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Rural Electrification Policy and Enterprise Business Models in India
Responding to Change

Victoria Plutshack

WORKING PAPER | OCTOBER 2018

Working Paper on 'Rural Electrification Policy and Enterprise Business Models in India Responding to Change'.

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Citation: Victoria Plutshack (2018) 'Rural Electrification Policy and Enterprise Business Models in India Responding to Change' October.

Reviewers: Dr Cle-Anne Gabriel, Lecturer - Environmental Services, The University of Queensland and Subhanjan Sengupta, Assistant Professor - Strategy, Innovation, Entreprenuership and CSR, Birla Institute of Management Technology (BIMTECH).

Cover image: Abhishek Jain/CEEW

Publication team: Alina Sen (CEEW), Mihir Shah (CEEW), Aspire Design, and Friends Digital.

Acknowledgements: This research was funded by the Department of Land Economy at the University of Cambridge, as well as the Bruckmann Fund of Peterhouse. Thanks go to Dr Cle-Anne Gabriel and Subhanjan Sengupta, both of whom reviewed earlier drafts of this paper and provided very insightful comments. My sincere thanks also go to Abhishek Jain and the Council on Energy, Environment and Water (CEEW), who provided support and feedback during and after the fieldwork portion of this research.

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Contents

Abstract

One of our key global challenges is a continued lack of energy access outside of urban areas across Southeast Asia and sub-Saharan Africa, with over a billion people without access to electricity. While off grid solar technologies have been identified as an ideal solution, governments still struggle to adequately engage third parties – the private sector and non-governmental organisations – in providing these products. Yet, very little research focuses on the interaction between policy and the enterprises that provide off grid solar technologies. This paper uses interview data from enterprises, government officials and key informants to explore the impact of rural electrification policies through the lens of enterprise, focusing on the dynamics between rural electrification programmes and business models. Findings from India suggest that policies predominantly impact the revenue streams and customer segments that enterprises target. These changes have knock on effects to other enterprise characteristics, which have implications for the impact of policy on the enterprise landscape and the efficacy of policy implementation.

Keywords: Energy Access, India, Solar, Rural Electrification, Policy, Business Model

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1. Introduction

Over 1 billion people in the world are currently without electricity access, with 240 million living in India alone. Although most developing countries are increasing access through grid expansion, there is the understanding that off grid, renewable energy sources will be needed to reach the most rural populations (IEA 2017). Despite mixed findings on the link between off grid energy and development outcomes, there is some promise that even the smallest systems may improve quality of life (Rahman & Ahmad 2013; Parikh et al. 2012; Grimm et al. 2017). A range of renewable technologies are considered viable, but solar energy in particular stands out as an ideal solution for most developing countries (Yadoo & Cruickshank 2012; IEA 2017; Brass et al. 2012). Nevertheless, their success is still partially dependent on the business models they adopt (Friebe et al. 2013).

Strong policy direction is needed to reach the remote areas with these technologies, but rural electrification policy has previously relied heavily on grid expansion and fossil fuel subsidies, lowering the incentives for off grid technology even where they would be a cheaper alternative (Haanyika 2006; Banal-Estañol et al. 2017; Rehman et al. 2012). Yet very little research focuses on the interaction between policy and the enterprises that provide these technologies (Brass et al. 2012). Research focuses instead on technological aspects (Molyneaux et al. 2016), institutional characteristics (Haanyika 2006; Zerriffi 2007), the viability of business models (Jolly et al. 2012; Lemaire 2011), and user-centric approaches (Graber et al. 2018; Schillebeeckx et al. 2012). Research in the field typically ignores the symbiotic relationship between government and enterprise seen in the public administration literature (Girth et al. 2012; Lecy & Van Slyke 2013).

The Government of India has focused fifteen years of off grid rural electrification policy on 1) supporting third parties' engagement in the rural space and 2) contracting out public services to the same third-party enterprises. However, policy changes have also occurred, most strikingly, the cancellation of the National Solar Mission's financial support via the National Bank for Agriculture and Rural Development (NABARD) in 2015 and 2017. For most of the sector, therefore, central financial assistance outside of the tendered DDG scheme exists currently for microgrids and mini-grids only.

Focusing on enterprises in the off grid solar sector, this paper explores how enterprise's respond to these policies. This is a question approached by the public administration literature, but generally ignored in the work on off grid technologies (Brass et al. 2012; Girth et al. 2012; Lecy & Van Slyke 2013). Research focuses instead on technological aspects (Molyneaux et al. 2016), institutional characteristics (Haanyika 2006; Zerriffi 2007), the viability of business models (Jolly et al. 2012; Lemaire 2011), and user-centric approaches (Graber et al. 2018; Schillebeeckx et al. 2012).

This paper aims to explore the impact of the Government of India's rural electrification policies through the lens of off grid solar enterprises. Using interviews with off grid solar enterprises, experts and government officials, I compare narratives of enterprise change to understand how business models change in response to policy interventions. Findings suggest that policies impact areas of the business models that are exposed to change, which in this case are an enterprise's revenue streams and customers. These changes have knock on effects within the business model, which suggests that policies do not simply increase or decrease revenues, but change the shape of the enterprise landscape. In India, changes can be seen in a broad trend 1) towards

grid-connected customers, and 2) some movement away from solar home systems by small and medium-scale enterprises.

Although there are multiple forces are at work within the industry, we can use interviews to determine where rural electrification policies have had an impact, identifying them as one causal factor in enterprise landscape change. The literature on public administration suggests that the shape of the enterprise landscape (the size, diversity, etc.) impact the efficacy of policies that seek to utilise them. Therefore, there are implications to the efficacy of India's programmes based on these business model changes.

Section 2 outlines the national policies, public administration literature and business studies research relevant to the paper, before covering the data and methodology used in this study in sections 3 and 4. Section 5 explores policy's impact on finance and end user selection, and the causal relationships between enterprise characteristics. The findings have implications for the efficacy of the Government of India's energy access plans. Thereafter, section 6 outlines potential policy recommendations based on these findings. The paper's findings are then summarised in section 7.

2. Background

2.1 Rural Electrification Policy in India

In 2003, the Government of India passed the Electricity Act of 2003, which created notified rural regions (Government of India 2003). These were areas that were officially 'rural' in which private enterprises could provide power at an unregulated price, opening up rural electrification to third parties. It was soon followed by the Rural Electricity Policy of 2006, which announced the aim to provide electricity access to all as well as defining what constitutes an electrified village (Ministry of Power 2006).

For a decade, the main rural electrification scheme was the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY), which was initiated in 2005. It was replaced in 2015 by the Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY). Both schemes focus on grid expansion as the primary form of electrification, but include a Decentralised Distributed Generation (DDG) Scheme. Grid expansion is now supported also by the UDAY 24x7 state schemes, which also aim to improve the quality of the grid. Both RGGVY and DDUGJY use census records to identify villages that would not be reached by the grid within 3-5 years, at which point they fall under the DDG Scheme. The DDG Scheme is implemented through state governments, which tender off grid projects to supply power to those villages, providing a subsidy that is met jointly by the national and state governments.

In 2008, the Government of India released its National Action Plan on Climate Change, which included eight programmes to support more sustainable energy, housing, and transport (Government Of India 2008). One programme in particular, the Jawaharlal Nehru National Solar Mission (JNNSM), includes a provision for the support of off grid electrification. Specifically, the JNNSM includes both targets and subsidies for off grid solar energy, which is funnelled directly to the system integrator (in the case of micro/mini-grids) or through the National Bank for Agriculture and Rural Development (NABARD) for end users purchasing solar home systems (MNRE 2012). The JNNSM-NABARD subsidy has been cancelled twice since its inception – first in 2015 and again in 2017 (MNRE 2017). Its future is uncertain. The JNNSM off grid policies stands alongside the DDG Scheme as the two key policies that support off grid electrification via solar energy.

Moving forward, both the national and state governments are looking to better support microgrids and mini-grids. In 2016 Uttar Pradesh released a micro-grid/mini-grid policy, and Bihar has a plan currently in development (Government of Uttar Pradesh 2016). In 2016, MNRE also asked for comments on a draft national micro-grid/mini-grid policy (MNRE 2016). These policies broadly clarify the role of micro-grid/mini-grid operators within India's electricity framework, and outline potential subsidies and tariff regulations.

2.2 Non-State Actors in Delivering Rural Electrification

The relationship between government and third-party actors (NGOs, social enterprises, private sector, etc.) in delivering public services has taken a range of forms. Over the last 30 years, the private sector has been invited to participate in rural electrification in developing countries (Haanyika 2006; Yadoo & Cruickshank 2010; Cabraal et al. 1996). Because rural electricity – whether grid-based or standalone systems – partially shares aspects of private goods, there is the assumption that the private sector could be engaged to provide these services. More specifically, depending on the technology, electricity can be measurable, consumers can be charged relative to the amount consumed, and can be excluded if payment is not made (Ostrom & Ostrom 2014). In the off-grid context, all of these activities face additional challenges, but they are technically possible.

However, the motivations of the private sector and the public sector are often at odds, and there is a concern that privatisation will mean the side-lining of rural electrification (Haanyika 2006). In some cases, private investment has been poor in the rural space, due to a perceived lack of profits to be made, heavy subsides for government grid power, and lack of access to credit (Ahlborg & Hammar 2014; Yaqoot et al. 2016). Additionally, there is evidence that relying on the private sector has slowed electrification efforts (Cook 2011). Nevertheless, there is still a great deal of support for the concept of non-state enterprises, particularly SMEs, social enterprises, and NGOs, getting involved in the off grid space (Yadoo & Cruickshank 2010; Jolly et al. 2012; Yaqoot et al. 2016; Lemaire 2011).

There are some further criticisms of this approach. The aim of engaging the private sector in delivering public services is to save the public money on those services through competition (Entwistle & Martin 2005). Contracting out public services has been seen as a way of capturing private sector benefits and reducing taxpayer costs without selling state assets (Domberger & Jensen 1997). Contracting private enterprises assumes that this competition is present, but that is not always the case (Amir Hefetz & Warner 2012; Girth et al. 2012). Additionally, engaging private enterprise is considered to be at its weakest in situations where there is not a customer 'with the resources to provide a profit to the organisation that performs it', as is often the case in rural contexts (Cohen 2001).

The World Bank, among others, has suggested Public Private Partnerships (PPPs) as a way to mitigate risk for private sector coming in to a new market with low margins (Reiche et al. 2000). These partnerships are usually supported because they purport to reduce government inefficiency and lessen the burden on the taxpayer (Linder 1999). However, the degree of decentralisation and extant redistributive policies impact the true equity of these partnerships and the benefit they provide to the poor (Miraftab 2004).

Other non-private sector options exist also. NGOs can have very different relationships to government, but increasingly low-income countries find themselves with NGOs that focus on providing basic services (Coston 1998; Rahman 2006). This is at least partially because NGOs are being encouraged as market actors who can provide services at lower cost and higher quality than the government (Hearn 1998). Local cooperatives have also emerged in some regions in response to the failure of the public sector to deliver these services (Yadoo & Cruickshank 2012).

Crucially, the private and non-profit sectors are also bolstered by government in an attempt to both create and to take advantage of competition and capacity within these sectors. Recent literature has suggested, for instance, that where the US government supports non-profits, they are more prevalent, which lends credence to the theory that non-profits are engaged by governments to assist with public services, rather than that they step in where government has failed (Lecy & Van Slyke 2013). Even in the private sector, governments use strategies to support private markets when competition is low, essentially using their own resources to build competition in order to then improve public service delivery (Girth et al. 2012). Understanding this symbiosis paints a richer, more accurate picture of how policy interventions impact electrification efforts.

2.3 Off Grid Enterprise Research and Policy

Exploring off grid energy through energy service companies usually focuses on case studies, but there are some prime examples of research on the state of the market (Singh 2016; Gabriel & Kirkwood 2016; Zerriffi 2007; Harish et al. 2013). All of these works aim to inform policy, but they take very different approaches to incorporating past interventions into their research.

Zerriffi focuses on small scale off grid technology in the context of Brazil, not limited to solar power, and explores how business models and institutions play a role in success and failure of enterprises. Policy is an integral part of that project, and the author breaks down the policy priorities and focus to show the link between policy interventions and the repercussions for rural electrification, using the fiscal consequences of policy as the pressure point for impact (Zerriffi 2007). While Gabriel & Kirkwood focus more broadly on renewable energy entrepreneurs in 28 developing countries, they also take policy as a key independent variable. In their paper, the number of renewable energy policies and the strength of government interest in those policies as two key axes for anticipating the types of businesses present in a country (Gabriel & Kirkwood 2016).

Similar literature in the Indian context exclusively focuses on the off grid solar market. A great recent example is Kartikeya Singh's work on the state of the market and relationship between technology options and scalability. Singh does ask whether enterprises take a government subsidy but primarily uses feedback about government programmes as a context for providing policy recommendations (Singh 2016). Harish et al. examine Karnataka's off grid solar market in order to disentangle the dynamics of technology adoption. While they cite the solar loan programme as a catalysing factor and note that sales dropped after the announcement of JNNSM, the focus is very much on the dynamics between enterprises, their offerings and end users.

Table 1: Business Model Components

Singh 2016	Harish et al 2013	Zerriffi 2007	Osterwalder 2004 (Gabriel & Kirkwood 2016)
Types of products sold	Type	*Independent Variables:*	*Product:*
Number of products sold/ distributed	Year of Establishment	Organisational Form	Value Propositions
Geography of distribution	Primary Product	Technology Choice	*Infrastructure Management:*
Primary reasons customers purchase the products	Volume of Sales	Target Customers	Key Partners
Information regarding warranty	Geographical Presence	Financial Structure	Key Activities
Availability of financing to purchase products		*Dependent Variables:*	*Customer Interface:*
Participation in government subsidy market		Electricity Access	Customer Segments
Research & development budget		Sufficiency	Channels
Marketing		Quality	Customer Relationships
After sales maintenance and servicing		Sustainability	*Financial Aspects:*
Perceived barriers to market entry and scaling		Replicability	Cost Structures
			Revenue Streams

Source: Author's compilation, 2018

There are two key shortcomings to the approaches described above. Firstly, there is a lack of comparability across authors, since each use a different set of components to break down and compare business models, as seen in Table 1. Singh uses a survey according to a set of pre-determined metrics such as types of products, marketing, and participation in government subsidy market. Likewise, Harish et al use a similar approach with a narrower band of metrics. Zerriffi goes in a different direction by breaking down characteristics into independent and dependent variables. Finally, Gabriel & Kirkwood rely on the business model canvas first developed by Osterwalder (Osterwalder 2004; Osterwalder & Pigneur 2010). Although 'types of products sold', 'primary product', 'technology choice', and 'value proposition' could all be describing the same component, their differences make comparison challenging. Only Gabriel & Kirkwood choose to use a set of components that have been developed by previous enterprise literature.

Secondly, most of these papers represent a snapshot of the enterprise landscape at one moment in time. Singh and Harish are particularly notable for using survey data, which are particularly good for making statistical generalisation, but weak when considering changes in the landscape. Zerriffi's focus on the relationship between policy's impact places a greater emphasis on the transformative power of policy, but only Gabriel & Kirkwood talk about enterprises as they change over time (see discussion of a life-cycle progression). As policy interventions are a time-bound phenomenon, snapshots of business models are inadequate to fully grasp their impact. This paper will specifically focus on the narratives of change within the interviews in order to focus primarily on the causal relationship between policy and business model.

3. Data

The primary data for this analysis comes from interviews conducted with enterprises working in the off grid solar space in India. Secondary data about the enterprises and states were used to confirm and expand upon information collected in the interviews. An off grid solar enterprise is an organisation that aims – in whole or in part - to provide solar products that do not connect to the national grid. Enterprises can be commercial, social, non-governmental, governmental or publicly owned.

The business model components represent the dependent variable of this study. However, the findings suggest that when one component changes, other components may change as well, turning the dependent variable into an independent variable. This is a part of my argument within the paper. The nature of the interviews is such that causality is explicitly discussed, and therefore, challenges with dependent variables subsequently becoming independent variables are side-stepped by focusing on the narrative order and explanation.

It should be noted that the impact of policy interventions of an enterprise is mitigated in part by an enterprise's political strategy. That is, the approach an enterprise takes to government and policy influence the extent to which policy changes impact the enterprise. However, the extent of that mitigating factor is outside the scope of this paper and is a place for further research.

This research incorporates 27 in-depth, semi-structured interviews, across a range of enterprises, government agencies and research institutes. 18 interviews were with high-level executives or managers of 15 enterprises that provided off grid solar technologies. Two were primarily commercial enterprises, seven social enterprises, four non-governmental organisations, one public sector enterprise and one governmental organisation (see Table 2). Several enterprises had additional products, but this research focused solely on off grid solar products for domestic lighting.

The enterprises selected give a fairly good overview of the market across India. Estimates vary, but recent research suggests that there are 45-60 key players within the off grid solar sector in the country (Singh 2016). That number focuses on the formal market, as does this study. An informal market of local dealers and distributers also exists within the country, representing a few hundred companies, but collecting data on these enterprises is challenging given their disparate locations and limited footprint outside of their local area (Singh 2016).

Within the field, there are a number of large private actors (e.g. TATA BP) and large public sector organisations (eg. REIL), as well as a growing number of small and medium-scale organisations that represent NGOs, social enterprises and smaller commercial enterprises. It should be noted that the line between each category can be blurry, as there are a number of organisations that fall within a range of public to private ownership, NGOs may have branches of their organisation that are run as a commercial enterprise, and India has no legal definition of social enterprise (Perry et al. 1988; Sengupta & Sahay 2017). All these types of enterprises are interviewed in this study, including a public sector enterprise and an enterprise run out of a government office, but which is not a government department and has aims to be run as a commercial enterprise.

Within these organisations, there is a wide range of engagement with the off-grid sector. That is, some organisations work solely with off grid products, even in grid connected areas, whereas others spend most

of their energies on grid connected products. Only three of the enterprises regularly engage in grid connected projects (ENT11, ENT13, ENT23). All grid connected products are outside the scope of this study. However, off grid products used in grid connected areas are within my scope. Description of the enterprises and their work will focus entirely on their off-grid products, except where explicitly discussed.

Finally, the study focused on enterprises that were active in Bihar, Uttar Pradesh and Rajasthan. Those states were chosen because of their high solar potential and lower rates of rural electrification, have led to a rise in enterprises working in these areas. However, most enterprises worked in multiple states, including those from outside the study area, without changing their business model across states. Because the focus on these areas was primarily to increase the number of enterprises that might be interviewed, this study also includes enterprises that were available for interviews from outside these states. As the policies studied are national level interventions, they apply equally to all enterprises.

Table 2: Enterprises Interviewed

Code	Off Grid Product Type (Past & Present)	Enterprise Type	Enterprise Focus	Established	States	Scale of Off Grid Component
ENT11	Micro-grid, SHS	Social	Solar Energy	2010	Rajasthan, Uttar Pradesh	Medium - 5000-50,000 HHs
ENT12	SHS	Commercial	Rural Products	2013	Rajasthan	Small - 500-5000 HHs
ENT13	Micro-grid, Mini-grid, SHS	Commercial	Solar Modules	2013	Rajasthan, Uttar Pradesh, Others	N/A - Panel Manufacturer
ENT14	Micro-grid, Mini-grid, SHS	Social	Energy Entrepreneurship	2014	Bihar, Rajasthan, Uttar Pradesh	Medium - 5000-50,000 HHs
ENT21	Mini-grid	NGO	Mini-grid Partnerships	2015	Bihar, Uttar Pradesh	Medium - 5000-50,000 HHs
ENT22	SHS	NGO	Rural Products	2009	Bihar, Rajasthan, Uttar Pradesh, Others	Very Large - 100,000-250,000 HHs
ENT23	Mini-grid, SHS	Public Sector	Solar Energy	1974	Bihar, Others	Large - 50,000-100,000 HHs
ENT24	Mini-grid	Social	Solar & Biomass Energy	2007	Bihar, Uttar Pradesh	Medium - 5000-50,000 HHs
ENT25	SHS	Social	Solar Energy	2013	Bihar, Others	Pilot - 0-500 HHs
ENT26	SHS	Social	Solar Energy	1995	Bihar, Rajasthan, Others	Very Large - 100,000-250,000 HHs
ENT27	SHS	NGO	Rural Development	2013	Bihar	Small - 500-5000 HHs
ENT28	Micro-grid, SHS	NGO	Research, Rural Development	2008	Bihar	Very Large - 100,000-250,000 HHs
GOV21	Mini-grid, SHS	Government	Rural Development	2012	Bihar	Small - 500-5000 HHs
ENT31	Mini-grid	Social	Solar Energy	2014	Haryana	Small - 500-5000 HHs
ENT32	Micro-grid, Mini-grid	Social	Solar Energy, Environment	2011	West Bengal, Jharkhand	Small - 500-5000 HHs

Source: Author's compilation, 2018

4. Methodology

Interview selection was made with the aim to have a variety of technology and enterprise types within the confines of off grid solar energy in Northern, Central and Eastern India. Given the different geo-political contexts of each state, the focus is on enterprises that are active or had been active in Bihar, Uttar Pradesh and Rajasthan. However, given the small population size, time constraints and commonalities between enterprises, responses have also been incorporated from two enterprises that worked outside of these states. This is an embedded case study of India, in that each enterprise represents a case study embedded within the case study of India (Yin 2009). For the majority of the study, this will be treated as a multiple case study of enterprises, which gives us a better understanding of how these processes work in India. The research focuses primarily on rural electrification policies that have been in place since the Electricity Act, 2003 and the implementation of the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) in 2005.

Interviews were conducted using a mixture of snowballing sampling from multiple entry points and theoretical sampling.[1] Three enterprises served as discrete entry points, reaching out them independently, and thereafter reaching most of the interviews by introductions from other enterprises. Many small to medium enterprises are members of networks such as the Clean Energy Access Network (CLEAN). To avoid this bias, I also purposefully sought out larger enterprises, public sector enterprises, and governmental organisations that may not have been in these networks. The theoretical saturation point was reached when all key enterprise types (NGO, public sector, commercial, and social) were represented within that sample (O'Reilly & Parker 2013). Arguably, a thematic saturation point was also reached within the interviews, in that narratives of change, while different, followed similar logic and represented common experiences (Eisenhardt 1989; Corbin & Strauss 2008; Guest et al. 2006). However, there is still scope for further research, particularly into those categories for which there are few respondents, notably public sector organisations.

In the Indian off grid space, there is a range of commercial, social and non-profit enterprises, as well as government organisations and state-owned enterprises. The true extent of the market is not clear, but the CEEW suggests there are approximately 250 formal and informal businesses nationwide (CEEW 2013). When it comes to major players in the formal market, estimates range between 34-40 key enterprises (Singh 2016).

The sample represents approximately 650,000 households who have received an off grid solar product through one of these 15 enterprises. Most of this population received their products through one of the three very large enterprises represented. However, it is important to note that the interview selection is biased towards smaller enterprises, because they are more responsive to interview requests, are often members of industry organisations and were more likely to connect me with additional interviews.

Since larger organisations are more likely to be eligible to engage with current rural electrification programmes, there is a potential bias against working with the government in this sample. In order to mitigate this, I purposefully sought out larger organisations, state-owned enterprises, and governmental organisations in order to get a fuller picture of possible government interactions. There is also a selection bias for successful enterprises. Unsuccessful enterprises are difficult to identify and reach out to, and so I

1 Theoretical sampling in qualitative research is equivalent to stratified sampling in statistical studies.

only contacted enterprises that were currently in business. This does not significantly negatively impact my results, as they are representative of enterprises currently functioning in the space.

In order to explore and categorize enterprise change and the impact of policy, I used qualitative methods to excavate the narratives within my interviews. Qualitative research is best positioned to give insight into the impacts of policy on business models because this is an area with very little extant literature (Brass et al. 2012). Qualitative methods are ideal for exploring new fields, whereas quantitative research falls short because it relies on variables and relationships that have not yet been defined (Yin 2009; Eisenhardt 1989).

Using interviews is increasingly popular in business literature (Hair et al. 2007; Carson & Coviello 1996; Barr 2004; Eriksson & Kovalainen 2008; Gabriel & Kirkwood 2016). The popularity of qualitative research is due in part to the opportunities that interview-based qualitative research provides. These studies give greater insight into causal mechanisms, allowing the researcher to explore causation rather than just correlation (Yin 1981). Having causal insights gives the researcher greater material for forming hypotheses (Hair et al. 2007; Corbin & Strauss 2008; Barr 2004). Additionally, this type of study has been highlighted as being particularly fitting for theory building, due its emphasis on causation (Eisenhardt 1989; Corbin & Strauss 2008; Ridder et al. 2014).

This study finds itself between a number of philosophical stances. Epistemologically it shares the social constructionist belief that artefacts are socially constructed through language, narrative and interaction, and that an organisation can represent such a society (Berger & Luckmann 1991; Burr 1995; Charmaz 2006). However, it follows the interpretivist approach that the models we create are interpretations of reality and that the researcher is not an unbiased observer (Lin 1998; Williams 2000). However, ontologically, the research follows more in the vein of critical realism, taking an ontological realism stance, married with epistemological constructionism (Maxwell & Mittapallo 2010). In that regard, the research imagines that the interviews are social constructions that reveal a single perception of an objective reality, and the models of interaction that the research proposes are interpretations of what that reality might be. In that regard, truth is provisional, and multiple interpretations may exist which are better or worse representations of reality.

Interviews lasted between 25-75 minutes, with the majority of interviews taking approximately one hour. The respondents were primarily the CEOs of small to medium scale enterprises, or else the senior manager of the off-grid division of larger enterprises. Questions focused on initial descriptions of the business model in use, reasons behind the use of this business model, how the business model had changed over time, interaction with government and the impact of policy changes on the enterprise.

In the first instance, interviews were transcribed and coded in NVivo. Primary coding focused on answering the question, 'what are the characteristics of the enterprise?' Secondary coding asked, 'what are the narratives of change that take place?' The answers to these questions were compiled in Appendix A. The characteristics of the enterprises were then categorised according to the nine building blocks of Osterwalder's business model canvas in order to better interface with other literature on business model development (Osterwalder 2004; Osterwalder & Pigneur 2010). The narratives of change were also compared, using the business model canvas as a framework for exploring how characteristics were impacted by policy (**section 5.2**) and what other factors influenced characteristic change (**section 5.3**). Finally, **section 5.4** takes a step back and outlines which changes to the business model have occurred most commonly, attempting to sketch the changes that policy has made to the enterprise landscape.

Table 3: Sample Enterprise from Appendix A

ENT ID	Starting Business Model	Changes to Business Model	Responsible Policy Change	Overall Themes	Reasons for Changes	Overall Themes
1	ENT11 began with SHS for both grid and non-grid connected end users, which included a government subsidy, and the expectation of partial cost recovery for the full capital cost of the system.	1. Shift away from bank financing for end users	1. NABARD subsidy cancelled	1. Revenue Model, Customer Interface	1. The loss of subsidy broke the link between the ENT and NABARD banking	1. Policy
		2. Move from SHS to microgrids and rooftop	2. NABARD subsidy cancelled	2. Product	2. Revenue model for SHS no longer worked without subsidy, so moved to microgrids and rooftops, which do no require end user subsidy	2. Policy
		3. Move from SHS to microgrids also caused a shift from total cost recovery to partial cost recovery	3. NABARD subsidy cancelled	3. Revenue Model	3. Revenue model for SHS no longer worked without subsidy, so moved to microgrids, which have a high capex and low to moderate likelihood of cost recovery, subsidised by rooftop projects	3. Policy
		4. Shift from both electrified and unelectrified areas into unelectrified hamlets	4. NABARD subsidy cancelled	4. Customer Interaction/ Customer Segments	4. Revenue model for SHS no longer worked without subsidy, so moved to microgrids, which are most in demand in unelectrified housing clusters	4. Policy
		5. Shifted from manufacturing and distribution to just distribution	5. N/A	5. Supply Chain Position	5. Could not compete with other manufacturers	5. Financial Aspects
		6. Moved from solar lanterns to solar home systems	6. N/A	6. Product	6. Shift of focus to distribution, rather than manufacturing	6. Supply Chain Position

Source: Author's compilation, 2018

5. Narratives of Enterprise Change

5.1 Summary

Table 4 cites 19 examples of the impact that the prominent rural electrification programmes have on 11 of these enterprises. The findings suggest that policies primarily influence revenue streams and customer segments, although the product offered is inextricably linked to the customer and finance options.

Eleven enterprises are represented here, the majority of the enterprises in the study. Of the changes in Table 4, 14 relate to subsidy regimes and three cite grid expansion. The two key policies cited are the JNNSM-NABARD subsidy and the RGGVY/DDUGJY programmes of grid extension. It is interesting to note that no enterprises cite the DDG Scheme.

The sections below explore the relationships between subsidy and finance, product and customers, as well as the relationships between grid expansion, product and customers. The interrelations between these the components of the business models contributes to larger-scale changes to the enterprise landscape that are initiated by policy change. In the case of the Indian off grid sector, enterprises move towards grid-connected customers, towards grid-based products, and an increased interest in financial sustainability.

While assessing the impacts of these changes on policy outputs is outside the scope of this study, the public administration literature would suggest that changes to the enterprise landscape would influence the success of these policies. However, as much of the JNNSM changes influence firms that are generally not targeted by the DDG scheme, the greater influence is likely to be on end users outside of that scheme, which is an area for further research.

Table 4: Enterprise characteristics impacted by policy

Enterprise ID	Changes to Business Model	Overall Themes	Responsible Policy Change	Reasons for Changes
ENT11	1. Shift away from bank financing for end users	1. Revenue Model, Customer Interface	1. NABARD subsidy cancelled	1. The loss of subsidy broke the link between the ENT and NABARD banking
	2. Move from SHS to microgrids and rooftop	2. Product	2. NABARD subsidy cancelled	2. Revenue model for SHS no longer worked without subsidy, so moved to microgrids and rooftops, which do no require end user subsidy
	3. Move from SHS to microgrids also caused a shift from total cost recovery to partial cost recovery	3. Revenue Model	3. NABARD subsidy cancelled	3. Revenue model for SHS no longer worked without subsidy, so moved to microgrids, which have a high capex and low to moderate likelihood of cost recovery, subsidized by rooftop projects
	4. Shift from both electrified and unelectrified areas into unelectrified hamlets	4. Customer Segments	4. NABARD subsidy cancelled	4. Revenue model for SHS no longer worked without subsidy, so moved to microgrids, which are most in demand in unelectrified housing clusters

Enterprise ID	Changes to Business Model	Overall Themes	Responsible Policy Change	Reasons for Changes
ENT12	1. Sales dropped for a time	1. Sales	1. GoI introduced a scheme with 50% subsidy on SHS	1. When high subsidies are introduced, customers stopped buying full price products from ENT, alternatively, the rumor of subsidies cause prospective customers to anticipate subsidies, depressing demand
ENT 14	3. Trying to move away from grant-based financing	3. Revenue Model	3. Microgrid/ Minigrid CapEx subsidies	3. Policy uncertainty makes incorporating subsidy into revenue model risky
ENT 23	1. Increasing manufacture of grid connected technology	1. Product	1-2. "Government incentive schemes" are "promoting grid tied" projects	1. Incentives from government encourage ENT to manufacture products for grid-connected projects
	2. Adding more grid-connected customers	2. Customer Segments		2. Increasing the manufacture of grid-connected products increase the amount of the ENT's work that focus on grid-connected customers
ENT 24	1. Shift from microgrids to minigrids	1. Product	1. Grid expansion under RGGVY/ DDUGJY programmes	1. Grid expansion decreased the market for small off grid systems
	2. Shift from unelectrified to electrified villages	2. Customer Segments	2. Grid expansion under RGGVY/ DDUGJY programmes	2. Grid expansion decreased the unelectrified market, unreliable grid increased demand in electrified villages
	3. Shifting focus of new work to Uttar Pradesh	3. Customer Segments	3. New UP Microgrid/ Minigrid Policy is "one reason" for that change	3. The new Uttar Pradesh Microgrid/ Minigrid is favorable to the ENT's product, and is a reason why they are starting more projects in Uttar Pradesh
ENT 25	1. Shift from unelectrified end users to both electrified and unelectrified	1. Customer Segments	1. Grid expansion under RGGVY/ DDUGJY programmes	1. Grid expansion brought electricity access into areas that they work in
ENT 26	1. Shift from government subsidy to no subsidy	1. Revenue Model	1. NABARD subsidy was cancelled	1. JNNSM subsidy cancellation meant that it was no longer available for the ENT's end users
ENT 27	1. Enterprise began work in conjunction with government NABARD subsidy, connecting NABARD bank with SHGs for financing.	1. Partnerships, Revenue Model	1. NABARD subsidy	1. Needed financing for rural end users, NABARD subsidy was available and NABARD was happy to partner because of ENT's reputation
	2. Shift from subsidy to grant-based model	2. Revenue Model	2. NABARD subsidy backlogged, then cancelled	2. The backlogging and then cancellation of the subsidy meant that the revenue model was no longer viable, so the ENT moved to grant-financing
	3. Increased product range	3. Product	3. NABARD subsidy was cancelled	3. Previous NABARD subsidy had only applied to one product, once cancelled, ENT27 added new tech

Enterprise ID	Changes to Business Model	Overall Themes	Responsible Policy Change	Reasons for Changes
ENT 32	1. Moved from 1 engineer with each grid to new monitoring technology and fewer engineers	1. Customer Interface, Product	1. JNNSM subsidy decreased from 30%–25%, putting strains on their finances	1. As capital expenditure subsidy decreased, ENT had to decrease the number of engineers and focus more on monitoring to cut costs
ENT 33	1. Incubatees do not offer subsidy to their end users.	1. Revenue Model	1. NSM–NABARD subsidy	1. Incubatee have too little experience to be elifible for NSM–NABARD subsidy & financing
GOV 21	1. Targeting unelectrified areas with SHS	1. Customer Segments	1. Government partnership	1. Partnership with government allowed for subsidy, influenced type of end user

Source: Author's analysis, 2018

5.2 Impacts of Policy on Enterprise Characteristics

5.2.1 Subsidy and Finance

All seven changes to the revenue model are precipitated by subsidy changes. The connection is an intuitive one, but there are broader implications for the "virtuous cycle" of financing and the lifecycle of an enterprise's revenue model. Once an enterprise has access to finance, it becomes easier to access additional finance, essentially creating a virtuous cycle of financing. Subsidies can reduce the time it takes for enterprises to break even, improving the attractiveness of the business model to investors. ENT32 described the importance of the 25% JNNSM capital subsidy for their mini-grids like this:

> "And I was telling you that the business model is recovering it in 7 years' time, but that's with the subsidy. If the subsidy wasn't around, it'll take us 20% more time, so possibly we would get it in 10 years back, 10 years' time. Therefore, the banks, which lend at the moment, are not accepting over a 10-year time frame, so to get back to the 7-year, 6-year time frame, we need to bring the capital cost down, operation cost down" (ENT32)

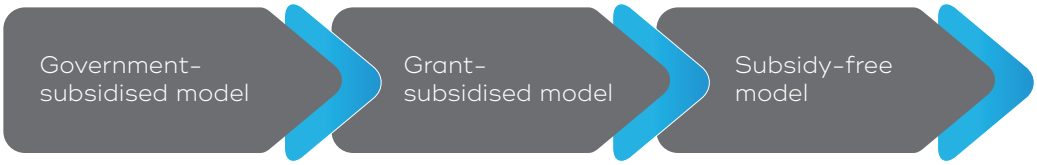
Similarly, once a customer has access to an end user subsidy, they also have access to the financing institution that provides it, because they are often channelled through some form of banking or microfinance, which allows the end user to also access loans. The two biggest examples are the JNNSM end user subsidy that was channelled through NABARD, and JNNSM subsidy channelled through SHGs. In the case of NABARD, end users were given a loan at a reduced interest rate in addition to the subsidy. However, there are other examples, such as the end user subsidy that was available through self-help groups, women-led microfinance organisations, in the case of ENT27:

> "… we used to procure solar home light systems from manufacturers, we had project money for that. We used to provide it to self-help groups, one of, part of the self-help groups, and they in turn rented it to the local villages, and they would collect monthly rentals from these households. And what- the amount which the self-help group was provided, these lights were subsidised, …so it was almost 40% subsidy was offered to them" (ENT27)

This connection with an MFI worked out well for end users, who were later able to buy the systems through the SHGs when the enterprise shifted to a grant-based model. In all of these cases, central financial assistance improved access to financing, whether through banks or MFIs for enterprises and end users.

Comparing the changes in business model, specifically the source and presence of the end user or capex subsidy, there is a common trend towards a subsidy-free model. The predominant financial pathway starts with a government subsidy, then moves to a grant-subsidised model and, finally, a number of enterprises are trying to remove the subsidy component from their model. This posited financing pathway is outlined in Figure 1 below.

Figure 1: Proposed Financing Pathway



Source: Author's analysis, 2018

While enterprises rarely go through all three financial states, no enterprise in my sample has successfully moved from a later state to an earlier one. Six enterprises change their financial states according to this pathway. While some enterprises may adopt additional technologies that start at a grant-based model (see the adoption of SHS by ENT13 or the adoption of microgrids by ENT28) no enterprises have yet moved from a subsidy-free model to a grant-based model, or from a grant-based model to a government-subsidised model with the same technology.

ENT26 and ENT11 moved from working with government subsidies to creating subsidy-free models. ENT 27 moved from a government subsidy to a grant subsidy when bottlenecks for the subsidy occurred:

> "We could have reached out to a greater number of people, but financing was a major problem for us. That was when we raised our own grant funds, so we got some funding for light 2,700 lights from one of the funders, then we started getting these lights and providing it to end users, even on individual basis."

They are now setting up a private limited company with a subsidy free model. With their compound business model, ENT32 has moved from a government and grant-based capex subsidy to a government subsidy that no longer relies on grants:

> "So, at first we tried to scale this model, we found the commercial establishments are the shops and the educational institutions, the schools where we are able to make this model viable because until that point we were 70% of the cost was the Capex which was met by this loans from NABARD. And other banks also pitched in later. 20% which is operational cost, which is salaries and maintenance costs for these batteries and so on, was met from our own foundation, and then a few other people started pitching in to help us out - other like-minded foundations. But before that, this was not a scaleable model unless we got rid of the grant part. It had to be completely financed, and you know?" (ENT32)

While this could be seen as a counter argument, the government grant was already present within the revenue model, and so removing the grant subsidy is actually a step towards a subsidy-free model, rather than a regression to greater reliance on government funding.

As another example, ENT23 typically works with a government-subsidy through engaging with tenders, but is now including more work with grant-subsidised models. Finally, ENT14 currently has a grant-based model, but is actively setting up a variety of projects to test a new subsidy-free model, because:

> "…these policies change so often that you cannot build on this, right? You can't invest, and solar is a long-term investment, it's not like a short-term, one-year pay back. It's like a seven, eight years, and in the seven, eight years, which is a long period on which the policy needs to be stable, suddenly the policy can change, suddenly. So that's why for solar I definitely struggle with the government policy. And we wanted to make it viable without government policy, without support of government because that can change."

Only two enterprises challenge this model. ENT21 works with seven ESCOs, all of which have grant financing and one of which are also has received the JNNSM subsidy. However, other ESCOs they work with are planning to apply for the NSM subsidy. Likewise, ENT24 currently does not receive a subsidy for any of its systems, but it planning to apply for the subsidy moving forward. In both cases the application has not been approved, but the intention is present.

While this model seems to suggest that enterprises require a subsidy to initiate their work, eight enterprises never receive central financial assistance on their products, with many starting from a grant-subsidised model. It is possible that the difficulties of receiving subsidies, such as extensive bureaucracy and stringent enterprise and technological criteria, make grants more attractive. For instance, ENT24 has not applied for a subsidy until now because "the procedure is so winding." However, although this might account for the lack of enterprises that have successfully moved from grants to subsidies, it does not explain the number of enterprises that begin their work with subsidies. In the end, the greatest implication is that enterprises have a drive towards financial sustainability.

5.2.2 Subsidy, Product and Customer

Of the eight changes related to customers, five were precipitated by the initiation or cancellation of subsidies. Subsidies target specific beneficiaries, which changes the customers that an enterprise is financially capable of serving. Additionally, the move away from the government end user subsidy, and the increase in corporate social responsibility donor funding, changes the customers that enterprises are incentivised to serve.

Are subsidies required to give a temporary handicap to technologies that have not yet reached market readiness or is a subsidy needed for these technologies to reach the rural poor? India's two primary rural electrification subsidy regimes disagree on the answer. The JNNSM subsidy for off grid solar focuses on supporting a nascent technology as part of a general push towards solar, although the cancellations of the SHS end user NABARD subsidy impact the poor end user. However, the Government of India supports the rural poor specifically in their DDUGJY DDG Scheme, which focuses the subsidy on the location of end user rather than on the technology. Thus, the removal of the NABARD subsidy led to several enterprises either picking up microgrids and moving deeper into the rural areas, or else shifting to mini-grids and focusing on those areas with unreliable grid connections, shifting both product and customer, since appropriate financing was no longer available.

Eight enterprises have added donor-funded projects to their portfolio in the past few years, either as grant-based SHS projects or by adding microgrid projects to their repertoire. At least one enterprise attributed this to the Government of India's Corporate Social Responsibility policy, which came into force in 2014 as section 135 of the Companies Act, 2013. The CSR policy states that companies that have a "Net worth of INR 500 crore or more; or Turnover of INR 1000 crore or more; or Net Profit of INR 5 crore or more during any financial year" must spend 2% of their net profit on projects for stakeholders that support the common good (Government of Bihar 2014). However, enterprises that engage with grant-based models find that donors have a great deal of control over the project, specifically the end user. ENT14 described an episode in which a donor company nearly pulled out because the intended village had become electrified in the course of the project, and they had wanted the project to be in an unelectrified area. ENT23 regularly

works with CSR grant-based projects, and described the location and end user as being selected by the corporation:

> "See, if a project is being donated by someone else, they have their own way, their own specifications and we have to follow them" (ENT23). In this case, corporations wanted to provide their projects in areas that are near to their own factories, offices or other manufacturing facilities. This can mean that grant-based models may have to manage an additional stakeholder whose interest is not necessarily in the financial sustainability of the project, or the need of the end user.

5.2.3 Grid Expansion, Customer and Product

On the other side of the spectrum is the Government of India's fast-paced grid expansion programme, the primary aspect of DDUGJY. This policy focuses on the national grid as the solution to under-electrification, and there is a complicated relationship between the success of this programmes and that of off grid enterprises. This tension is played out in the competing narratives about the future of off grid energy, and its multiple possibilities. In the end, grid expansion changes the market by increasing the grid connected customer base, which is more commonly served by mini-grids and larger solar home systems.

The DDUGJY programme of electrification consists primarily of grid extension, with a small DDG component for off grid technologies where the grid will not reach. The pace and quality of the grid extension has created two dominant narratives: one, the grid will soon be nearly everywhere, and two, the grid is elusive and of poor quality. Most government officials interviewed, especially those working with MNRE or the state nodal agencies, supported the first narrative. Off grid technologies are, in this narrative, for very remote areas only.

However, of the 16 enterprises, eleven provided off grid technologies to grid-connected customers, where the grid was considered to be unreliable. This gap between the government's expectation and the work of the enterprises was clearly described by minigrid system integrator ENT21:

> "Yeah, see there you could find a little bit of dichotomy between what the state government might be looking out for and what our programme is looking out for, because the state government would be looking out for areas which are off grid. So off grid is a very different beast, compared to unreliable grid areas where our programme primarily works. [Ours is] a private sector model, it's a market-based model … So in such cases, if you start looking at off grid areas then you would get into places where you have 15, 20 households and absolutely no productive load and there's no possibility of going. So I think that what I see is that, the government - there has been a UP policy last year, in fact that happened to a large extent because of this programme. The UP government came out with a mini grid policy last year. It was the first state ever in India to come out with a policy, so there, we do see - the government wants the mini grid operators to go into off grid areas and believes that the unreliable grid areas, as such, where the government grid is going to come anyways over a period of time, we should not be spending our time there." (ENT21)

However, all but one minigrid operator worked in unreliable grid areas, rather than in exclusively off grid villages. Where the national grid is unreliable, off grid enterprises see a range of new customers who need a technology that will augment their substandard access.

The related expectation was that grid extension would negatively impact off grid sales, but the experience so far has been mixed. Three enterprises experienced a drop in sales or demand, which has caused them to move to a different area or technology, such as ENT28, which claimed to have moved microgrids when the grid arrived in the village. On the other hand, SHS enterprise ENT25 has had the grid arrive in a number of their pilot villages, and they claim that sales drop slightly before the grid actually arrives, but increase after the grid has arrived:

> "So, when the poles and wires got, were introduced to the village, demand went down, from this point, because people got this hope that, okay we will get electricity now. So, and they thought, we'll get stable, more capacity, so demand actually went down. After a few months they realised that even a) either the power is not coming at all, coming in the near future, or even if it has been introduced, it's unstable… then after a point, there was no hope from grid electricity, they got a reality check - that's the way it is in rural India, right? - so they got a reality check and demand shot up." (ENT25)

So even with a grid connection, customers revert to using their SHS in addition. This is proto-typical 'energy stacking,' in the same way that we might use an oven, a microwave and a rice cooker for our cooking needs. The impact on demand is therefore related both to the quality of the national grid and the anticipation of that quality. Both of these aspects will change as grid expansion continues, which actively changes the potential market for off grid products.

Expansion is a key component of the move towards providing for grid-connected customers. With a rapid expansion, but questionable quality of the grid, a new market of unreliably grid-connected customers has emerged. The enterprises that have moved into this market have had to shift their technology offerings and revenue models in order to capitalise on their demand, and this has primarily been reflected in the rise of the minigrid. In the past three years alone, five of the enterprises began minigrid projects for the first time (ENT32, GOV21, ENT31, ENT14, ENT21). Mini-grids are, with one exception, for grid connected villages, because they are large pieces of infrastructure and require commercial, as well as domestic loads:

> "You see, why we are gravitating to commercial hubs. Earlier our biomass plants were primarily based in areas that had no grid, now that reality is going to change with the government promising every village is going to be grid connected. So earlier our offering was, I would say, meant for [not grid connected] people. …The changing reality of time is that every village is going to be grid connected, so you switch over to commercial hubs who need reliable and good quality power, 24x7. And this is our focus now." (ENT24)

However, while mini-grids offer domestic lighting services, their focus is on commercial, agricultural or other productive loads, which may have implications for hamlets or other impoverished areas that require only domestic lighting. What is most clear is that these enterprise characteristics are interrelated, and the expansion of the grid does not just open up a new market, but changes the way in which end users are getting their power and the capacity of the systems that may serve them.

5.3 Impacts of Enterprise Characteristic Change

Stepping away from policy and exploring other narratives of change, we see that changes occur because of both exogenous and endogenous factors. Specifically, nine out of 18 enterprise changes are precipitated by another change within the business model. Table 5 outlines the precipitating factors of all changes described that do not cite policy.

Half of the changes take place due to external circumstances, or factors exogenous to the business model. In three cases, demand changes the enterprise's off grid product, whether that is through sales of products or the opinions of the customer (ENT12, ENT28, ENT32). In the case of ENT28, they found that an increase in consumer demand led to a "natural progression" to larger systems, including microgrids. Likewise, ENT27 found that their customers preferred to buy panels out right rather than renting them, and so they change their revenue model and their value proposition:

> "So we're two things: one was self help group model in which home light systems were being rented, and the other model was where women entrepreneurs were selling solar lamps on direct

> purchase and sale. And slowly what the impact of home light systems was tremendous and then there were households, at least 57 households came back to us, and said we want to own these products. We don't want to endlessly pay rent for it, and that was a very critical learning for us. That ownership of these decentralised renewable energy systems, and we realised that if actually we let them own it, then there would be more care and maintenance problems would be less. If people pay more attention, it's going to be easier for us to manage." (ENT27)

In other examples, a lack of cost recovery from a post-payment system leads to a shift to a pre-payment model (ENT24), and the low cost of solar led that same enterprise to shift towards solar hybrid mini-grids. All these changes take place because external forces (demand, customer responsiveness, cost of solar) lead to a change in the business model itself.

The other changes occur due to endogenous factors, namely shifts in other enterprise characteristics. A change in the supply chain position, for instance, shifted the products sold (ENT11, ENT13) and the channels (ENT25) that enterprises worked through. ENT25 chose early on in their lifespan to focus on product development, rather than distribution, which influenced the channel through which their customers receive the technology:

> "So as a company we decide that we won't get into distribution, we will have distribution partners, like micro finance institution, or government institutions, or NGOs, and there are other companies, like, other... companies who have foothold in rural areas. We ultimately use their services. So we'll have distribution partners across. They will distribute the kit for us, that is how we'll get the reach." (ENT25)

Other enterprises found that starting and ending partnerships affected the means of distribution also (ENT14, ENT26). In the case of ENT14, microfinance partnerships fell apart, which meant they were no longer able to provide financing, which led to a breakdown of their distribution channel and a move away from solar home systems:

> "And normally, the people work with a micro finance business, but they, in India the solar lantern, solar household system - it is sold mostly through micro finance, because people don't want to buy credit or six months of installment papers, that a microfinance company can do, because they have a much better... So, anyone who's a micro finance company - so some of these product companies, they're tying up with these micro finance companies. So, the smaller product, they don't even charge interest, they just give a four-month installment and you pay. For a bigger product they give you also loan and all, right? Somehow in the basics what happened, after this 2009/10, our micro finance system was off. So, without micro finance business, for us distribution was very challenging" (ENT 14).

Essentially, changes with one aspect of the business model, can lead to changes to other aspects. A good final example is ENT12, which used to sell a wide range of products, but then focused on solar products when only they were selling. However, having a small basket of products negatively impacted their village level entrepreneur channel of distribution:

> "So, we started with different models to reach in rural market, so VLE, then we tried to associate with NGOs, then our dealer were already selling something and they're interested in our product. So VLE didn't work, because the basket was too small. Once we have a basket, then we will see again whether it works or not, but for now. … [VLEs] are bread earners in the family, they could not provide a sufficient basket so it didn't work….So, finally the model we developed was through dealers."

While it was an exogenous demand that caused the enterprise to alter the products available, that change affected the success of their distribution channel. The implication is that some modes of distribution are more effective with a smaller selection of products (whether women VLEs or dealers). These findings reinforce the interdependency of business model components, which explains how a change in a single policy instrument may have an outsized, or unexpected, impact on the enterprise landscape.

5.4 Changes to the Enterprise Landscape

These findings suggest that during the course of their lifespan, enterprises that survive are highly agile, changing business models frequently. And so, rather than simply increasing or decreasing demand, a policy change can shift the shape of the entire enterprise landscape. Six enterprises adopted new technology, two scaled up microgrids to mini-grids, and six dropped technologies. Similarly, enterprises changed payment methods (1), changed funding sources (5), changed end users (6), changed maintenance plans (1), and changed distribution methods (8). While each change comes with its own set of circumstances, we can see three broad trends: increased targeting of grid connected customers, an uptick in the popularity of microgrid and mini-grids, and a general trend towards financial sustainability.

The move towards working with grid connected areas includes both grid-connected technologies or, more commonly, off-grid technologies in areas with unreliable connectivity. As seen in section 5.2.3, grid extension has opened up a new range of customers while limiting the number of truly off grid customers. Currently only two enterprises (ENT11 and ENT23) work in only off grid areas with their off-grid technologies, and both these enterprises also have added additional grid connected technologies and projects. However, six enterprises have changed their end users, and five of those changes included work in more grid connected areas. Some enterprises expressed a belief that the grid was shortly going to be everywhere, and explained that it was increasingly difficult to find areas that were truly off grid, although many areas suffered from unreliable and poor-quality electricity access.

Related to a shift towards grid connected end users, there is also an increase in the system size of technologies, with enterprises adding microgrids to their repertoire and microgrid enterprises scaling up to mini-grids. Of the thirteen enterprises that have started or added new technologies since 2000, ten added or worked exclusively with micro and mini-grids. Currently, five enterprises work with both SHS and a grid-based system, six work with just grids systems, and only four enterprises work solely with solar home systems. Mini-grid systems have risen in popularity along with the move towards grid connected areas, in great part because minigrid operators require a certain amount of productive or commercial demand, which they believe is more readily available in areas that have unreliable connections. See ENT21, ENT24, ENT32, and ENT31 for examples.

The final trend noticeable in the narratives is a move away from government financing and towards greater cost recovery, which is partially a response to the end of the JNNSM-NABARD subsidy. For the most part, total financial sustainability, defined as complete cost recovery for the capital cost of the system coming from the end user, is an elusive dream for anything other than solar home system enterprises. Four out of seven minigrid operators already reported that their minigrid models should allow for total cost recovery over the payback period, although few systems have reached the end of their payback period. Multiple enterprises did identify the aim or plan to reach total cost recovery going forward, such as ENT27, which began by working with government, and is now trying to move to a subsidy free model:

> "We've done almost some 2,500 systems until now, and we're just in the process of setting up a distribution company now. We taking…this model and scaling it up, and we set up a company, it's a private, limited company…It will be functioning as a distribution company in the sense that we get products from manufacturers, provide end user financing and after sales service and products,

> and bridge that last mile gap…We also finalised what the model is, what the business plan is, where we're going to raise the investments in any case." (ENT27)

Or, as it was described by GOV21 who currently provide subsidised SHS, moving forward they are "planning a stable business model," which will not include a subsidy for end users. While some of these changes may be a natural progression away from policy risk (see section 5.2.1), some are a direct response to the changes to the off-grid subsidy regime in the past three years. Additionally, the adoption of larger scale systems with more grid connected customers has improved the ability of the business model to recoup costs, highlighting the manner in which rural electrification policies shape the enterprises that provide off grid technologies.

5.5 Policy Implications

The changes to the enterprise landscape precipitated by changes to the Jawaharlal Nehru National Solar Mission may impact the implementation of the Government of India's DDG Scheme. The scheme relies on SHS enterprises bidding for large projects, but we have documented the move of small and medium scale companies away from solar home systems. It is not clear from this research whether this shift in technology has an impact on the implementation of the DDG scheme, since many of these enterprises are not eligible to participate. However, we do know that there have been challenges to implementation of the DDG scheme, such as delayed and cancelled tenders, which have slowed the progress of the programme. 820 villages that were initially slated to be electrified through DDG have subsequently been moved to the grid expansion programme (REC 2018).

This could be for a variety of reasons: poor tender construction, changes to the grid expansion plans, or a lack of competition within the off grid solar sector. That lack of competition may not relate directly to the move away from SHS by SMEs, but other empirical studies have suggested that government has a role in supporting the sectors that it expects to provide public services (Lecy & Van Slyke 2013; Girth et al. 2012). As discussed in section 2.1, contracting out public services assumes robust competition in the sector in order to reap the intended benefits (Entwistle & Martin 2005; A. Hefetz & Warner 2012; Girth et al. 2012). However, reliance on a few larger companies may not be viable in such a new industry. SMEs play a large role in the Indian economy, and although every sector is different, SMEs are considered to a key part of economic progress and a site of innovation and new competition particularly important in newer industries (Das & Banerjee 2018; Savlovschi & Robu 2011; Rothwell & Zegveld 1982; Reynolds 1997). It should also be noted that, while this research does not provide us with evidence of the scale of these changes across industry, it gives us an idea of what types of changes take place. This in turn may provide some insight into how populations might be affected.

Table 5: Enterprise characteristics impacted by other factors

Enterprise ID	Changes to Business Model	Overall Themes	Reasons for Changes	Overall Themes
ENT11	1. Shifted from manufacturing and distribution to just distribution	1. Supply Chain Position	1. Could not compete with other manufacturers	1. Financial Aspects
	2. Moved from solar lanterns to solar home systems	2. Product	2. Shift of focus to distribution, rather than manufacturing	2. Supply Chain
ENT12	1. Moved from selling a range of products, now primarily sell solar products	1. Product	1. Only solar products sold	1. Sales
	2. Shifted from VLE for distribution to selling via NGOs, now selling via dealers	2. Channels	2. Small basket of products did not allow for (male) VLEs to make sufficient money	2. Product

Enterprise ID	Changes to Business Model	Overall Themes	Reasons for Changes	Overall Themes
ENT 13	1. Stopped sale of solar lamps, but still provide in grant-based projects	1. Product	1. Found distribution difficult	1. Supply Chain
	2. Began manufacturing solar panels	2. Product	2. Acquired enough capital to manufacture panels, felt there was unmet demand	2. Infrastructure Management
ENT 14	1. Stopped providing financing for products	1. Customer Interface/ Channel	1. Previously enterprise had worked with microfinance, but microfinancing fell apart after 2010	1. Partnerships
	2. Stopped selling SHS	2. Product	2. Manufacturing and Microfinance partnerships that were used for selling SHS ended	2. Partnerships
ENT 24	1. Move from post-pay to pre-pay model	1. Revenue Model	1. Poor cost recovery from post-pay model	1. Cost Recovery
	2. Inclusion of solar/biomass hybrid systems	2. Product	2. Low cost of solar	2. Cost Structure
ENT 25	1. Focused on manufacturing and integration, use VLEs and MFIs for distribution and collection	1. Customer Interface/ Channels	1. Early on, the enterprise realized that they could not produce and distribute the product	1. Supply Chain
ENT 26	1. Including built-in financing for systems	1. Revenue Model, Customer Interface/ Channels	1. In period 2007-2009, enterprise finds range of new financing through partnerships with rural banks, credit cooperatives and microfinance agencies for end users	1. Partnerships
ENT 27	1. Stopped selling solar lamps	1. Product	1. Solar lamps were of poor quality and broke after approx. one year	1. Quality, Knowledge
	2. Enterprise moved from loaning to selling systems	2. Revenue Model	2. There was a desire to own products from end users.	2. Demand
	3. Enterprise beginning own limited company and moving towards a financially sustainable model with no subsidy	3. Revenue Model	3. Aim for sustainability	3. Revenue Model
ENT 28	1. Adding larger and larger systems to their product line	1. Product	1. It is a “natural progression” as end users experience a growth in consumer demand	1. Demand
ENT 32	1. Focusing on solar products	1. Product	1. Started with a range of products, but had demand for more solar capacity	1. Demand
GOV 21	1. Enterprise aims to build maintenance capacity	1. Value Proposition	1. In order to “build a stable business model” and run future projects as a business	1. Revenue Model

6. Policy Recommendations

Governments do not stand alone in providing public services, but increasingly engage with and expect non-governmental organisations and the private sector to play their part. The Government of India is no exception, in that the current DDG Scheme requires the participation of third parties in tendering large-scale SHS projects. However, this research has highlighted how changes in levels of support have a strong impact on the enterprise landscape. It follows that if the Government of India hopes to minimise the number of tenders that are unmet, it would be wise to improve their support for the solar home system market.

The Government of India's DDG Scheme presupposes a burgeoning SHS market, which can be tapped into to provide least-cost solutions for the most remote villages. In order to do that, the programme routes large-scale SHS tenders through state nodal agencies, which ask for bids from third parties. However, several enterprises noted that off grid tenders were regularly cancelled, postponed or re-tendered. While there is limited evidence confirming that these tenders are cancelled at higher rates than other programmes, there is recent evidence for tender cancellations of off grid solar projects.[2] As mentioned above, poorly drafted tenders and changes to the DDUGJY plans are possible contributing factors to phenomena. However, the movement of 820 villages from the DDG scheme to the grid expansion scheme suggest that implementation has been slower than anticipated (REC 2018). Challenges in garnering enough bidders for the DGG scheme are likely to play a role.

At the same time, support has moved from SHS to micro- and mini-grids. This study has shown that enterprises are very responsive to changes in support, and there is evidence that this policy shift has contributed in part to the enterprise focus on grid-based systems. The double cancellation of the Jawaharlal Nehru National Solar Mission end user subsidy through NABARD was the most frequently cited policy change in the interviews. As explored in greater depth above, enterprises that relied on the subsidy moved either to larger grid-based systems, or towards subsidy free models. This limits their customer base to those rural users who can pay full price for energy access. Current off grid subsidies, outside of the tender system, focus solely on capital costs for mini-grids and microgrids.

The public administration literature suggests that a more fruitful symbiotic relationship exists where the government supports the sector that it engages to provide public service (Girth et al. 2012; Lecy & Van Slyke 2013). If this is the case, the Government of India might consider improving its support for the solar home system market, which could be achieved in three ways. The first way to do this might be to better incorporate enterprise stakeholders in decision-making. Although stakeholder meetings and conferences already exist, enterprises broadly felt that their interests were not fully considered, and that these meetings existed more as a symbolic show of support than a true consultation.

Secondly, financial support for SHS may still be necessary, whether through subsidy or through improved financing options, specifically to end users outside those defined by the DDG scheme. A key challenge in providing this support is that the costs of these systems are very low, making the administrative charges relatively high for each small loan or subsidy. This was a challenge that NABARD faced when it was

2 See the recent cancellations of Uttar Pradesh's UPNEDA/Solar power pack/2017 and Bihar's BREDA/Tender/SPV/SWPS/19/2017-18

administering the JNNSM SHS subsidy, but experts believed that NABARD is still the correct institution for administering such a subsidy, because of its experience with implementing other rural policies.

Another way to address the issue of administration would be to have the enterprise act as an aggregator of subsidies. In this capacity, the enterprise would sell systems to the end user at the subsidised price, and apply to receive the subsidy on behalf of those customers, cutting down on administrative costs for the bank, but shifting them to the enterprise (Jain & Ramji 2016, pgs 25-26). It may also be worth considering using the new Direct Benefit Transfer scheme, which is already being rolled out for kerosene, to provide subsidies to those end users that already have bank accounts. This might add an obstacle for those who do not currently have bank accounts, but, conversely, it may encourage more rural customers to apply for bank accounts, which are commonly seen as the first step on the credit ladder.

Finally, eligibility requirements for participation in the DDG Scheme exclude small to medium sized enterprises, which is a challenge to scaling up through winning government contracts. To incorporate SMEs into the tender systems, eligibility requirements could be relaxed to allow enterprises with a shorter history to apply. Another challenge in accessing those tenders is that the size of the contract often precludes SMEs. By breaking tenders into smaller packages of households, SMEs could take on more manageable contracts, and larger enterprises could have more control over the amount of work they wish to take on. However, doing so would undoubtedly increase administration and transaction costs. Studies in other contexts have suggested that current infrastructure and competition within the market are greater indicators of successful contracting than transaction costs (Amir Hefetz & Warner 2012). While we cannot extrapolate such a study to this precise context, it does suggest that other factors than transaction costs may be important.

7. Conclusion

Governments are relying on non-state actors to provide rural electrification, and in the case of India, this involves central financial assistance that targets particular off grid technologies, as well as contracting out the electrification of rural villages. However, the impacts that policy changes have on enterprises have thus far been understudied (Brass et al. 2012). In this study, fifteen enterprises have given their accounts of enterprise change, which have been analysed and compared.

The findings suggest that enterprises are impacted by policy directly where their business models interact with programmes, but changes have knock-on effects to the rest of the business model. When policy changes, it alters the entire enterprise landscape, which may impact the successful implementation of policy. In the Indian off grid solar context, revenue streams and technology are the two aspects of the business model that are initially impacted by rural electrification programmes. However, knock-on effects led many enterprises to change large parts of their business model. In India, changes can be seen in a broad trend 1) towards grid-connected customers, and 2) some movement away from solar home systems by small and medium-scale enterprises.

Given that the implementation of the DDG scheme have faced challenges, it is possible that these changes to the enterprise landscape have impacted the success of the programme. In either case, the changes to the enterprise landscape are likely to have implications for which end users are being targeted and which technologies are available for them. Further research might broaden these findings to additional rural electrification contexts, exploring whether enterprises in other countries respond in similar ways to policy changes.

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Appendix A

Summarised Narratives of Change

ENT ID	Starting Business Model	Changes to Business Model	Responsible Policy Change	Overall Themes	Reasons for Changes	Overall Themes
ENT 11	ENT11 began with SHS for both grid and non-grid connected end users, which included a government subsidy, and the expectation of partial cost recovery for the full capital cost of the system.	1. Shift away from bank financing for end users	1. NABARD subsidy cancelled	1. Revenue Model, Customer Interface	1. The loss of subsidy broke the link between the ENT and NABARD banking	1. Policy
		2. Move from SHS to microgrids and rooftop	2. NABARD subsidy cancelled	2. Product	2. Revenue model for SHS no longer worked without subsidy, so moved to microgrids and rooftops, which do no require end user subsidy	2. Policy
		3. Move from SHS to microgrids also caused a shift from total cost recovery to partial cost recovery	3. NABARD subsidy cancelled	3. Revenue Model	3. Revenue model for SHS no longer worked without subsidy, so moved to microgrids, which have a high capex and low to moderate likelihood of cost recovery, subsidised by rooftop projects	3. Policy
		4. Shift from both electrified and unelectrified areas into unelectrified hamlets	4. NABARD subsidy cancelled	4. Customer Interaction/ Customer Segments	4. Revenue model for SHS no longer worked without subsidy, so moved to microgrids, which are most in demand in unelectrified housing clusters	4. Policy
		5. Shifted from manufacturing and distribution to just distribution	5. N/A	5. Supply Chain Position	5. Could not compete with other manufacturers	5. Financial Aspects
		6. Moved from solar lanterns to solar home systems	6. N/A	6. Product	6. Shift of focus to distribution, rather than manufacturing	6. Supply Chain Position
ENT 12	ENT12 began with SHS for both grid and non-grid connected customers, with no subsidy, total cost recovery for the systems and the use of village level entrepreneurs for distribution	1. Sales dropped for a time	1. GoI introduced a scheme with 50% subsidy on SHS	1. Sales	1. When high subsidies are introduced, customers stopped buying full price products from ENT, alternatively, the rumour of subsidies cause prospective customers to anticipate subsidies, depressing demand	1. Policy
		2. Moved from selling a range of products, now primarily sell solar products	2. N/A	2. Product	2. Only solar products sold	2. Sales
		3. Shifted from VLE for distribution to selling via NGOs, now selling via dealers	3. N/A	3. Channels	3. Small basket of products did not allow for (male) VLEs to make sufficient money	3. Product

ENT ID	Starting Business Model	Changes to Business Model	Responsible Policy Change	Overall Themes	Reasons for Changes	Overall Themes
ENT 13	ENT13 began with the manufacture of solar lanterns.	1. Stopped sale of solar lamps, but still provide in grant-based projects	1. N/A	1. Product	1. Found distribution difficult	1. Supply Chain Position
		2. Began manufacturing solar panels	2. N/A	2. Product	2. Acquired enough capital to manufacture panels, felt there was unmet demand	2. Infrastructure Management
ENT 14	ENT14 began working with solar lanterns before moving on to SHS, which were for both grid and non-grid connected users. They did not provide a subsidy for the systems, and expected total cost recovery.	1. Stopped providing financing for products	1. N/A	1. Customer Interface/ Channel	1. Previously enterprise had worked with microfinance, but microfinancing fell apart after 2010	1. Partnerships
		2. Stopped selling SHS	2. N/A	2. Product	2. Manufacturing and Microfinance partnerships that were used for selling SHS ended	2. Partnerships
		3. Trying to move away from grant-based financing	3. Micro-grid/Mini-grid CapEx subsidies	3. Revenue Model	3. Policy uncertainty makes incorporating subsidy into revenue model risky	3. Policy
ENT 21	ENT21 is a new enterprise with three models for their mini-grids. Some mini-grids are for grid connected customers only, and expect total cost recovery for the system, although some of these mini-grids also receive a government subsidy. The last minigrid model is for non-grid connected users, is typically grant-based and has the expectation of partial cost recovery.					

ENT ID	Starting Business Model	Changes to Business Model	Responsible Policy Change	Overall Themes	Reasons for Changes	Overall Themes
ENT 22	ENT22 has three SHS models, all for both grid and non-grid connection end users. The first two are subsidy free, expect the total cost for the system to be paid, and are distributed through either microfinance organisations or village level entrepreneurs. The final model is grant-based and therefore has the expectation of no or only partial cost recovery.					
ENT 23	ENT23 began by manufacturing and providing SHS to non-grid connected users with a government subsidy through winning DDG tenders, therefore they sold the systems at a price the provided only partial cost recovery.	1. Increasing manufacture of grid connected technology	1-2. "Government incentive schemes" are "promoting grid tied" projects	1. Product	1. Incentives from government encourage ENT to manufacture products for grid-connected projects	1. Policy
		2. Adding more grid-connected customers		2. Customer Interface/ Customer Segments	2. Increasing the manufacture of grid-connected products increase the amount of the ENT's work that focus on grid-connected customers	2. Policy
ENT 24	ENT24 began with microgrids for non-grid connected customers, which expected only partial cost recovery for the capex and open costs.	1. Shift from microgrids to mini-grids	1. Grid expansion under RGGVY/ DDUGJY programmes	1. Product	1. Grid expansion decreased the market for small off grid systems	1. Policy
		2. Shift from unelectrified to electrified villages	2. Grid expansion under RGGVY/ DDUGJY programmes	2. Customer Interface/ Customer Segments	2. Grid expansion decreased the unelectrified market, unreliable grid increased demand in electrified villages	2. Policy
		3. Shifting focus of new work to Uttar Pradesh	3. New UP Micro-grid/ Mini-grid Policy is "one reason" for that change	3. Customer Interface/ Customer Segments (state)	3. The new Uttar Pradesh Micro-grid/ Mini-grid is favourable to the ENT's product, and is a reason why they are starting more projects in Uttar Pradesh	3. Policy
		4. Move from post-pay to pre-pay model	4. N/A	4. Revenue Model	4. Poor cost recovery from post-pay model	4. Cost Recovery

ENT ID	Starting Business Model	Changes to Business Model	Responsible Policy Change	Overall Themes	Reasons for Changes	Overall Themes
		5. Inclusion of solar/biomass hybrid systems	5. N/A	5. Product	5. Low cost of solar	5. Cost Structure
ENT 25	ENT25 began with a SHS type product that focused on providing power for non-grid connected customers, expecting total cost recovery and providing no subsidy.	1. Shift from unelectrified end users to both electrified and unelectrified	1. Grid expansion under RGGVY/ DDUGJY programmes	1. Customer Interface/ Customer Segments	1. Grid expansion brought electricity access into areas that they work in	1. Policy
		2. Focused on manufacturing and integration, use VLEs and MFIs for distribution and collection	2. N/A	2. Customer Interface/ Channels	2. Early on, the enterprise realised that they could not produce and distribute the product	2. Supply Chain Position
ENT 26	ENT26 began with SHS that were for both grid and non-grid connected customers. The systems received a government subsidy and had the expectation of partial cost recovery.	1. Shift from government subsidy to no subsidy	1. NABARD subsidy was cancelled	1. Revenue Model	1. JNNSM subsidy cancellation meant that it was no longer available for the ENT's end users	1. Policy
		2. Including built-in financing for systems	2. N/A	2. Revenue Model, Customer Interface/ Channels	2. In period 2007-2009, enterprise finds range of new financing through partnerships with rural banks, credit cooperatives and microfinance agencies for end users	2. Partnerships
ENT 27	ENT27 began with SHS for non-grid connected users, which were distributed through self help groups and received a government subsidy. The sale of these systems partially covered the full cost of the SHS.	1. Enterprise began work in conjunction with government NABARD subsidy, connecting NABARD bank with SHGs for financing.	1. NABARD subsidy	1. Partnerships, Revenue Model	1. Needed financing for rural end users, NABARD subsidy was available and NABARD was happy to partner because of ENT's reputation	1. Policy, Customer Interface/ Customer Segments
		2. Shift from subsidy to grant-based model	2. NABARD subsidy backlogged, then cancelled	2. Revenue Model	2. The backlogging and then cancellation of the subsidy meant that the revenue model was no longer viable, so the ENT moved to grant-financing	2. Policy
		3. Increased product range	3. NABARD subsidy was cancelled	3. Product	3. Previous NABARD subsidy had only applied to one product, once cancelled, ENT27 added new tech	3. Policy
		4. Stopped selling solar lamps	4. N/A	4. Product	4. Solar lamps were of poor quality and broke after approx. one year, didn't 'understand the technology'	4. Quality, Knowledge
		5. Enterprise moved from loaning to selling systems	5. N/A	5. Revenue Model	5. There was a desire to own products from end users.	5. Demand

ENT ID	Starting Business Model	Changes to Business Model	Responsible Policy Change	Overall Themes	Reasons for Changes	Overall Themes
		6. Enterprise beginning own limited company and moving towards a financially sustainable model with no subsidy	6. N/A	6. Revenue Model	6. Aim for sustainability	6. Revenue Model
ENT 28	ENT28 began with SHS and Micro-grids. SHS were for grid and non-grid connected customers, received a grant-subsidy, had partial cost recovery, and were distributed through self-help groups or village level entrepreneurs. The microgrids are provided for non-grid connected users only, rely on grant funding and expect only the partial recovery of opex and capex costs.	1. Adding larger and larger systems to their product line	1. N/A	1. Product	1. It is a “natural progression” as end users experience a growth in consumer demand	1. Demand
ENT 31	ENT31 has a range of products but is currently scaling up their minigrid systems. These are for both grid and non-grid connected end users, have a grant subsidy for the capital expenditure, but expect high levels of cost recovery, either partial or total.					

ENT ID	Starting Business Model	Changes to Business Model	Responsible Policy Change	Overall Themes	Reasons for Changes	Overall Themes
ENT 32	ENT32 began their off-grid electrification work with microgrids for non-grid connected customers, which were enabled by grants for capital expenditure, and expected only partial cost recovery.	1. Moved from 1 engineer with each grid to new monitoring technology and fewer engineers	1. JNNSM subsidy decreased from 30%-25%, putting strains on their finances	1. Customer Interface, Product	1. As capital expenditure subsidy decreased, ENT had to decrease the number of engineers and focus more on monitoring to cut costs	1. Policy
		2. Focusing on solar products	2. N/A	2. Product	2. Started with a range of products, but had demand for more solar capacity	2. Demand
ENT 33	ENT33 is an incubator for sustainable energy companies, with a heavy focus on rural electrification, including a number of off grid solar entrepreneurs.	1. Incubatees do not offer subsidy to their end users.	1. NSM-NABARD subsidy	1. Revenue Model	1. Incubatee have too little experience to be eligible for NSM-NABARD subsidy & financing	1. Policy
GOV 21	GOV21 works with solar home systems and microgrids. SHS are specifically for non-grid connected end users, and receive either a grant or government subsidy, meaning that they expect only partial cost recovery in the sale of the system. The microgrids they work with are also intended for non-grid connected end users, are reliant on grants, and expect only partial cost recovery, primarily for the operating costs.	1. Targeting unelectrified areas with SHS	1. Government partnership	1. Customer interface/ Customer Segments	1. Partnership with government allowed for subsidy, influenced type of end user	1. Partnership
		2. Enterprise aims to build maintenance capacity	2. N/A	2. Value Proposition	2. In order to "build a stable business model" and run future projects as a business	2. Revenue Model

Source: Author's analysis, 2018

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