local content criteria, in the [sector development plan]. ... Foreign companies visit the countries and find out local possible partners or vice versa. ... In more and more projects, international companies find local partners. You get a range of [benefits] if you meet certain criteria of local content.” 	SSA in general (C9)
Integrating local industry growth priorities	<ul style="list-style-type: none"> [Quote 52]: “You get a range of incentives if you meet certain criteria of local content. I see that in Scaling Solar [in Zambia]. ... I have seen tenders in Senegal that also have criteria for local content. It’s coming and it’s there already.” 	Zambia (C7)

has actively refrained from doing so (Ghana), C28 explains that the promise of scale in Sierra Leone’s sector development strategy has made it possible for them to innovate their value capture approach to include offering rice milling services: “[*Our potential to scale in Sierra Leone*] gives us a big enough marketplace that you can test an idea ‘what’s our rice milling strategy?’ Among 10,000 connections, you are going to have at least 50 rice millers. ... The scale is a foundation for a lot of innovation” [Quote 8]. Several energy companies have echoed the importance of creating scale early on to be able to experiment with the type of value they want to create (C7, C27 – C29, C31). By contrast, the Tanzanian policy change from pursuing a heavy to an almost non-existent off-grid sector development strategy (Appendix B.5) has led to uncertainties and revisions of value propositions compared to the old policy strategy [Quote 10].

Third, off-grid energy sector development policy strategies have enabled the formation of new value networks, a key component of complex BMI we study due to the added expertise it requires in productive value chains. A number of interviewees point out that while long-term sector development policy strategies primarily target focal firms, in our case energy providers, they also attract a range of support

service companies which are crucial for delivering their complex BMI (C9, C24, C25, C27). C24 explains that in Uganda, “[*t*]he government knows it needs the private sector ... I wouldn’t say they actively build networks, but they are building opportunities ... bringing people together” [Quote 11]. These companies have been building elaborate value networks, partnering with small-scale appliance financiers, productive electrical appliance companies, customer acquisition consultants, local-level agro-business companies, training and software providers and mobile network operators, all of which were attracted by long-term sector growth strategies (C7, C23 – C27, E1). Conversely, building partnerships is challenging where government either never intended to build a private off-grid sector like in Ghana [Quote 13], or does not actively support the sector, leading to a considerable degree of hesitation by potential partners entering the market like in Tanzania [Quote 14].

4.1.2. Sector-specific policy instruments

Implementing off-grid energy sector development plans, we find that sector-specific policy instruments can foster BMI by **implementing**

Table 11

The impact of society-wide policy instruments on business model innovation: Exemplary empirical evidence for the “implement societal constraints” mechanism.

Primary effect	Sub- mechanism	Type	Exemplary quote	Country context / source
Systemic	Mandating additional value creation	Regulatory	• [Quote 53]: “Community engagement is key when working in Zambia. Everyone has to do it. ... When you are designing [a mini-grid], you are required to interact with the community and get their acceptance and why you are doing it. We really believe in this process. Otherwise, you create all sort of problems. ... We work through women groups, ... you can sit down [with them] and have conversations about payments and budgeting. you can have them for training, communication, for recruitment. The regulator now wants you to have agreements with customers, customer service standards, standards for call centre. You have to be prepared for that.”	Zambia (C9)
	Mandating additional value creation	Economic	• [Quote 54]: “The uniqueness is that the water treatment and fish drying are implemented in collaboration with the district and women’s association on the islands. The agreement we signed with the district [government], there is a revenue sharing provision where the company retains only 55% of the value, and then the rest is shared between women operating the water and fish plants and then the district as well”	Uganda (C27)
	Mandating additional value creation	Economic	• [Quote 55]: “We also have a partnership with the government through Kalangala District local government. In this partnership we are producing ice. So, we took over ice facilities that the district owns and were redundant for the last 10 years and we made them operational again. ... [Now] we [are] the productive use partner to produce ice on [another mini-grid company’s] mini-grid to cool fish.”	Uganda (C26)
	Lack of mandating additional value creation	Regulatory	• [Quote 56]: “[The off-grid energy policy] was based on the extensive work in Nigeria ... by local developers. Unfortunately, there is no local content built into the funding to serve. [Something like] maybe 30 percent of this fund to be accessed by local developers, [but] there is nothing like that.”	Nigeria (C30)
Demand-pull	Adding financial pressure to innovate	Regulatory	• [Quote 57]: “Their [Ugandan policy makers] requirement [to connect all households] comes with extra high CAPEX, and to cover the CAPEX, and to get the CAPEX back, we need to be able to charge an amount of money to the community but then they also have a limit of the tariff, so they kind of gridlock us from two sides; they say your CAPEX needs to be ginormously high because it needs to be able to cover 100% of household connections, but your tariff cannot be high because you are working with poor communities”	Uganda (C19)
	Adding financial pressure to innovate	Regulatory	• [Quote 58]: “If you look at a mini-grid developer, government has 0% share in the project, but their regulations, they are forcing the tariffs of the electricity down, and they are still forcing you to make this feasible in 10 years. ... And yes, we will make it work.”	Uganda (C26)
	Adding financial pressure to innovate	Regulatory	• [Quote 59]: “There is a limit to what you can charge, but it’s not really clear what that limit is. ... You have to negotiate everything with ERA [Electricity Regulatory Authority]. They will look at it and determine if it makes sense or not. ... I guess it depends a bit on the context what can and cannot make sense.”	Uganda (C 7)
	Adding financial pressure to innovate	Regulatory	• [Quote 60]: “The tariff has to be approved by EWRC [Sierra Leone Electricity & Water Regulatory Commission]. They got really stressed out by our tariff. ... I have some concerns whether or not they are going to allow it. ... But when it comes to leasing and value chains, they are perfectly happy.”	Sierra Leone (C28)
	Adding financial pressure to innovate	Regulatory	• [Quote 61]: “If you cannot charge high tariffs, you have to offer more and more services related: You work back on what people want and can afford over time, and give them a service package for that.”	Zambia (C9)
	Adding financial pressure to innovate	Economic	• [Quote 62]: “The government is pretty much hands-off. As long as we pay our taxes.”	Zambia (C1)
	Lack of adding financial pressure to innovate	Regulatory	• [Quote 63]: “In Nigeria, in the villages, I can charge a tariff I want, I just have to clear with the local community. ... I suggest a price, the villagers say yes or no, and if its yes, then we sign an agreement, and that’s all I have to present to government to be allowed and start selling.”	Nigeria (C29)

supportive conditions for companies’ operations. We identify a total of six associated sub-mechanisms through which these conditions are created (Table 9). Three of these primarily have a systemic effect, two have a technology-push effect, while one functions via demand-pull, indicating that setting supportive sector-specific conditions can involve and benefit from a mix of different types of instruments.

4.1.2.1. Systemic instruments. Systemic sector-specific instruments create supportive conditions that foster BMI by organising the market via three sub-mechanisms, namely (1) providing legal security, (2) easing operations and (3) ensuring an effective flow of information. First, while mini-grid regulations vary considerably in Uganda, Tanzania, Nigeria and Sierra Leone (Appendix B), companies operating there nevertheless repeatedly point to the importance of the respective governments introducing regulatory frameworks to provide legal security in the first place. For instance, C33 pointed out that “[Tanzania] were the first who had useful and easy regulations in the mini-grid sector. That was the original reason why we targeted the country ... [as it] gave us the security to [proceed with] our business idea [Quote 15] (see also [Quote 16] – [Quote 18]). The introduction of off-grid energy sector regulations has

lowered legal risks and with this, the barriers to entry. As more companies are drawn into the sector, chances for BM experimentation increase due to greater activity in the market and higher chances to form new value networks ([Quote 16], C7, C28, C29), even in cases where the regulations have been subject to processual inefficiencies [Quote 17]. A reliable regulatory framework also allows companies to plan and allocate project development resources more accurately as a large part of these costs are determined by the requirements defined in the regulations, hence enabling them to commit a fixed share of these costs to BMI (C7, C12, C23, C26, C27, C31, E7). By contrast, companies active in Zambia criticise the lack of implementation of the country’s off-grid energy masterplan which has made BMI challenging: “*Mini-grids [in Zambia] is risky. ... There is no procurement of mini-grids. ... We would like to change because technology’s moving faster [but] regulation is always behind*” [Quote 20] (see also Appendix B.6).

Second, we find that the introduction of a regulatory framework for off-grid energy in Sierra Leone, Nigeria, Uganda and Tanzania has helped off-grid energy companies to considerably ease their operations (C7, C18, C24, C26 – C29, E1). Implementing transparent sector rules has guided companies in how to organise their operations to comply with

Table 12

The impact of sector-specific versus society-wide policy mix interactions on business model innovation: Exemplary empirical evidence for the “maintain productive tensions” mechanism.

Primary effect	Sub- mechanism	Instrument type	Exemplary quote	Country context / source
Demand-pull	Keeping financial pressure to innovate	Economic	<ul style="list-style-type: none"> [Quote 64]: “There’s no risk capital available right now but I think this is an indication for people to actually start developing, whether looking at these multi-lateral development banks, start looking at new ways of financing these types of projects and new ways of creating more risk-accepting models, and really market-driven models, market-driven business models are needed. ... I don’t think subsidies make sense because if [the sector] is going to rely on subsidies it’s not going to be scalable. ... In the Ugandan context, ... there are better ways to spend [public] money. For us, it’s just about becoming more creative in terms of the business model ... because the only setup where you need subsidies is if people say ‘we are not going to change our business model’.” 	Uganda (C25)
	Lack of keeping financial pressure to innovate	Economic	<ul style="list-style-type: none"> [Quote 65]: “The low tariff that we are charging now, 30 dollar cent, is only because the project is 100% grant finance, fully subsidised. The 30 cent is used to cover the O&M.” 	Nigeria (C29)
	Lack of keeping financial pressure to innovate	Economic	<ul style="list-style-type: none"> [Quote 66]: “Our tariffs are the lowest and the most aggressive amongst mini-grid operators anywhere. ... We are super aggressive on cost, and that was not good enough for the Ghanaian government. ... There is a policy called a universal tariff policy with a ... rate which is about 6 cents per kilowatt hour ... which is completely unsustainable.” 	Ghana (C28)
	Lack of keeping financial pressure to innovate	Economic	<ul style="list-style-type: none"> [Quote 67]: “The challenge that we have in the policy and regulatory environment in Nigeria is that [import tax] affects companies’ business model and value proposition. ... What we want to do [is] promoting energy access in such a way that it is affordable. ... But putting that [tax] obligation on us ... contributes to the project cost, and by extension it’s going to increase the levelised cost of energy ... It [increases] the tariff that we have to charge based on the LCOE of the project.” 	Nigeria (C30)
	Lack of keeping financial pressure to innovate	Economic	<ul style="list-style-type: none"> [Quote 68]: “One of the biggest fears I have is around policy, specifically around import tax instruments. The reason I say that is because until June 2016, everything [solar energy equipment] was tax exempted, import duty and tax exempted. Import taxes changed in July 2016. They added a clause that specifically [increased] duty and tax. This really hurt us in 2016. We actually had to raise prices. It was a really grim time. Morale was down, prices went up. ... What worries me is the Ministry of Finance will get together in Tanzania and may decide to start applying import duties on batteries which is unlikely but a possibility. If something like that were to happen... We are barely profitable at pricing today.” 	Tanzania (C2)
	Ensuring operative flexibility	Regulatory	<ul style="list-style-type: none"> [Quote 69]: “[Policy makers in Uganda] allow us to be flexible with how we operate. ... We have mini-grids, but also ice plants, agro-processing, internet and communication solutions. There are some legal things you have to do, but that’s not really major. ... In the end, who cares about electricity anyways?” 	Uganda (C24)
	Lack of ensuring operative flexibility	Regulatory	<ul style="list-style-type: none"> [Quote 70]: “For the GIZ tender, they have a scoring system how they evaluate bids: 30% is technical, 70% is the tariff. So they are really pushing for cheap tariffs. ... [But] for this tender, GIZ and REA [Rural Electrification Agency in Uganda] just wants electricity ... So we provide the electricity that is needed. If it was our own project, we would look more into productive use [of energy], into what do the people need. ... What REA wants is the connections, ... we are following what the tender is giving us. How REA has structured the tender is limiting us in our business model, is limiting what we usually do [in Uganda].” 	Uganda (C7)
	Lack of ensuring broad inclusion of companies	Economic	<ul style="list-style-type: none"> [Quote 71]: “[Public] development organisations ... need to work with somebody with track record. They can’t work with you if you just opened a company today and here you are. ... They are ... strict, you are never paid in advance, so you have to deliver the task then get paid. [As a result], business goes to those companies that are well-capitalised, well-established [i.e. not us]” 	Uganda (C12)
	Lack of ensuring operative flexibility	Regulatory	<ul style="list-style-type: none"> [Quote 72]: “We haven’t solved the problem of electricity that 600 million Africans don’t have. In order to get there, we need innovation. ... The regulations need to allow for that, and most regulatory frameworks don’t. ... Part of the point of the regulation is actually to limit innovation, or put boundaries around it, in the name of protecting the customer.” 	SSA in general (C28)
	Lack of ensuring broad inclusion of companies	Economic	<ul style="list-style-type: none"> [Quote 73]: “The World Bank funding, the major component is a performance-based grant, so you are not paid any money upfront. You are expected to go ahead, raise your capital, develop your project and once your project is developed you get paid the subsidy per connection. If there is a local developer and a foreign developer, because a foreign developer has access to funds, the foreign developer quickly mobilises funds and can develop maybe 100 mini-grids within 3 years, but a local developer who also has technical capacity could only raise money to do 20 sites. ... They want to see traction on ground. They want to start seeing results. ... We will see a considerable level of energy access within the next 1-3 years.” 	Nigeria (C29)
	Lack of ensuring broad inclusion of companies	Economic	<ul style="list-style-type: none"> [Quote 74]: “[Our international funding organisation] requires us to connect 3,000 customers in 5 months, and we were to procure the materials, to do the connections, then we would get reimbursed after verification. [...]. We showed that it would cost us a billion shillings a month, as part of the cost. As a company that hardly makes a billion shillings a month, you can see how that affects us commercial wise. We ... told them we cannot do it.” 	Uganda (C21)
	Lack of ensuring broad inclusion of companies	Economic	<ul style="list-style-type: none"> [Quote 75]: “GIZ are very poor at communication. They never get back to you. ... It might take you months, no response. ... We realized the criteria or requirements that they put forward. I don’t think there was any Ugandan company [who] would qualify. So for such bids, why have you wasted your time to call people [like us] and the guy tells you the company must have the annual turnover of an equivalent of say 10 million euros. Yea? You want 10 million euros? That is a joke.” 	Uganda (C18)

(continued on next page)

Table 12 (continued)

Primary effect	Sub- mechanism	Instrument type	Exemplary quote	Country context / source
Technology-push	Lack of ensuring broad inclusion of companies	Economic	<ul style="list-style-type: none"> [Quote 76]: “[The grants] were specifically aimed at local entrepreneurs so you have to be Nigerian to get that grant from the Bank of Industry. In fact, in our own case, I partnered with a Dutch registered company and we applied and we did not get shortlisted. Even though our proposal was number 1, we were not shortlisted because the company was registered in the Netherlands” 	Nigeria (C29)
	Lack of ensuring broad inclusion of companies	Economic	<ul style="list-style-type: none"> [Quote 77]: “I think it’s been fairly easy for foreign companies to enter the market but there’s always a stage that they will need a local company to do the ground work and because we understand the environment and the communities. The main hindrance for the locals, of course, is the financing. Foreign companies have always come in with cheap money. They are able to borrow at a fairly good interest rate. It’s easy for them to enter the markets with that kind of leverage. [...] That is the consequence [that foreign companies push out local companies] because when foreign companies come largely they implement projects with their interests in mind so we have seen very little in the aspect of developing local capacity” 	Zambia (C6)
	Lack of ensuring broad inclusion of companies	Economic	<ul style="list-style-type: none"> [Quote 78]: “The only challenge is that you will find that often times local developers don’t have access to funding as much as foreign developers do. Most of them are citizens of the US, European countries, UK. They have access to funding. It is easy for them to raise funding than local developers. Local developers are in a disadvantage. So we have to work twice as hard as our foreign competitors would do to raise money to do some considerable amount of work within this space” 	Nigeria (C31)

regulatory requirements such as technical performance and environmental impact standards (C7, C14, C27, E1, E3). This has facilitated quicker implementation of successful projects, accelerated company-internal learning processes and enhanced opportunities to develop and test BMIs (C4, C7, C26 – C28). For instance, C4 explains that Sierra Leone’s pragmatic off-grid regulatory framework “*has really allowed us to invest more time and resources into what we offer to customers, what our value proposition can be*” [Quote 21]. It has also helped protect entrepreneurs from making mistakes in their early projects, with the Ugandan regulations going as far as formally requiring small-scale entrepreneurs to form partnerships as they enter the market [Quote 23, Quote 24]. By contrast, in the Nigerian case where regulations have taken longer to be implemented, innovations of value capture approaches and value networks have taken longer than in Uganda and Sierra Leone, and have diverged considerably, ranging from collaborating with a single small-holder farm (C29) to developing encompassing BMIs targeting several rural value chains and acting as producer and distributor for these products (C31).

Third, ensuring an effective flow of information increases transparency in terms of policy objectives and customer needs, eases the forming of partnerships, and accelerates learning and capacity building (C3, C20, C25 – C27). Information flow instruments can be targeted at three critical interactions in this regard, namely between companies and consumers, between companies and policy makers, and between different companies themselves. Uganda for instance targets all three of these interactions: The government legally requires community engagement, actively includes the private sector developing new sector regulations and holds infrequent but regular off-grid sector events (E13, E14, Appendix B.3). For C20, this engagement with the local community was important to align value propositions and value capture approaches with the actual needs and barriers on the ground, stating that “[t]hose meetings served as a platform for the private sector to improve. So if you look at the first systems the private sector put in, they are very different from what they are now” [Quote 26]. Including the private sector in policy development implies that planned changes to policy strategies and instruments are communicated to companies ahead of time such that they can plan and adjust their operations accordingly, a process of critical importance according to C25 [Quote 29]. Finally, sector meetings have helped create a value network characterised by a common identity and narrative amongst several local mini-grid developers in Uganda who refer to themselves as “*the class of 2012*” ([Quote 27], C25, C26), marking the year of the first major off-grid energy sector meeting in the

country. Indeed, C24, C25, C26 and C27, all regularly taking part in these meetings, have been experimenting with the same class of complex BMI in Uganda simultaneously. By contrast, C2 and C6 note that this type of state-sponsored transparency is largely absent in Zambia, exacerbating knowledge exchange and the formation of strategic partnerships due to higher levels of uncertainty [Quote 30, Quote 31].

4.1.2.2. Technology-push instruments. We find that sector-specific technology-push instruments create supportive conditions for BMI by (1) supporting innovative entrepreneurs, and (2) building innovation-relevant capacities. First, economic technology-push instruments such as grants for entrepreneurs and concessional loans, in our case often provided by international donor organisations, have been a feature of almost all companies in our sample who have engaged in complex BMI (C23 – C31, E1 – E3). They have been instrumental in allowing local, African companies to use their local knowledge to design their own versions of off-grid energy sector BMIs ([Quote 33], also C20, C26, C29, C31). For instance, a grant to local Ugandan mini-grid entrepreneur C26 in 2017 enabled them to quickly implement their vision of moving from primarily being a power company to being a food cold chain company [Quote 32]. On the contrary, local companies who have not benefitted from targeted financial support have repeatedly reported their struggles in innovating their BM despite being aware of the needs for novel, upfront finance-heavy value capture approaches that help make energy access affordable: “*We have never received any external finance from anyone. ... We cannot finance equipment, or do pay-as-you-go. ... It is really a challenge for us, because when you go to [see] people in the village, they cannot afford the initial investment of a typical solar system*” ([Quote 34], also C1, C12, C14, C32). Another example for a widely deployed technology-push instrument are import tax exemptions for solar PV cells, and, in some cases, related solar equipment, to provide an incentive for companies to move into the off-grid solar market (C1, C2, C12, E1, E7, E8).

Second, policy instruments to build innovation-relevant capacities in Sierra Leone and Uganda have helped to build the critical skill of quickly implementation new BMs. Sierra Leone’s effort to improve technical and management capacities in both government and the private sector is helping to accelerate design and deployment of new BMs ([Quote 35], also E2, E7). Furthermore, Uganda’s Centre for Research in Energy and Energy Conservation at Makerere University provides a limited degree of state-sponsored entrepreneurial training to complement their wide range of technical trainings (E10). By contrast, international company

C6 explains how in Zambia, the poor quality of public education is a key barrier for innovation in the sector: “[The biggest challenge] would be the lack of entrepreneurs, the ability to run the company. ... Schools don’t teach it properly” [Quote 37].

4.1.2.3. Demand-pull instruments. Systemic and technology-push instruments are being complemented by sector-specific demand-pull instruments to improve the business case for off-grid energy companies. They provide operational and financial incentives to engage in the market, a key step especially early on in the industry development phase where economies of scale and learning curve effects have not yet had significant effects (C25, C26, C30, C31, E1, E2, Appendix B.2, B.3). An exemplary economic instrument for this purpose, deployed in Sierra Leone, Nigeria and Uganda, is to package several mini-grid sites into one combined tender issued via public procurement, implementing the policy strategy of accelerating scale for off-grid companies (C7 – C9, C19, C25, C28 – C30, E3, E6). Four different interviewees suggested that the increased number of sites within one project enabled them to define and test broad approaches to value proposition and capture approaches, combining affordable electricity access with economic development opportunities ([Quote 39], also C7, C24, C28). Furthermore, both international donor organisations such as the World Bank or German development institution GIZ, as well as national governments in Nigeria and Uganda provide different types of subsidies to off-grid energy companies which some companies have indicated to be critical for them [Quote 40, Quote 42]. While subsidies have increased the number of companies operating in the market, Section 4.3 shows that they need to be carefully balanced to foster BMI.

4.2. Impact of society-wide policy mixes on BMI

4.2.1. Society-wide policy strategies

While sector-specific strategies primarily set a long-term foundation for companies to operate in the market, our findings suggest that society-wide policy strategies **integrate societal objectives** into the sector. These objectives are key to defining the system conditions and boundaries which influence off-grid energy companies’ BMI. Specifically, we find that society-wide policy strategies built on societal objectives such as inclusiveness and affordability of services, local and national development needs or environmental concerns (see Table 6 for the key examples in our data) can influence the direction of BMIs by (1) integrating pricing guidelines, (2) integrating type of service guidelines, and (3) integrating local industry growth guidelines.

First, policy makers in Uganda, Sierra Leone, Ghana and Zambia are convinced of the necessity to provide public services to poor rural households in an equitable way, declaring it politically intolerable to charge these households more than what urban grid-connected households pay (E10 – E12). Such society-wide objectives of inclusive development through affordable services appear to have been important drivers for all interviewed off-grid companies with a complex BMI in Uganda and Zambia in our study (C7, C9, C24 – C28): These companies all indicate that they have motivated by such society-wide policy strategies to adjust their value propositions towards supporting and actively creating rural development. While such policy strategies alone do not exert a concrete legal or economic constraint mechanism without associated policy instruments, they have an important role to signal government preferences and provide guidelines for compatible strategic directions for companies within which they can innovate their BMs [Quote 44]. Critically, this signalling effect exists for companies even before entering the market, inducing companies to think about adequate BMs for the specific policy mix setting and thereby accelerating the BMI process (C25, C27, C28). For instance, C27, who started the company with the intention of only selling electricity, explains that in their very first mini-grid project in Uganda, “due to [Uganda’s affordability and development policies], our value proposition now is to deliver an integrated

community development project” [Quote 43]. This is closely coupled with a value capture approach of marketing a range of productive services capable of higher per-kWh returns than selling electricity to households (see also [Quote 44, Quote 46]). It is key to note that policy instruments in Uganda do not force companies to adopt this type of BM, suggesting the salience of society-wide policy objectives as strategic guidelines for BMI. By contrast, we find that in Nigeria and Tanzania, where this society-wide objective of affordability of public services has not featured in relevant policy strategies (Appendix B.2, B.5, E3, E7), mini-grid companies in our sample are charging roughly double the per-kWh price compared to what mini-grid companies in Ghana and Uganda charge, where such constraints exist, despite similar cost structures (C7, C24 – C28). As selling electricity to customers alone would not be a financially viable option for most mini-grid projects (C6, C7, C19, C23, C24), companies operating in a system characterised by affordability objectives are driven to experiment with value capture innovations to broaden their revenue streams ([Quote 43, Quote 44], also C28).

Second, societal objectives can help to underline government intentions for certain types of services, which may require changes to companies’ BMs to adjust their service offerings accordingly. A salient society-wide advocacy for specific types of services can motivate companies to consider value proposition and capture innovations. For instance, the societal objective of ensuring inclusive rural development can manifest itself in a priority of electrifying most households in a given village regardless of how profitable each one of those connections are (E2, E11). Companies entering the market are aware that meeting this policy objective can only be achieved by innovating their BMs away from established off-grid approaches of providing electricity (Table 2) towards new value capture approaches that allow them to still remain profitable. For example, company C7 in Uganda states that “the Rural Electrification Agency, they are pushing us to connect all households in the village. All of them! They tell us to come up with innovative solutions to make it happen” [Quote 49]. C7 went on to report that in response, they innovated their value capture approach by integrated agro-processing, food cold storage, internet connectivity and e-mobility into their operations in Uganda as these options, by virtue of delivering productive economic value, are able to increase the return for each kWh of electricity generated compared to just selling electricity for household appliances. This example is particularly instructive as C7 is a company that has specialised in offering highly standardised solar mini-grids following the established, energy-centric off-grid BM in several African countries in our sample (Zambia, Uganda, Nigeria and Ghana), but has only applied substantive innovations to its BM in Uganda and Sierra Leone where such a BMI was required to be successful in the market and comply with society-wide policy strategies.

Third, society-wide strategies with the objective of growing local industries (Appendix B.2, B.3, B.6) encourage localised approaches to value creation and value network expansions. For instance, Zambia has been considering a stronger emphasis on local industry and business development, which would imply that a certain percentage of investment has to benefit Zambian companies (E5, E6). In effect, this would constitute what C9 calls a “local constraint” for international companies when designing their value network [Quote 51].

4.2.2. Society-wide policy instruments

Ensuring the achievement of the societal policy objectives and strategies discussed in Section 4.2.1, society-wide policy instruments **implement societal constraints**. These instruments exert a regulatory or economic force on companies to innovate their BMs to conform to these objectives. While we do not find evidence for society-wide technology-push instruments, our data suggest links between both systemic and demand-pull society-wide instruments and complex BMI.

4.2.2.1. Systemic instruments. Systemic society-wide regulatory and economic instruments implement societal constraints for companies in

the form of mandating additional value creation which tends to involve BMI to do so. For instance, the regulatory measure of a required minimum local content component in off-grid energy projects are thought to be key in directing companies towards the development of new localised value networks (C25, C26, C30). Company C27 in Uganda states that they signed an agreement with the local district government which implements a communal value capture approach, specifically *“a revenue sharing provision where the company retains only 55% of the value, and then the rest is shared between women operating the water and fish plants and then the district as well”* [Quote 54]. The revenue component belonging to the community, 45% of the total, implied that C27 had to build a deep value network with villagers and small local businesses in order to deliver value. It also meant that their value capture approach had to be adjusted to be feasible within their local setting working with the women's groups. Similarly, C26 explains its work under a Public-Private Partnership (PPP) arrangement, an economic profit-sharing instrument where the public sector enters into an agreement with a private firm to deliver and operate a project [Quote 55]. The PPP instrument allowed C26 to divide tasks and focus on expanding its complex BMI based on productive use of energy.

4.2.2.2. Demand-pull instruments. Adding financial pressure on companies to innovate is the main sub-mechanism linking society-level demand-pull instruments with BMI. In our data, instruments that implement either one of the society-wide objectives to provide affordable public services and to foster inclusive rural development can exert this pressure. To start with, a key regulatory instrument to enforce the society-wide constraint of affordable public service provision in Uganda and Sierra Leone is a legal obligation for each mini-grid project to negotiate the tariff with the regulatory authority. Notably, for most projects, neither country quantifies a strict tariff limit in its mini-grid laws but allows for case-by-case assessments (C7, C23, C24, C28, E7, Appendix B.3, B.4). In response, companies have refined their BM to ensure affordability of services for households (C24 – C27). As Ugandan entrepreneur C26 explains, regulations to ensure affordability are *“forcing”* them to find innovative solutions to make their projects financially viable, with C26 expressing confidence that they will be able to implement such BMs [Quote 58]. Similarly, objectives to create inclusive economic development can be translated into regulatory constraints on the minimum number of households a mini-grid must supply, driving companies to expand their value propositions to reflect inclusiveness of their services, and adapting their value capture approach to meet the financial challenges of this inclusivity constraint (C7, C27). Instruments that add financial pressures to innovate can thus be motivated by more than one society-wide strategy: As C19 explains, instruments applying pressure to provide both affordable and inclusive access to energy, have combined to *“gridlock us from two sides”*, namely requiring to charge customers low tariffs to recover the high upfront investments needed to provide electricity connections to all households [Quote 57].

4.3. Impact of sector-specific and society-wide policy mix interactions on BMI

The off-grid energy sector in the six African case countries we study is subject to sector-specific and society-wide policy strategies that are informed by different policy objectives. In combining our analyses in Sections 4.1 and 4.2, a tension becomes salient between these two types of policy objectives, namely the market-opening function of sector-specific policy strategies and instruments on the one hand, and the constraining function of society-wide strategies and instruments on the other. In this section we examine how the interplay between these two types of policy objectives can foster BMI by **maintaining productive tensions** between multiple objectives. We find that this tension can result in drawing companies into the market for the long-term and

supporting their development of new BMs, while simultaneously applying pressure to accelerate BMIs and guide them towards achieving societal objectives. For this mechanism to function, however, it is critical that an adequate balance between sector-specific support and society-wide constraints is maintained in order for the resulting tension to have a productive effect for BMI.

In this section, we present evidence for three sub-mechanisms illustrating how this balance can become distorted, and conversely, how it can be maintained, namely through (1) keeping financial pressure to innovate, (2) ensuring operative flexibility, and (3) ensuring a broad inclusion of different companies. While tensions between different objectives are apparent when comparing sector-specific versus society-wide policy strategies, they tend to become tangible for companies when they are implemented via concrete instruments as they actively legally and/or financially govern the companies' operations. We find demand-pull instruments to be most prone to distorting the balance between different policy objectives as such interventions can most readily be tied directly to one objective. This forces the focus on one specific objectives over several others and thereby limits the potential for BMI to address multiple policy objectives simultaneously.

First, the balance that creates productive tensions can become significantly distorted if economic demand-pull instruments provide such substantial support that they pull companies toward their specific objective to an extent where complex BMI to achieve other objectives becomes uninteresting and financially unnecessary. We find several different instruments implemented by international donor organisations in the off-grid energy sector in SSA that were designed to foster the donor organisations' objective of achieving the sector-specific SDG7 of increasing energy access. In an effort to push for SDG7, subsidies from the World Bank and GIZ have been so high that they make selling electricity to rural households financially viable without having to generate additional revenue streams (C22, C25, C24, C29, C30, E1). Indeed, almost all traditional mini-grid companies without complex BMI in our sample have stated their firm belief that they require these subsidies to make mini-grids in SSA financially viable while offering affordable tariffs (C5, C6, C9 – C19, C21, C22, C33). Companies with highly innovative BMs, however, have figured out ways to do so without relying on subsidies (C7, C23 – C31). Hence, these generous subsidies for household connections have taken away incentives for companies to design new BMs capable of meeting different policy objectives and their own financial viability. As a consequence, two leading innovators, C25 and C26, passionately argue against operational finance support instruments: *“I don't think subsidies make sense because if [the sector] is going to rely on subsidies it's not going to be scalable. ... For us, it's just about becoming more creative in terms of the business model ... because the only setup where you need subsidies is if people say ‘we are not going to change our business model’”* [Quote 64]. At the other extreme of the spectrum, especially in contexts with highly constraining society-wide instruments such as strict requirements for low tariffs or full electrification coverage of all households, too little demand-pull support can similarly hinder BMI. For instance, C28, a company implementing complex BMI in Sierra Leone said that in Ghana, the fixed electricity tariff for off-grid projects of 0.06 USD/kWh, less than 10% of what other companies in our sample have been charging despite similar cost structures (C7, C24 – C27), is simply too low to make work [Quote 66].

Second, regulations need to allow companies enough flexibility to innovate. Where demand-pull instruments are conditional on achieving a narrow set of objectives, they often automatically limit the types of acceptable value proposition and capture options of companies. This approach of focusing companies on achieving a set of narrow preferred objectives reduces the funders' risks in achieving their underlying objective, but at the same time prohibits complex BMI capable of meeting multiple policy objectives. For instance, the mini-grid regulations drafted by the Rural Electrification Agency (REA) for a public tender in Uganda co-organised by German development agency GIZ, explicitly did not allow for the critical value capture innovation response

of adding revenue streams but required companies to focus on electricity access provision (Appendix B.3). As C7 explains, “REA just wants electricity ... If it was our own project, we would look more into productive use [of energy], into what do the people need. How REA has structured the tender is limiting us in our business model” [Quote 70]. In this specific example, there is a noticeable disconnect between these narrow regulatory boundaries and Uganda’s economic development vision informed by a belief that “electricity is a driver of socio-economic transformation of a nation” (Government of Uganda, 2016).

Third, both demand-pull and technology-push instruments can be designed in ways that exclude certain companies from participating in the market, instead favouring those companies closer aligned to a narrow set of policy objectives. This makes complex BMI less likely to occur as companies benefitting from such schemes are chosen based on their strength in established and, in our case, BMs with a single objective of providing energy access. For instance, the World Bank’s recently introduced result-based financing for mini-grids in Nigeria and Uganda explicitly tie payments to a traditional type of value proposition (electrifying households). As C21 explains, in its quest for rapid energy access scale-up, this instrument has been designed with such aggressive energy access performance targets as prerequisites for accessing the energy connection subsidies that it *de facto* excluded them and other local and early-stage companies from participating [Quote 74]. C29 states that through its associated instrument, the World Bank “want[s] to see traction on the ground” in terms of energy access quickly, as opposed to focusing on long-term economic development [Quote 73]. In some cases, such economic demand-pull instruments have been coupled with explicit regulations about minimum required annual turnover and prior experience in mini-grids that local and early-stage companies have been excluded from these schemes *de jure*, greatly limiting opportunities for BMI in the process (E1, E2, E8). Furthermore, while technology-push instruments critical to ensure a broad inclusion of innovative companies in the market (C5, C6, C18, C20, C21, C27, C29, C31, E1, E2, Appendix B.2, B.3), we find several examples where they have, similarly to demand-pull instruments, resulted in excluding a significant subset of specific companies for the sake of companies with a profile viewed by policy makers to be favourable for a specific policy objective. For instance, to minimise funder risks, international grants are often provided to established and usually non-African companies with proven value propositions that directly adhere to objectives the funders have set out (C7, C12, C21, C29, E1, E7, E10). C6 points out that international

companies who benefit from these funds tend to be equipped with both a narrower understanding and a narrower incentivisation regarding the value proposition of its off-grid energy operations than domestic companies, for instance paying less attention to local development objectives which decreases their drive to innovate their BM in such directions [Quote 77].

5. Discussion

5.1. Explanatory model: Conducive structural conditions for complex business model innovation

Illustrating the results discussed in detail in Section 4, this section presents a theoretical model to explain how policy mixes create conducive structural conditions for BMI (Fig. 1). It summarises both how the five main mechanisms derived in Section 4 influence the conditions for business model innovation (Table 7), and the empirical evidence underlying the model along a cross-country comparison (see Table 13 for an overview). The model is able to explain how the policy mixes summarised in Table 6 are able to foster conditions for complex BMI in some of our country cases while they largely fail to do so in others.

Regarding the five mechanisms illustrated in Fig. 1, our results show that, first, sector-specific policy strategies creating a long-term foundation for the private sector are a *sine qua non* for BMI (Section 4.1.1). Such policy strategies, formulated as sector development plans, are informed by long-term sector growth objectives. As detailed in the results section, policy strategies create long-term foundations by signalling the provision of reliable market access, the acceleration of scale-up opportunities for companies, and the promotion of partnerships. In our context, off-grid sector development plans in Zambia, Tanzania, Nigeria, Uganda and Sierra Leone have opened up the market for business and created a long-term foundation for engagement and potential for companies to innovate their value proposition and value capture approach as well as form new collaborations (Tables 6 and 8). Ghana, however, wants to develop mini-grids entirely through its public sector, making it clear that private companies have no significant role to play in their off-grid electrification strategy and providing no meaningful space for BMI.

Second, sector-specific policy instruments are critical for implementing sector-specific development plans and objectives by setting supportive conditions for complex BMI to occur (Section 4.1.2). They

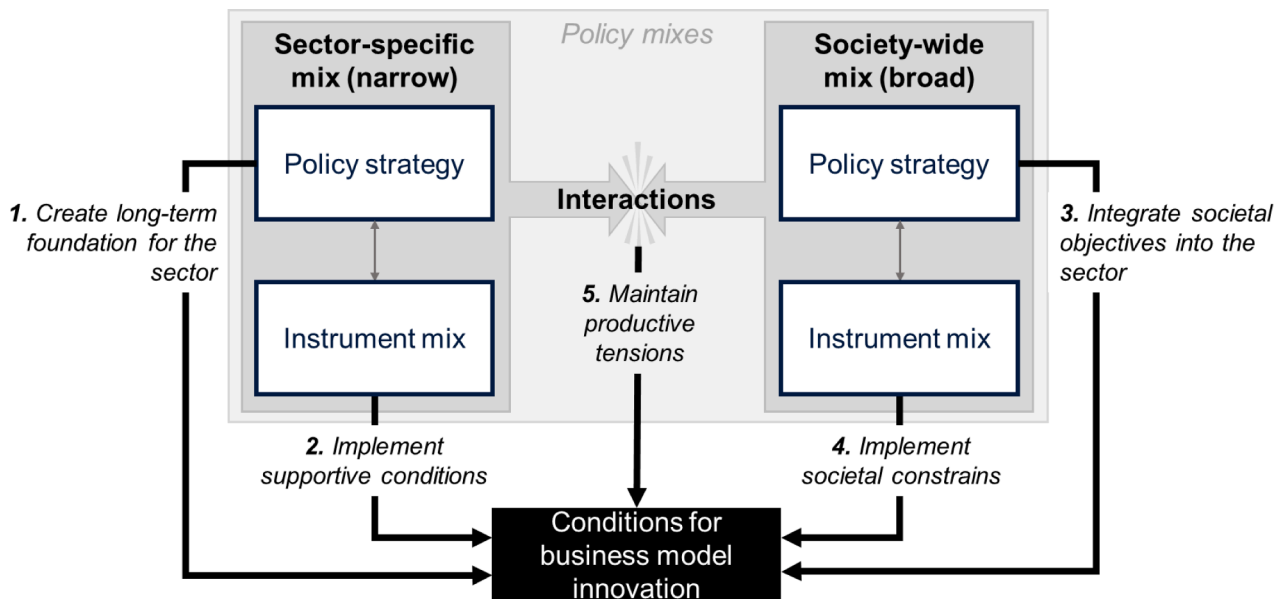


Fig. 1. : Explanatory model for how policy mixes create conducive structural conditions for complex business model innovation.

Table 13

Explanation of type of structural BMI conditions for the six empirical country cases studied in this paper using the different mechanisms of the explanatory model.

Country cases studied in this paper ¹							
Model stages	Ghana	Zambia	Tanzania	Nigeria	Sierra Leone	Uganda	Rationale for cases with “No”
1. Create long-term foundation	No	Yes	Yes	Yes	Yes	Yes	<i>Ghana</i> : Strategy to not develop off-grid energy through the private sector
2. Implement supportive conditions		No	Yes/No ²	Yes	Yes	Yes	<i>Zambia / Tanzania since 2016</i> ² : Sector development plan exists but lacks implementing instruments
3. Integrate societal objectives			No	Yes/No ³	Yes	Yes	<i>Tanzania / Nigeria</i> : No national government policy strategies that integrate affordability of services and broader development into the off-grid energy sector. In Nigeria, a programme by an international donor organisation exists which does integrate affordability into the off-grid energy sector ³
4. Implement societal constraints				Yes/No ³	Yes	Yes/No ⁴	<i>Nigeria</i> ³ : No national policy instruments to implement societal constraints, but a programme by an international donor organisation exists which does regulatory constraints on tariffs companies can charge <i>Uganda</i> ⁴ : The country features a case of international donor involvement where the specific regulations prohibit off-grid companies to integrate into rural value chains
5. Maintain productive tensions				No	Yes	Yes/No ⁴	<i>Uganda / Nigeria</i> ^{3,4} : Strong demand-pull instruments implemented by international donor organisations take away pressure to innovate BMs
Outcome: Conductive structural conditions for BMI?	No	No	No	No	Yes	Yes/No ⁴	

¹ We did not observe significant within-case variation in the policy mixes in Ghana, Zambia and Sierra Leone, but did observe within-case variation in Nigeria, Tanzania and Uganda, either due to a significant policy mix change over time or due to international donor organisations supporting and implementing their own policies in a given country context. The main cases of within-country variations are discussed in the footnotes 2 – 4 below.

² In Tanzania, the political regime change in 2015/16 meant several off-grid energy instruments were being scaled back as the new government implemented significantly less supportive structures to the sector (see also [Appendix B.5](#)).

³ In Nigeria, the World Bank implemented the Nigerian Electrification Programme. They introduce societal affordability objectives and associated instruments, but provide high levels of demand-pull subsidies and performance-based finance to enable them (see also [Appendix B.2](#)).

⁴ In Uganda, German development agency GIZ ran a pilot mini-grid tender that effectively prohibits firms to innovate their value proposition and value capture. The World Bank has also set up a similar, albeit smaller initiative as the one in Nigeria governed by a highly similar policy mix (see also [Appendix B.3](#)).

can have systemic, technology-push, and demand-pull effects: In the comparably nascent off-grid energy sector, our interview data suggest that systemic instruments are especially key as they organise the market by easing operations, providing legal security and ensuring an effective flow of information. Technology-push and demand-pull instruments combine to support innovative entrepreneurs, build relevant long-term capacities and improve the business case for off-grid energy. In our context, Tanzania, Uganda, Nigeria and Sierra Leone all use a combination of systemic, technology-push, and demand-pull instrument mixes to implement supportive conditions for BMI ([Tables 6 and 9](#)). On the contrary, BMI is challenging where sector-specific strategic plans are not effectively implemented, for instance because a country is lacking effective regulatory, economic and information instruments such as in Zambia, or where regulatory and economic instrument changes worsen the market attractiveness like in Tanzania after its political regime change in 2016.

Third, society-wide policy strategies integrate societal objectives into the specific sector under investigation, thereby helping to define the solution space for BMI in terms of the type of value companies are expected to deliver, and how to do so ([Section 4.2.1](#)). Societal objectives can manifest themselves through government guidelines related to different aspects relevant to a company's BM such as pricing, service delivery and types of partnerships to form value networks. Our results suggest that some societal objectives, in our case those related to fostering broad socio-economic development and affordability of basic public services, have stronger implications for the solution space for BMIs than others such as local industry growth guidelines: These former objectives are directly linked to key features of the value proposition and value capture approaches the companies are expected to use. Both Sierra Leone and Uganda combine different society-wide policy strategies that aim to foster broad socio-economic development and affordability of services ([Tables 6 and 10](#)). Where these objectives have not been as dominant like in Tanzania and Nigeria, off-grid energy companies are not guided as stringently to design BMs capable of meeting both sector-

specific and societal objectives. While both countries featured periods with supportive sector-specific conditions, the relative lack of societal policy objectives has meant that established off-grid energy BMs have largely been appropriate in meeting government objectives than in Sierra Leone and Uganda.

Fourth, society-wide policy instruments place concrete societal constraints onto companies' BMs by implementing society-wide policy strategies ([Section 4.2.2](#)). We find examples where systemic instruments are designed to encourage companies to extend their value proposition beyond the core sectoral objective of increasing the electrification rate, while demand-pull instruments add constraints which increase the financial pressure for companies to innovate their value capture and networks. In Sierra Leone and Uganda, both of these sub-mechanisms combine as government regulations ensure that energy access is not only provided, but provided such that a majority of households are electrified with a case-specific cap on what companies can charge for their service ([Tables 6 and 11](#)). Rather than defining a fixed maximum tariff for off-grid energy as is the case in Ghana, Sierra Leonean and especially Ugandan regulators assess each case individually, ensuring that the tariff constraint exerts innovation pressure but allows for sufficient degrees of freedom to remain navigable for companies and enables them to experiment with their BMs.

Fifth, the interactions between sector-specific and society-wide policy strategies and instruments create conducive conditions for complex BMI if a productive tension between the two is maintained ([Section 4.3](#)). We find that this productive tension arises when a policy mix manages to balance the implementation of supportive conditions for companies with ensuring that there is pressure to innovate to attain society-wide objectives. Sector-specific instruments, informed by related policy strategies to develop a certain sector, open up the market through supportive sector-specific conditions, while society-wide instruments constrain companies to create certain types of value consistent with the associated society-wide policy objectives. We find that this productive tension weakens if the balance gets tilted to either side, making the

conditions less conducive for complex BMI. Demand-pull instruments specifically may be prone to tilting this balance (Tables 6 and 12), with both economic (in the case of World Bank subsidies in Nigeria and Uganda) and regulatory (in the case of the GIZ tender in Uganda) instruments being designed such that there either was no meaningful financial pressure for companies to move past their established BM approach, or that they were outright prohibited to do so. By contrast, a policy mix appears to be conducive for complex BMI where its balance between support and constraints mandates and allows for BM experimentation in terms of value proposition, value capture and value network design, as is the case in Sierra Leone, or where international donor organisations have not intervened with economic and regulatory instruments in Uganda.

While the structural focus of our model does not aim to predict every individual occurrence of complex BMI, it corresponds with the frequency with which companies implement complex BMIs within our six case countries. In our case, we did not manage to identify a single company with complex BMI in those three countries where conditions have been either close to prohibitive (Ghana) or highly non-conducive (Zambia and Tanzania) for them to occur (Table 13). In Nigeria, a country with a population of over 200 million, the by far largest off-grid energy market of the six countries in our sample and where a sub-set of the mechanisms ensuring conducive structural conditions are implemented, we managed to identify only one off-grid energy company that has started to implement a complex BMI². By contrast, in Uganda and Sierra Leone where conditions are most conducive, there are a considerable number of companies simultaneously implementing BMIs, notably despite a comparably weaker macroeconomic environment: Out of the six countries in our sample, Uganda and especially Sierra Leone rank towards the bottom in terms of human development index, population size and rural electrification rate, GDP per capita and ease of doing business index (The World Bank, 2019; Table 1). They are furthermore neither the most democratic nor the most politically stable countries in the sample (Marshall et al., 2017).

5.2. Implications of the model

There are three main implications of our model for theory at the intersection between policy mixes and innovation. First, we identify the mechanisms that connect policy mixes with BMI. Although there have been calls for more attention to the link between policy and BMI particularly in the context of sustainability (Bolton and Hannon, 2016; Wesseling et al., 2020), there has still been an inadequate understanding of the role of policy for this type of innovation (Foss and Saebi, 2017). Our study is the first to our knowledge to unpack the role of policy mixes for BMI. Our model combines a focus on both policy strategies and policy instruments, illustrating in detail the mechanisms connecting these policy mix elements to BMI (Section 5.1). In doing so, we expand the previously limited literature and holistically assess the role of policy strategies in conjunction with instrument mixes for innovation. The policy mix literature has suggested that policy strategies are important to create a long-term foundation for innovation (Kivimaa and Kern, 2016; Rogge, 2019; Schmidt et al., 2012). However, we find that the mechanisms connecting policy strategies and their corresponding instruments to BMI are multifaceted: Sector-specific objectives drive long-term foundation and support, whereas society-wide objectives inform clear constraints. This finding resonates with the work of Howlett (2009) who identifies the importance of considering different levels of

abstraction for policy design. We contribute by showing how society-wide policy mixes operate differently from sector-specific in shaping the conditions for BMI. We build on a core empirical insight of our work that the effects of policy mixes are similar across BM components and suggest a holistic perspective to fostering complex BMI rather than an approach that focuses specifically on individual BM components.

Second, we identify how the balance between sector-specific and society-wide objectives within a policy mix operates. Our results suggest that maintaining a productive tension within a policy mix is key to enabling complex BMI. The balance, we find, is in fact a tension between support and constraint. When the tension is kept active, the conditions are more conducive for complex BMI. Once the tension is disrupted either by providing too much support or too much of a constraint, innovation is limited. This tension at the heart of our model contributes to the policy mix literature by offering an expanded conception of balance that integrates policy strategies. Balance in a policy mix has typically referred to a balance between instruments, often between demand-pull and technology-push instruments (Borrás and Edquist, 2013). Balance between these instruments accounts for the different market failures being addressed by each with demand-pull focused on the development of a market and technology-push addressing technology uncertainty and risk (Costantini et al., 2017; Hoppmann et al., 2013). We suggest a new approach to considering balance that abstracts from the primary effect of the individual instrument (demand-pull or technology-push) and instead identifies a balance between multiple objectives (sector-specific, society-wide) associated with policy strategies and instruments. Future research is required to develop different ways of operationalising balance in the context of BMI and other systemic innovations where multiple objectives at different levels are critical in guiding innovation. This might involve for instance measuring the balance between sector-specific and society-wide objectives of a policy mix, or identifying the extent to which there are active tensions between support and constraints by measuring how policies differ in their underlying focus. We argue that tensions have typically had a negative connotation in the policy mix literature, with a focus on reducing conflicts and negative interactions. At the same time there have been suggestions that tensions or some degree of inconsistency in policy mixes can sometimes be good for innovation, for example in the case of policy strategies (Edmondson et al., 2020) and the connection between policy strategies and instruments (Makkonen et al., 2015). We contribute by providing a theoretical foundation to understand how tensions can indeed be productive.

Third, we suggest that the distinction between sector-specific and society-wide is an analytical tool that allows for the effects of multiple policy objectives to be considered explicitly in policy mix research. In doing so, we contribute to recent conversations in the policy mix literature calling for more attention to multiple policy objectives (Edmondson et al., 2019; Kanger et al., 2020). Our focus on BMI, which is a type of innovation that connects multiple sectors and technologies, allows us to clearly identify the effects of different policy objectives. Our setting of low-income countries in SSA clearly illustrates the importance of studying these effects, because of the pressing need to consider not only individual sector priorities but also the societal needs for holistic and inclusive economic development. We call for more research to test whether the effects of sector-specific and society-wide objectives within policy mixes operate in the same way for different types of innovation. We also encourage scholars to expand policy mix research in low-income countries where the needs for addressing multiple policy objectives offer opportunities for impact and innovation. Finally, we challenge policy mix researchers to develop conceptual clarity on the use of terms including goals, objectives and rationales which have been under-theorized to date. These terms tend to be used interchangeably and we contend that their use has led to a rather siloed approach to fostering innovation. One avenue for conceptual development would be to engage with the emerging literature on purpose in management studies, where

² This company, C31, has discussed the critical importance of sector-specific support in Nigeria (Quote 3), but also its unique defiant and almost rebellious reaction to a lack of adequate society-wide policies in Nigeria (Quote 50), suggesting an isolated case where entrepreneurial drive has been able to at least partly overcome sub-par conditions (see the conclusion section for associated implications).

purpose is seen as distinct from strategy. The purpose is the underlying reason an organization (or a system) exists (Mayer, 2021). In the literature on corporate purpose, the concept has been used to push thinking about the role of business in society beyond a focus on making profits and more recently to consider broad societal and environmental values (Gartenberg et al., 2019; George et al., 2021). In the policy and innovation literature, the concept of purpose could enable deep engagement with the underlying reasons for fostering innovation in different contexts beyond the diffusion of technologies or even change in individual systems. Our concept of society-wide objectives starts to move in this direction, although what we observe is still a translation of purpose into a policy strategy. Future work that engages with the idea of purpose at a systemic level could offer a lens for combining sector-specific and society-wide priorities.

6. Conclusion

BMs are a vehicle to adapt technologies and other novel solutions in ways that can meet combinations of sector-specific and society-wide objectives. While BMI is increasingly seen as being critical to enable sustainability (Bohnsack et al., 2014; Cohen and Kietzmann, 2014; Hall et al., 2020; Khosla et al., 2021) transitions, to date, there has been a limited understanding of how policy mixes navigate multiple objectives in general, and how they can actively support complex BMI specifically. Through our inductive, cross-country study, we develop a theoretical model which explains through five key mechanisms how policy mix elements foster conducive structural conditions for complex BMI. At its core, our model suggests the importance of maintaining productive tensions between sector-specific and society-wide policy mixes. These tensions foster the conditions for complex BMI by simultaneously supporting companies within their sector and pushing them into addressing society-wide objectives. There thus appears to be merit in avoiding to resolve these tensions and instead to embrace them as a way of fostering BMI. Complex BMI is a key ingredient across many socio-technical systems and by its nature goes to the core of value being offered and the needs being addressed. Encouraging companies and other actors to engage in complex forms of BMI can challenge the boundaries between systems, which is a critical dimension for sustainability transitions and in addressing multiple sustainable development challenges. Supporting these types of expansive approaches to innovation requires fostering conversations and connections between sector-specific and society-wide priorities, not shying away from them.

There are several limitations of our study that provide opportunities for future research. First, there are structural factors other than policy that are likely to affect BMI. We do not directly focus on factors such as political systems, strength of institutions or cultural differences. We take some of these aspects into account in our description of the country cases, but we are unable to identify the effects of these factors or their interactions with policy. This is a rich area for further cross-country research. Second, we rely on reported accounts of our interviewees in identifying the connections between policy and BMI in our model. It would be preferable instead to observe the effects of policy mixes on BMI and to track these effects over time. We incorporate policy documents and archival research in order to triangulate some of our findings. We also used follow-up interviews to gain more clarity on certain connections, and to challenge our emerging understanding. Third, our paper focuses on the structural conditions for BMI as opposed to the actual onset of BMI. Indeed, our results suggest that adequate policy mixes alone may not be sufficient for complex BMI to occur as not all companies operating within suitable structural conditions rapidly innovate their BMs. Similarly, in isolated instances, companies may implement complex BMIs despite operating in sub-ideal policy environments. In addition to the structural factors this paper has shown to be critical to support complex BMIs, this suggests the importance of the agency of entrepreneurs for complex BMI. A noteworthy facet of company agency in our data is that small number of companies operate with different BMs

in different countries. This suggests that some companies may have the ability and preference to localise their BMs depending on the national context, adapting to specific business opportunities or market conditions. Future work in individual country contexts could focus more strongly on entrepreneurs as a unit of analysis to add an agency-driven perspective to our structural understanding of the conditions for BMI.

The main lesson for policymakers in the context of rural electrification is to consider carefully the combination of support and active constraints for the private sector. The right combination of support and constraints can enable and encourage the private sector to go beyond providing basic energy access and serve multiple sector-specific and society-wide objectives simultaneously. Conversely, unsuitable combinations can lock in solutions that may solve an immediate problem but not provide flexibility for local needs to evolve. For instance, it is critical to consider to which extent sector-specific instruments (e.g. the timing and type of financial support for companies) disable or impel any underlying BMI forcing mechanisms (e.g. affordability constraints). For sustainable development contexts, there appears to be a critical opportunity to improve the connection between different policy objectives through a careful assessment of stakeholder needs. The connections between sector-specific and society-wide policy mixes can open new ways of tackling complex challenges and new opportunities for collaboration between private and public sectors. We encourage policymakers to adopt a needs-centred approach in designing policy mixes that consider society-wide objectives. Asking questions such as what stakeholders need beyond a single sector and why, rather than starting with technology, opens ways to connect multiple solutions and to connect the work of multiple government ministries and departments. For example, focusing on providing jobs and steady income for people affects several industries such as agriculture and transport where reliable energy access could expand opportunities. Developing an objective for inclusive income generation may not seem like a traditional measure for energy ministries, but it can serve as a shift towards focusing on the nature of energy as a means of enabling other outcomes. Strategic visions are important, but they can often lead to siloes. Combining top-down and bottom-up policy approaches is critical in order to ensure that innovative solutions can be implemented in ways that address an underlying purpose.

Author Credit Statement

Both authors contributed equally to the paper. Both authors designed the research approach. P.A.T. led the data collection and coding, A.B. contributed to data collection and coding. A.B. led the development of the theory of the paper, P.A.T. contributed to the development of the theory of the paper. Both authors developed the explanatory model and wrote the paper.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

Appendix A

Appendix A

Classification of companies by degree of business model innovation.

Company	Country	Business model components ¹			Type of BMI ²
		Value proposition	Value capture	Value network	
C1	Zambia	Established	Established	Established	None
C2	Zambia	Established	Established	Established	None
C2	Uganda	Established	Established	Established	None
C2	Nigeria	Established	Established	Established	None
C3	Zambia	Established	Established	Established	None
C3	Uganda	Established	Established	Established	None
C3	Ghana	Established	Established	Established	None
C3	Nigeria	Established	Established	Established	None
C3	Sierra Leone	Established	Established	Established	None
C3	Tanzania	Established	Established	Established	None
C4	Zambia	Established	Established	Established	None
C4	Uganda	Established	Established	Established	None
C4	Ghana	Established	Established	Established	None
C4	Nigeria	Established	Established	Established	None
C4	Sierra Leone	Established	Established	Established	None
C4	Tanzania	Established	Established	Established	None
C5	Zambia	Established	Established	Established	None
C6	Zambia	Established	Established	Established	None
C7	Zambia	Established	Established	Established	None
C7	Uganda	Innovative	Innovative	Innovative	Complex ³
C7	Ghana	Established	Established	Established	None
C7	Nigeria	Established	Established	Established	None
C7	Sierra Leone	Innovative	Innovative	Innovative	Complex
C8	Zambia	Established	Established	Established	None
C9	Zambia	Innovative	Established	Established	Limited
C10	Uganda	Established	Established	Established	None
C11	Uganda	Established	Established	Established	None
C11	Tanzania	Established	Established	Established	None
C12	Uganda	Established	Established	Established	None
C13	Uganda	Innovative	Innovative	Established	Limited
C14	Uganda	Established	Established	Established	None
C15	Uganda	Established	Established	Established	None
C16	Uganda	Established	Established	Established	None
C17	Uganda	Established	Established	Established	None
C18	Uganda	Established	Established	Established	None
C19	Uganda	Established	Established	Established	None
C20	Uganda	Established	Established	Established	None
C20	Tanzania	Established	Established	Established	None
C21	Uganda	Established	Established	Established	None
C22	Uganda	Established	Established	Established	None
C23	Uganda	Innovative	Innovative	Innovative	Complex
C24	Uganda	Innovative	Innovative	Innovative	Complex
C25	Uganda	Innovative	Innovative	Innovative	Complex
C26	Uganda	Innovative	Innovative	Innovative	Complex
C27	Uganda	Innovative	Innovative	Innovative	Complex
C28	Ghana	Established	Established	Established	None
C28	Sierra Leone	Innovative	Innovative	Innovative	Complex
C29	Nigeria	Innovative	Innovative	Established	Limited
C30	Nigeria	Innovative	Innovative	Established	Limited
C31	Nigeria	Innovative	Innovative	Innovative	Complex
C32	Tanzania	Established	Established	Established	None
C33	Tanzania	Innovative	Established	Innovative	Limited

¹ For definition of “established” and “innovative” for all three business model components, see Table 2.

² In accordance with Foss and Saebi (2017), a BMI can only be called complex if an innovation occurs in all three business model components.

³ C7 is also involved in the public tender project set up by GIZ in Uganda and hence governed under a different policy mix (see Section 4). In that specific project, C7 is forced de facto to deploy an established business model.

Appendix B. Off-grid energy country policies and context

B.1. Ghana

While it initially allowed a small number of private companies into the country to develop pilot-style mini-grids in the country, the government of Ghana has been applying a strictly public sector-led model for the development of mini-grid electrification projects in Ghana in the last five years, and of energy access in general over the past two decades (Trotter, 2016). Under the Mini-Grid Renewable Energy Policy approved in 2016, the Ministry of Power (MoP) is fully responsible for the investment, ownership, and management of all mini-grid installations. The Volta River Authority (VRA), and the Electricity Company of Ghana (CG) and the Electricity Distribution Company (NEDCo) are responsible for power generation and distribution, respectively (Ghanaian Ministry of Power, 2016; Ghanaian Ministry of Power, Energy Commission of Ghana and National Development Planning Commission, 2019). This policy leaves the private sector with a virtually non-existent role in the mini-grid sector other than project execution: it is limited to out-contracted engineering and construction tasks (ESMAP, 2019). Less than five private mini-grid companies remain in the country today, and they are legally prohibited to expand their operations.

The existing Uniform Tariff Policy is applied throughout the country to ensure that all customers, regardless of location and type of electricity connection, pay the same price of electricity (Ghanaian Ministry of Power, 2016). However, because the national tariff is set up below the levelized cost of energy (LCOE), subsidies and funds such as the Renewable Energy Fund (REF) are needed to cover the revenue gap (African Climate Technology Finance Centre and Network (ACTFCN), African Development Bank Group and Energy Commission of Ghana, 2015; ESMAP, 2017, 2019). For example, the World Bank implemented the Ghana Energy and Development Project (GEDAP), which funded five pilot mini-grids located on a several islands of the Volta Lake. However, the national tariffs applied are not high enough to fully cover the operational costs of the mini-grids (Reber et al., 2018). The National Renewable Energy Laboratory (NREL) estimated that an annual amount of between 80 and 140 million USD of subsidies are required to cover the losses (Reber et al., 2018). The recent increase in public sector-focus included cases where the rare commercial licenses issued to private developers were either not renewed, revoked or constrained to small-scale operations, severely limiting the options for private sector mini-grid developers in Ghana. (ESMAP, 2019).

B.2. Nigeria

The Electric Power Sector Reform Act in 2005 was the first step in creating a legal environment for the private sector in developing and operating power plants in Nigeria. The Act established the Nigerian Electricity Regulatory Commission (NERC) as an independent regulatory authority that determines and approves codes and standards and sets cost-reflective tariffs and created the Rural Electrification Agency (REA), which supports rural electrification initiatives and oversees the Rural Electrification Fund (REF) (Federal Government of Nigeria, 2005). The Act also provided licensing requirements for power projects (Babatunde, 2011). However, mini-grids were not regulated since the Act only requires a mandatory license from systems with generating electricity above 1MW (Federal Government of Nigeria, 2005; World Bank and ESMAP, 2017). The first mini-grids in Nigeria, established in the early 2010s were governed by informal institutions, involving negotiations with communal and central political stakeholders and mostly conducted by local companies. A cross-industry scheme by the Nigerian government to provide seed funding to local technology entrepreneurs in the early 2010s constituted a crucial source of finance for these local firms.

In 2016, the Rural Electrification Agency in Nigeria issued its Off-grid Electrification Strategy, featuring quickly growing off-grid electrification targets over the coming decade (Rural Electrification Agency Nigeria, 2016). At the same time, NERC complemented this strategy

with a comprehensive regulatory framework for mini-grids. The framework categorizes the mini-grid sector into three main areas: (1) Mini-grids with below 100kW of distribution capacity; (2) above 100kW of distribution capacity, but below 1MW of generation capacity; and, (3) interconnected mini-grids (NERC, 2016). For mini-grids below 100kW, only registration with the NERC is sufficient to obtain a license to sell electricity, with the additional option to apply for a permit in order to have access to compensation if the main grid arrives. Companies are free to determine the tariffs with communities (IRENA, 2018b), and do not require building permits to start construction of the mini-grids. Mini-grids above 100kW of distribution capacity but below 1MW of generation capacity are required to obtain a permit. As for interconnected mini-grids, the mini-grid developer is required to enter into a Tripartite Contract with the connected community and distribution licensee. Nigeria does not have a policy strategy focusing on low tariffs for off-grid solutions. Mini-grids above 100 kW, the tariff is formally approved by the commission (NERC, 2016). Despite the regulatory framework providing a detailed policy and clear criteria for mini-grid development, as of 2017, all mini-grid developers purposely operate their mini-grids under the regulation's threshold of 100kW as they are not fully comfortable with the regulation (World Bank and ESMAP, 2017). To mitigate this concern, REA, with the financial assistance from the World Bank worth 350 million USD, implemented the Nigeria Electrification Project (NEP) in 2018. This five-year plan has two components dedicated to the development of solar hybrid mini-grids (World Bank, 2018). For the first component, REA will select 250 sites with already high interest from the private sector and prepare necessary information, including site surveys, tariff ceiling, minimum technical specifications, and minimum population that should be connected. REA then will invite private mini-grid developers to bid for minimum capital cost subsidies in order to provide electricity in these sites (World Bank, 2018). For risky areas such as northern Nigeria, the projects will be publicly financed, with the private sector constructing and operating the mini-grids. As for the second component, REA will provide result-based grants to mini-grid operators based on connections to new customers (USD per end-user), aiming to ensure financial viability for the supplier (World Bank, 2018).

B.3. Uganda

Uganda first introduced detailed rural energy access targets in 2012 as part of its Rural Electrification Strategy and Plan 2013 – 2022 (REA, 2012), and has set ambitious energy access targets since: It aims to grow its electrification rate from roughly 20% in 2018 to 60% in 2027 and 80% in 2040 according to Uganda's official Vision 2040 policy (Government of Uganda, 2016). To achieve these targets, the Ugandan government has acknowledged that both on-grid and off-grid solutions are required (Trotter et al., 2019). Uganda's main electrification sector development policy foresees that on-grid solutions will play a bigger role than off-grid in terms of realising the 60% target, but repeatedly states that it intends rapidly develop the off-grid sector, and intends to heavily rely on the private developers to do so (Government of Uganda, 2017).

Uganda has some of the most detailed and extensive mini-grid regulations in SSA to implement their sector strategy (Electricity Regulatory Authority (ERA), 2019). Mini-grids under 500kW must obtain a highly formalised license exemption certificate, those over 500kW need to obtain a full generation license. Both types of permits require obtaining environmental, financial and land right permitting processes, as well as, crucially, an agreement about the tariff to be charged. In a stark contrast to Nigeria, private developers need to negotiate the per kWh tariff for every project centrally with the Electricity Regulatory Authority (ERA). ERA is responsible for enacting a society-wide policy strategy of keeping public services affordable, with Uganda's Vision 2040 policy explicitly aiming for "affordable quality health and education services, ... affordable and reliable energy sources to facilitate industrialization, ... [and] affordable capital for start-ups" (Government of Uganda, 2016). Uganda's regulations also set an emphasis on effective

flow of information, requiring mandatory meetings between mini-grid developers and community members, as well as provide companies the opportunity to comment on regulatory and strategic policy plans ahead of their implementation. Uganda's has managed to attract foreign donors such as USAID to provide early-stage funding for local entrepreneurs. Furthermore, since 2018, Uganda's Rural Electrification Agency (REA) has been providing financial support for the distribution grid to some mini-grid developers to increase the number of households served through the mini-grid. In any qualifying project, the private company has to cover the cost of project development, power source and storage, as well as metering and any operational expenses, while REA pays for parts of the distribution grid at the site.

In parallel to Uganda establishing its own policies and regulations, the frequent involvement from donor organisations in the mini-grid industry in Uganda has led to two notable schemes within Uganda where companies are subject to a different policy mix: The first one is the World Bank results-based subsidy scheme as discussed for the Nigerian case (see [Appendix B.2](#)), where a small number of mini-grid companies can obtain substantial subsidies for connecting households to their mini-grids. For the second, German development agency GIZ developed designed specific regulations for REA for commercial tenders of mini-grids where a set of 15 to 25 mini-grids are clustered together. These tenders are highly focused on connecting as many households as possible, and leave considerably less room in their specific regulatory frameworks to navigate for companies than the national regulations in terms of the types of businesses can participate, and the types of services that have to be delivered.

B.4. Sierra Leone

The development of the off-grid sector in Sierra Leone is first mentioned in the country's National Energy Policy in 2009, albeit in a limited fashion. The policy's main objective is to ensure the provision of modern energy services for increased productivity, wealth creation and improved quality of life with a considerable focus on on-grid services ([Republic of Sierra Leone, 2009](#)). In 2015, the government of Sierra Leone began to develop dedicated strategic plans to combat low energy access rates in the country which comprises three main policy documents. Firstly, it launched the Country Action Agenda in 2015 which outlines Sierra Leone's energy access target of increasing its overall energy access to 92 percent by 2030. To achieve this, the country features a noteworthy explicit target of 37 percent of all rural connections to come from off-grid solutions ([SE4All, 2015](#)). Secondly, the Renewable Energy Policy in 2016 concretises the approach towards achieving some of these targets, focusing on strengthening capacity of state agencies to govern mini-grid projects, developing public-private partnerships (PPP) for mini-grids, and sensitising local communities on the benefits of mini-grid projects ([Republic of Sierra Leone, 2016](#)). Thirdly, the Electricity Sector Reform Roadmap 2017-2030 implemented in 2017 identifies necessary actions required in three periods – recovery (2017-2018), transition (2018-2020) and delivery (mid-term: 2021-2025 and long-term: 2025-2030) – to improve the electricity sector ([Republic of Sierra Leone, 2017a](#)), again featuring off-grid energy as a key strategy to improve energy ([Okafor, 2017](#); [Tice, 2016](#)). Critically, the roadmap puts a repeated and strong emphasis on communal needs and affordability, with a stated principle of focusing “on the complex needs of Sierra Leone's population and business community at national and local level, [namely a] sustainable and affordable service-delivery model based on understanding the needs of Sierra Leone ... [which draws] on the diverse and rich perspectives of the people, business community and staff members as invaluable sources of knowledge, experience and insight” ([Republic of Sierra Leone, 2017a](#)).

Regarding mini-grid regulations and licensing, the Electricity and Water Regulatory Commission Act established the Sierra Leone Electricity and Water Regulatory Commission (EWRC) in 2011 to regulate the provision of electricity and water services ([Republic of Sierra Leone, 2011](#)). The commission's main functions include issue, renew, monitor,

suspend and cancel licenses, provide guidelines on rates chargeable, and monitor the standards of performance for provision of electricity and water services. To enable the implementation of the country's off-grid policy strategy, EWRC drafted the mini-grid regulations in 2018 to provide guidelines on mini-grid licensing procedures, customer service rules, tariff setting, and mini-grid interconnection rules. According to the regulations, there are two categories of mini-grids: basic mini-grids, which are up to and including 100kW of distributed power, and full mini-grids ([Sierra Leone Electricity and Water Regulatory Commission, 2018](#)). The licensing and tariff setting process are different based on the mini-grid type. A basic mini-grid license authorises the licensee to construct, install and operate a basic mini-grid. In theory, tariff negotiations occur mainly between the licensee and consumers, however, the EWRC can intervene to ensure affordability principles. The tariffs for a full mini-grid licenses are set by the commission using a standard tariff determination methodology which is determined by factors including the cost of generating, distributing and selling electricity as well as socio-economic conditions of the mini-grid's site ([Sierra Leone Electricity and Water Regulatory Commission, 2018](#)). The Finance Act of 2017 also supports the development of the off-grid sector by providing duty waivers of solar PV equipment that meet the International Electrotechnical Commission (IEC) standards ([Republic of Sierra Leone, 2017b](#)).

B.5. Tanzania

Tanzania was one of the first countries in SSA to formally focus on off-grid energy provision: The Electricity Act in 2008 implemented a streamlined licensing process for Small Power Producers (SPP), which allowed all mini-grids with capacity below the comparably large size of 1MW to be exempted from requiring a license to operate ([Government of Tanzania, 2008](#)). The Energy and Water Utilities Regulatory Authority (EWURA) developed the closely related SPP Framework in 2008, outlining licensing and procedures, tariff setting guidelines and Standardized Power Purchase Agreements (SPPA) to stimulate SPP development ([International Renewable Energy Agency, 2016](#); [The Energy and Water Utilities Regulatory Authority, 2009](#)).

The Government of Tanzania opted for light-handed, business-friendly regulations in the early 2010s ([Contejean and Verin, 2017](#)). Companies were not limited in the tariffs they could charge but were allowed to reflect their costs, which allowed the government to save up to an estimated 1.1 million USD in avoided subsidies ([Reber et al., 2018](#)). Combined with regulations that were easy to navigate and through financial incentives from donor organisations, the number of mini-grids in Tanzania quickly increased in these years ([Odarno et al., 2017](#)). However, the Tanzanian general election in October 2015, where President Jakaya Kikwete was ineligible to run again due to term limits, resulted in significant development policy changes introduced by the country's new president John Magufuli. Nicknamed “the bulldozer” ([Roder, 2019](#)), Madufuli's government has quickly turned towards a nationalistic, state-driven policy strategy if development, declaring ‘economic war’ on foreign companies in Tanzania accused of capturing large portions of Tanzania's wealth. His “anti-foreign discourse” ([Jacob and Pedersen, 2018](#)) has made foreign companies weary of investing in Tanzania. Policy instruments in the off-grid sector have similarly been affected: The regulatory regime for mini-grids has been tightened, with the latest version of the Electricity Act in 2019 revoking the licensing exemption process such that all SPP regardless of system size are now required to have a license ([United Republic of Tanzania, 2019](#)). EWURA also released a new SPP Framework to provide updated regulatory guidelines, but as of this writing, the Framework was currently unavailable from the EWURA's official website.

B.6. Zambia

Zambia started to develop a policy strategy for rural electrification through its Rural Electrification Act in 2003 ([Government of Zambia, 2003](#)). Heavily supported by the Japan International Cooperation

Agency (JICA), it developed its Rural Electrification Masterplan for Zambia, adopted in 2009, which focused on the expansion of the national grid (Japan International Cooperation Agency (JICA), 2008). Zambia shifted more strongly towards integrating off-grid energy as part of its strategy to tackle low access rates in the late 2010s, and, via the Energy Regulation Board (ERB), presented a first draft regulatory framework for mini-grids in October 2018 (Energy Regulation Board Zambia, 2018a). The framework comprises of licensing, tariffs and technical requirements. It plans to categorise the mini-grid sector into three main segments based on the system capacity: (1) Less than 100kW, (2) between 100kW and 1MW, and (3) above 1MW. According to the draft framework, mini-grids with less than 100kW are licensed in a 'very light-handed manner', between 100kW and 1,000kW in a 'light-handed manner', and above 1,000kW require a 'full license' similar to grid-connected generation. Specifically, mini-grids with less than 100kW are planned to be exempted from the Electricity Act (EA) and the Electricity Regulatory Act (ERA) after gazetting (Energy Regulation Board Zambia, 2019). It is crucial to note, however, that at the time of writing, Zambia was still in the process of designing their mini-grid regulations, with most of the current regulations subject to potential change.

In principle, all three mini-grid categories are allowed to charge cost-reflective tariffs. Mini-grids with less than 100kW are exempted from formal tariff regulation and will have to submit information on average tariff applied, finances and sales on a five-year interval (Energy Regulation Board Zambia, 2018b). Mini-grids over 100kW, however, will need to provide ERB with proposed five-year tariff design, tariff levels and escalation rates. These tariffs are subject to review. Once approved, the tariff either stays fixed for five years (for mini-grids below 1MW) or is adjusted annually (for mini-grids over 1 MW) and periodically reviewed in five-year regulatory periods (Energy Regulation Board Zambia, 2018b). In addition to this affordability constraint, Zambian regulations are requiring companies to ensure local-level benefits for communities and local companies via required needs-based assessments, and provide different incentives for ensuring that local industry benefits are realised.

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