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Original research article

The paradox of mini-grid business models: A conflict between business viability and customer affordability in rural India

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ABSTRACT

Policy-makers struggle with the following wicked problem in the energy access context: if existing socio-technical solutions can alleviate energy poverty, why is the energy transition slower than expected in rural Bottom of the Pyramid (BoP) markets? Here, social enterprises are starting to play a vital role. Using Husk Power Systems (HPS) as a longitudinal case study, we analyse how a social enterprise in India attempts to serve low-income customers. In this study, we aim to address the following research question: how and to what extent can a mini-grid based social enterprise resolve the technical and organisational challenges associated with providing services in a rural BoP environment? Our interdisciplinary approach navigates the landscape between social entrepreneurship and socio-technical aspects of mini-grid operations in the rural BoP market using a Multi-Level Perspective (MLP). We rely on narrative analysis to delineate the complexities of mini-grid operations in low-income settings to integrate on-site experiences and firm-level processes to energy access discourse. The paper argues that continuous conflicts exist between social and commercial objectives concerning the socio-technical configuration of mini-grids in the rural BoP markets. As this case study reveals, social enterprises need to manage the socio-technical complexities inherent to mini-grid processes; otherwise, customer affordability and business viability become an unsolvable paradox. The sustainability of a business model depends on how socio-technical aspects of the mini-grid are designed, managed and operated. Finally, this study proposes a business model framework integrating social and technical aspects employing socio-technical regimes in the MLP.

1. Introduction

Mini-grids are essential to achieving the United Nations' Sustainable Development Goals (SDGs) relating to energy access (SDG-7), and the World Bank estimates that around $220 billion funding is required to ensure this goal is met [1]. Participation by private enterprise is therefore instrumental in overcoming the limitations of public utilities [2]. Yet, the majority of mini-grids must target low-income customers in rural areas. This low-income customer segment is best known as the Bottom of the Pyramid (BoP) [3]. Despite the market need for energy access and the opportunities of private-sector, policy-makers struggle with the following wicked problem: if existing socio-technical solutions can alleviate energy poverty, why is the energy transition slower than expected in rural BoP markets? The slow progress can be attributed to characteristics of rural BoP markets. The characteristics include acute market imperfections and resource constraints, which are not adequately addressed by private commercial enterprises [4]. Social enterprises – an altruistic variant of commercial enterprise that seek a balance between social and commercial objectives [5] – could fill this void in rural BoP markets.

Recent evidence suggests that in-depth analysis of social enterprises – those operating in rural BoP markets and serving low-income customers – promises to uncover hindrances to private-sector participation in the energy access context [6]. Expressing a similar view, Pedersen et al. [7] have called for further studies to investigate business models balancing commercial and social objectives in order to accelerate the deployment of mini-grids. Moreover, there is a research gap between on-site experiences and the current understanding of mini-grid business models [8]. To address this gap, we focus here on a longitudinal case study of a social enterprise, Husk Power Systems (HPS), to examine the

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trials and tribulations of a social enterprise managing mini-grid operations in a rural BoP environment. HPS began operations in 2007 and operates primarily in Bihar, India, with expanding operations in East and West Africa. Having demonstrated long-term sustainability, HPS represents a valuable case study for uncovering organisational challenges and revealing the complexities of mini-grid operations in a rural BoP setting.

This study aims to address the following research question: how and to what extent can a mini-grid-based social enterprise resolve the technical and organisational challenges associated with providing electricity in a rural BoP environment? Our interdisciplinary approach navigates the landscape between social entrepreneurship and the socio-technical configuration of mini-grid operations in rural BoP markets. For our case study analysis, we utilise the social entrepreneurship framework proposed by Austin et al. [9] and the Multi-Level Perspective (MLP) model developed by Geels [10]. Both frameworks enable us to contextualise the case study and facilitate the investigation of the interrelationships between specific events, narratives, and processes [11] (p. 231). In particular, the MLP approach broadens the unit of analysis to socio-technical systems [12] and allows for the amalgamation of social and technical perspectives [13]. Using socio-technical system, as unit of analysis, permit the application of social and technical lenses simultaneously. We also rely on the method of narrative analysis proposed by Boje [14] to identify overarching themes that describe organisational processes, practices, and strategies. This method has unique advantages in energy and climate research helping to uncover nuances and complexities overlooked in quantitative studies [15]. We have used the term '*socio-technical configuration*' throughout this article in accordance with the MLP approach, i.e., in terms of societal function (see Section 4.3), whereas the word '*socio-technical design*' is used as an artefact.

Our single case study approach follows the tradition of business and management research – though we acknowledge the strengths and weaknesses of the single case study approach [16] (p. 183–186) - and we provide a detailed description of the surrounding culture, actors, events, and processes in a contextual setting [11] (p. 93–95). The findings of this longitudinal study will be of use to both practitioners and policymakers. For practitioners, the study offers insights into challenges experienced by a mini-grid enterprise and its transformations in a resource-constrained BoP environment. For policymakers, it provides valuable lessons on how to create a market environment conducive to active private sector participation.

This article is structured as follows. In Section 2, we provide background on mini-grids, business models and rural BoP market. Section 3 then provides a background our case study, while in Section 4, we present our methodology for analysing qualitative data. Section 5 begins by introducing customer affordability and business viability, before analysing the conflicts from an organisational alignment perspective, considering how partnerships support companies in their efforts to innovate and adapt. Before concluding, we illustrate how social enterprises install, manage, and expand mini-grid operations in BoP settings.

2. Mini-grids and social enterprises in rural BoP markets

This section investigates and integrates research trends concerning the relationship between mini-grids and social enterprises in the global south. This integrative approach promotes the combination of perspectives and insights from different fields [17]. First, we present prior knowledge concerning mini-grids and private sector interventions relating to energy access. Second, we incorporate this background information into research on rural BoP settings and social entrepreneurship.

2.1. Mini-grid business models: a definition

The importance of mini-grids for rural electrification is widely acknowledged in the energy access setting. Mini-grids serve a wide range of electricity needs in rural areas than other off-grid alternatives [18]. Broadly, rural electrification literature focuses predominantly on renewable technologies [19]. This technology dominance also holds for the literature on mini-grids too. Technology-dominant studies may be grouped into two categories: those focused on feasibility (e.g., [20,21,22]), and case studies of specific projects (e.g., [23,24,25]). Alternatively, some investigations (e.g., [26,27]) have focused on customer willingness to pay for electricity in low-income rural areas. Policy-oriented studies (e.g., [28,29,30]), on the other hand, concentrate on barriers within the regulatory environment for mini-grids. To summarise, it is important to include the nuances of social, economic, and cultural contexts in mini-grid studies, alongside the technological perspective [31]. These studies indicate the relative importance of mini-grid technologies and end-user perspective in advancing energy access, while also leaving research gaps to be filled concerning business models.

Business models underline the importance of sustainability and scalability for achieving universal energy access through mini-grids. The term *business model* has various interpretations in energy access discourse [32,33]. These interpretations focus on ownership structure, system design, choice of customers, and funding mechanisms (e.g., [1,34,35]). This article relies on the definition proposed by the Asian Development Bank, which focuses on the operation and maintenance of mini-grids, ownership structure, financing, risk mitigation, and stakeholders. This definition takes a broader view of what constitutes a business model [36] and is compatible with the multidimensional nature of mini-grid business models [37]. In practice, privately owned, developed, operated, and maintained mini-grids are the focus of this article, though we acknowledge other ownership structures such as community operated mini-grids [38].

2.2. Business models in BoP settings and private sector participation: what is missing

The private sector is an essential partner in efforts to achieve the SDGs owing to the problem of scalability in rural BoP settings. In the case of mini-grids, the private sector has experimented with a number of different business models in low-income rural settings [33]. As Kagimu and Ustun [39] have argued, the scalability of a business models depends mainly on risk management, capital costs, and the policy environment. In general, sustainable business models require an environment that encourages private-sector participation [40,41,42]. A favourable business environment promotes private-sector participation and thereby enables mini-grids diffusion in low-income settings. Considerable effort has been put into developing an environment conducive to solving the energy access problem, but these efforts have failed to encourage the private sector. This failure is evident, especially in low-income countries.

In BoP settings in particular, business models are a vital aspect of private-sector participation. One literature review stresses the importance of realignment with the policy environment, regulatory frameworks, and support systems for navigating the inherent risks associated with rural BoP markets [43]. This literature review highlights the importance of risk management in low-income settings. In relation to this, Malhotra et al. [44] suggest increasing the investment volume as a risk-mitigating strategy by aggregating and spatially diversifying mini-grids. In other words, risk management is easier if a private entity operates many mini-grids simultaneously. Overall, local conditions shape business models in rural BoP markets, and organisations must adapt and refine their business models accordingly [45].

Enterprises operating in rural BoP markets face a variety of problems due to the inherent risks of that environment. Many development agencies, including governments, have initiated policies and programmes to minimise these risks. These efforts have failed to accelerate private investment. One study by Schmidt et al. examines private-sector investments in rural electrification and highlights the knowledge gap about private sector participation in the mini-grid literature [46]. A recent study on Kenyan solar mini-grids acknowledges this knowledge gap [47]. Similarly, Moner-Girona et al. [8] suggest that little attention has been paid to the on-site experiences of private firms. Overall, this knowledge gap indicates a need to integrate on-site experiences with the business model literature. The case study in this article is intended to present and analyse the experiences of HPS in order to improve understanding of mini-grid operations. In addition, Knuckles [33] argues that most studies typically overlook the nuances of firm-level processes in BoP settings. Moreover, the critical issue of entrepreneurial efforts has been under-examined in the literature on low-income markets, as Park [48] indicates. The current case study attempts to fill the research gap concerning firm-level processes by focusing on the mini-grid operations and entrepreneurial efforts of HPS.

2.3. Mini-grids and social enterprises: a partnership of convenience

Even though there is tremendous need for energy access in rural BoP settings, the business viability of mini-grids can be challenging for a traditional enterprise with commercial objectives. These challenges can be attributed to low-income customers and uncertain return on investment. Given this situation, social enterprises may be a solution for the diffusion of rural mini-grids in the context of the SDGs. Their potential can be attributed to the inclusive nature of business models [5,49,50,51,52], which emanates from their efforts to strike a balance between social and commercial objectives. In brief, rural BoP markets appeal to social enterprises due to their potential for social objectives, such as expanding access to energy, and education.

Despite the potential of social enterprises for alleviating energy poverty in rural BoP markets, only a small number of studies have examined social enterprises in conjunction with mini-grids. The principial findings of these studies, however, is that mini-grid enterprises require sufficient financial support to create synergy between their commercial and social objectives in order to succeed in the rural BoP market [7]. One study focusing on insights from the Indian experience underlines the need for an innovative ecosystem to serve low-income consumers in BoP markets to address energy poverty [53]. This ecosystem must support capacity building and partnerships from an organisational perspective. Kumar and Tiwary [54] assert that further empirical investigations are required to improve understanding of the role of social enterprises and to support the eco-system perspective. A case study on Grameen Shakti, a social enterprise, concludes that underlying socio-political complexities concerning energy poverty creates additional challenges and calls for further case studies to be carried out [55]. In sum, the existing literature reveals the need for more empirical studies, a need that our case study of HPS seek to address.

To summarise; due to their emphasis on social objectives, social enterprises are well suited to addressing problems such as energy access in resource-constrained settings. Promoting mini-grid- based social enterprises in rural BoP markets is essential given their potential to serve low-income customers. A limited literature review establishes the need to integrate the on-site experiences and firm-level processes of mini-grid enterprises with existing academic discourse. More case studies are needed to improve the sustainability of private enterprises in rural BoP markets. In this context, our case study provides insights into the activities of HPS by analysing the company's mini-grid operations and entrepreneurial efforts.

3. Case study and background information

This section presents background information on HPS. First, we outline the origin and expansion of HPS focusing on its business models, financial and organisational structure, socio-economic context, and technology. Second, we establish HPS's credentials as a social enterprise utilising social entrepreneurship literature followed by an academic perspective. Finally, we explain what makes HPS a unique case study.

3.1. The origin and expansion of HPS

HPS began operations in 2007 by providing off-grid electricity in Bihar through mini-grids powered by proprietary low-cost gasification technology using rice husk. Rice husk, a bio-residue, is in abundant supply in rural Bihar. Bihar is a state in northern India, most often characterised by its economic under-development, especially in rural areas [56]. The low human development index of Bihar reflects poverty and social inequality compared with other states in India [57]. This under-development is rooted in caste, class, and ethnic divisions, as well as weak institutions and poor infrastructure [58]. According to 2010 census, rural electrification of Bihar stands at 30.2% [59], reflecting the state's energy poverty. Overall, rural Bihar exemplifies the challenges faced in other BoP areas. These conditions have resulted in numerous institutional voids and the subsequent market exclusion of rural areas [60]. Private enterprises such as HPS have attempted to fill these institutional voids by serving rural BoP markets.

The initial modus operandi of HPS included recruitment of workers from local communities, who lacked the formal skills for plant operations. This approach helped HPS keep operational costs low and become locally embedded within rural communities. Moreover, the company's strategy focused on functional and essential aspects of the technological and organisational models to navigate the market imperfections and resource constraints inherent in BoP markets. In other words, the practices of HPS exhibited frugal innovation characteristics [61,62]. *Frugal innovation* in this context refers to reducing system complexity and minimising costs. From 2014 to 2015 onwards, HPS transitioned to a hybrid mini-grid model that utilised rice husk and solar power to supply on-demand electricity. This hybrid-grid operation required a workforce with a more formal skill-set than the initial modus operandi.

The company opted for three business models for its organisational expansion: Build-Own-Operate-Maintain (BOOM), Build-Own-Maintain (BOM) and Build and Maintain (BM). These models are explained later in the article. Plant operations are decentralised across different regional clusters overseen from the corporate headquarters in Patna, in Bihar. In 2015, HPS began expanding operations to East Africa. HPS began operations with an initial investment of $40,000, along with a $12,000 subsidy from government of India. Further expansion was funded by competitions, grants, loans, and equity investments [63]. In 2018, HPS received a $20 million equity investment from strategic partner Shell Foundation [64]. This investment indicates continued interest in HPS as a mini-grid enterprise instrumental to universal electrification.

3.2. HPS as a social enterprise

HPS's approach demonstrates the key characteristic of a social enterprise: a balance between commercial and social objectives [5,9]. This balance is apparent from the company's social objectives: affordable rural electrification, local employment, women's empowerment, and rural development [65]. These societal objectives are Social Value Propositions (SVPs), as understood in the social enterprise literature. In practice, these societal objectives are achieved as follows. First, HPS provides electricity through mini-grids and employs people from rural areas. Electrification and employment contribute to rural development. Second, the company employs local women in incense stick factories, which reuse the ash from energy generation [66]. Due to this inclusive approach, HPS can be deemed a social enterprise operating in the rural BoP market. This claim is supported by two other studies [49,67].

3.3. HPS in the literature

HPS has been a subject of some academic interest. Rao et al. [68] examined the company using a business model canvas. The canvas includes key activities and stakeholders, revenue streams, and socio-economic impact. In the same vein, one study compared HPS business model with that of publicly owned mini-grids [69]. Bhattacharyya [70], on the other hand, uses HPS as a case study for investigating the viability of mini-grids using rice husk. This case study identifies two main threats to HPS's business model in Bihar: regulatory uncertainty and grid extension, which has now increased to almost near universal electrification. In 2015, a cross-country collaboration project explored HPS as a scalable solution [71]. Two other studies have considered HPS as an innovation in BoP markets [49,72]. Adopting a similar perspective, Kayser and Budinich [73] identify two managerial challenges from an organisational perspective: operating an extensive network of plants and navigating regulatory environments. In terms of sustainability, Lyytinen [74] agrees with other authors on the social impact of HPS's modus operandi, but questions the financial sustainability of its approach in the long run. Together, these studies provide important insights into the business models, business viability, managerial and organisational challenges, and social impact of the company. However, far too little attention has been paid to on-site experiences and firm-level processes. Most importantly, no other study has utilised narrative analysis to uncover underlying complexities resulting from mini-grid operations in rural BoP markets.

3.4. HPS: a distinct business model for a longitudinal case study

In this article, the term *business model* refers to privately owned, developed, operated, and maintained mini-grids, as described in the previous section. Few companies (e.g., DESI power, Mlinda, OMC power) operate in India based on above definition. HPS is a unique player compared to other companies in India, it has gradually progressed from a start-up to a scalable enterprise [75]. This distinction is explicit in the company's funding structure and organisational expansion. Unlike firms such as OMC Power, for example, HPS relies mainly on end users for its revenue, rather than productive loads such as telecom towers. This customer segment is a crucial differentiator in the rural BoP setting.

In addition to distinctive characteristics set out above, the following reasons make HPS ideal for a case study. First, HPS is among the few enterprises to exhibit long-term sustainability and scalability in India. This longevity is a significant achievement considering the off-grid environment in India [26,76]. Second, HPS began operations in Bihar, known for its weak socio-economic conditions (the state has the lowest literacy and per capita income of all Indian states [77]). Third, HPS has since the beginning dedicated itself to rural empowerment. HPS can be considered to operate on an inclusive business model, as described by Bhattacharyya [70]. In-depth analysis of inclusive business models, such as that of HPS, will promote private-sector participation, thereby contributing to the achievement of the SDGs and benefitting BoP communities [50]. Therefore, our use of HPS as a longitudinal case study will also promises to improve understanding of entrepreneurial efforts relating to energy access in constrained settings.

4. Methods and methodology

This article uses a case study approach to integrate the on-site experiences and firm-level processes of a particular mini-grid-based social enterprise into academic discourse through qualitative analysis. We focus on mini-grid operations and entrepreneurial efforts to answer the research question set out in the Introduction. As a methodology, the case study approach facilitates in-depth explorations of multidimensional issues in complex real-time settings in energy research [78]. The multidimensionality is rooted in the various social, economic, technological, and organisational nuances involved. In other words, the case study must adopt a holistic and systemic view for qualitative analysis. This holistic and systemic view allows for the uncovering of multidimensional complexity embedded within on-site experiences and firm-level processes and enables the identification of meaningful patterns [79]. In short, the case study approach requires interdisciplinary perspective. To this end, our approach to qualitative analysis is a combination of three frameworks: social entrepreneurship [9], narrative analysis [14], and MLP [10]. In the following sections, we briefly explain these frameworks and the rationale behind our adoption of three framework.

4.1. Social entrepreneurship

One of the main prerequisites for private-sector participation is a favourable organisational context. In this longitudinal case study, the organisational context is a social enterprise serving low-income customers in rural areas to understand mini-grid operations based on on-site experiences. Therefore, a process-centric view of social entrepreneurship [9] has a number of distinct advantages, while we acknowledge other interpretations of social entrepreneurship [80]. First, the process-centric framework helps interpret nuances related to the firm-level processes (as Knuckles [33] suggests) and entrepreneurial efforts (as asserted by Park [48]) of HPS. Second, this framework fits the multidimensional nature of mini-grid operations involving market imperfections and resource constraints in the rural BoP environment.

To strategically analyse HPS's activities, we utilise three elements of the social entrepreneurship framework. The first element deals with *social value propositions*. In essence, SVPs articulate the social objectives of a social enterprise [81]. These social objectives provide the competitive advantage necessary to manage constraints [82]. In the case of HPS, the leading social objective is rural electrification, ensuring affordability and reliability. The second aspect of the framework, *organisational alignment*, concerns the strategic choices made to ensure long-term survival and growth by managing people and capital [83]. An organisation's alignment is directly related to critical decisions addressing operational challenges in the acquisition, management, and deployment of constrained resources to improve business viability [84]. Essentially, organisations need to manage and allocate resources effectively. In practice, HPS's strategic choices are categorised and analysed in terms of technical and organisational capabilities and challenges. The third aspect of the framework, *stakeholder collaboration*, is crucial to operating in resource-constrained environments. A stakeholder is 'any group or individual who can affect or is affected by the achievement of the organisation's objectives' [85] (p. 46). Social enterprises rely on multiple stakeholders with different motives to achieve their social objectives [86]. Moreover, stakeholder collaboration is crucial to the sustainability of social enterprises, as one study concludes [87], to circumvent constraints. In other words, the partnership between stakeholder provides the leverage necessary to navigate a high-risk environment categorised by limited resources. By utilising this framework, we can identify stakeholders' roles within HPS's organisational alignment strategies, ensuring reliable and affordable electricity for low-income customers.

4.2. Narrative analysis

Narrative analysis is commonly used across a range of disciplines [88]. To analyse the interviews and secondary data, we have adopted Boje's [14] narrative approach to organisational research. Theoretically, *narratives* are 'verbal everyday modes of reality construction' [89]. Practically, narratives make sense of the variety of realities envisaged, performed, and expressed in retellings. As a research method, narrative analysis maintains a balance between deductive and inductive approaches to organisational research (p. 13) [14]. This balance permits the identification of overarching themes and highlights otherwise invisible nuances [90], and allows researchers to interpret chronological developments while performing qualitative data analysis [11] (p. 536). Briefly, narrative analysis enables chronological data segmentation specific to different organisational challenges and processes.

The narrative analysis offers a holistic approach to integrating essential information around a case study. Riessman [91] suggested three main approaches to qualitative analysis: thematic, structural and interactional. These three approaches are not mutually exclusive. In this case study, we primarily rely on thematic analysis. The thematic approach helps the study of organisations [92], as the narratives capture organisational processes through 'stability and change' [89,93]. Here, *stability and change* refer to the temporal dynamics of an organisation in terms of characteristics such as structure, strategies and innovation over a time-period.

Narrative analysis is a valuable research method for qualitative data analysis in energy research and social sciences as it allows data to be organised around prominent themes [78]. In practice, we have analysed the interviews and secondary data as organisational narratives in order to identify meaningful patterns to elucidate how HPS functions on a micro level. This thematic analysis reflect conflicts between stability and change regarding the challenges associated with mini-grid operations [89,94]. In other words, narrative analysis allows for conceptualisation of qualitative material as a series of thematic events within particular temporal and spatial dimensions as described by respondents. Overall, narrative analysis will be a valuable tool for understanding on-site experiences and firm-level processes of HPS in its rural BoP settings.

4.3. Multi-level perspective

Primary qualitative data analysis reveals that HPS's endeavours represent reconfiguration and reorganisation of processes in terms of mini-grid design, mini-grid operations, business models, and organisational dynamics. Qualitative data analysis therefore requires a framework for dealing with this reconfiguration and reorganisation. In this respect, MLP has established itself as a powerful analytical tool in the energy domain (e.g., [95,96]). In this study, MLP allows us to organise and analyse the data to capture this reconfiguration and reorganisation in a meaningful manner.

We will now briefly explain the MLP within the scope of our study, drawing on four other studies (see [10,12,97,98]), though we acknowledge other interpretations used in transitions research. MLP encompasses three central elements: niches, socio-technical regimes, and the socio-technical landscape. Niches are embedded within regimes and regimes within the landscape. Innovation originates from niches responsible for transition pathways in regimes, and subsequently changes the landscape of the socio-technical configuration. The socio-technical configuration fulfils a societal function such as providing electricity for energy needs. For example, the socio-technical configuration of electricity as a system involves generation, transmission, distribution. and utilisation in relation to the rules, policy regulations, and resource constraints within an energy market consisting of various actors. Among the three MLP elements, socio-technical regime mainly accounts for stability and change guided by five sub-regimes: policy, science, the socio-cultural regime, the technological regime and the user and market regime. The practical manifestation of MLP is explained later in methodology section.

MLP has found wide acceptance [99] and expanded to organisational research, where it is used to investigate the development of new technologies and the formation of innovation systems [100]. In this processes, organisational researchers applied and adopted concepts and frameworks used in management studies. In particular, MLP facilitates the use of a holistic and systemic perspective to assess business models [101]. In our opinion, the holistic and systemic perspective is best able to encompass the multidimensional nature of rural electrification and mini-grid operation in rural BoP markets. It is important to note that the scope of socio-technical transition in an organisational context is often narrower than that in large socio-technical systems (example: solar electricity in Ontario [102]).

4.4. Methodological approach

This longitudinal case study applies the above-mentioned theoretical frameworks to investigate the rural BoP environment surrounding mini-grid operations undertaken by HPS. In this respect, the social entrepreneurship framework helps to conceptualise HPS organisational activities and firm-level processes as entrepreneurial efforts, as outlined in Section 4.1 [9]. The narrative analysis method allows us to categorise qualitative material as organisational narratives to capture the nuances of contextual settings [14], while MLP facilitates the amalgamation of HPS's on-site experiences from a transition perspective of an organisation.

This case study uses narrative analysis to identify meaningful patterns that HPS personnel perceive and communicate about the company's mini-grid operations. In practical terms, various on-site experiences are arranged and connected in chronological order based on predominant themes. This chronological arrangement provides the basic building blocks for thematic analysis. Overall, while we acknowledge the limitation of narrative analysis [78], this framework allows for in-depth analysis and explanation of qualitative data. The usefulness of in-depth thematic analysis is evident from recent publications in this journal (e.g., SHS business models in India [6], technical transitions [95] and energy services in slum rehabilitation [107]).

As discussed above, the social entrepreneurship framework employed in this case study consists of three elements: SVPs, organisational alignment, and stakeholder collaboration. These elements support qualitative data analysis to enable us to identify HPS's entrepreneurial efforts. Practically, this framework separates narratives related to different on-site experiences and firm-level processes. The separation of narratives unearths inherent managerial and organisational complexities associated with the socio-technical configuration of mini-grid operations in rural BoP markets.

To uncover the complex and multifaceted nature of electrification efforts, we utilise the MLP framework, as it permits the simultaneous application of social and technical perspectives in a given socio-technical landscape. In practical terms, this framework encompasses production, diffusion, and the use of technology within a social setting, with niches at the micro level and socio-technical regimes at the *meso* level shaping the socio-technical landscape at the macro level. For narrative analysis, we rely on three niches, namely the socio-technical configuration, the BoP environment, and the business model. The organisational transition is guided by the social and commercial objectives governed through five MLP regimes. The transition is driven by customer affordability, system reliability, and business viability in practical terms. The five MLP regimes are elaborated in Table 1 in the context of the HPS case study. In summary, through narrative analysis, we identify the tension resulting from three niches associated with five regimes that shape the socio-technical landscape of HPS. In practice, both frameworks - social entrepreneurship and MLP - support an adequate analysis of organisational narratives to discern how mini-grid operations have developed in a particular rural BoP market.

4.5. Qualitative data collection

This longitudinal case study attempts to understand how HPS sustained in resource-constrained settings. Given the longitudinal nature of research endeavour, secondary data compliments primary data for qualitative analysis [108]. Thus, we utilise both primary and secondary data for qualitative data analysis. Three researchers collected the primary data during a 10-day field trip to Bihar in February 2016. The secondary data was collected during 2015–2020. Bellow we explain primary and secondary data collection strategies.

Secondary data is beneficial for the case narrative analysis as it aids the interpretation of stories told in the context of research [109]. The secondary data sources used in this longitudinal study are news articles, company reports, social media posts, and video material (e.g., interpersonal discussion, public speeches). Secondary data is collected through i) company website and ii) web search. For the web exploration, the search terms include "Husk Power Systems", "Mini-grid", "Bihar", and "Africa". We indexed search results with a custom time range,

Table 1
Socio-technical regimes and HPS.

Regime	Explanation	HPS context
Technological	Defined as specific combination of technological opportunities, the appropriability of innovations, cumulative technical advances, and the knowledge-base properties underpinning firms' innovative activities [103]	HPS mini-grids are designed primarily to cater to rural electricity needs through biomass gasification in peak hours. The technical regime was modified into a hybrid strategy that included ground-mount solar power for 24 × 7 electricity provision
Science	A contractual environment built on alliances and networks for knowledge production within an organisation or through collaboration [104] (p.112)	HPS has an in-house research and design team and collaborates with other actors outside the organisation to address technical challenges
Policy	Policy regimes represent the instituted arrangements for addressing policy problems [105]	The policy problem in the context of this study is off-grid rural electrification. HPS operates within the policy regime of the local government
Socio-cultural	The symbolic meaning of technology within a socio-technical configuration. In this respect, technology serves a societal function due to the alignment between a heterogenous set of elements [106]	Institutional voids characterise the socio-cultural regime of HPS in terms of socio-technical configuration
User and market	Characteristics of users and markets are central to socio-technical systems transition.	In the HPS case, user and market regime can be described with reference to the rural BoP market environment. The user regime is defined by low household income, and poverty and the market regime is characterised by imperfections

document type and video material. This data collection strategy is similar to two case studies published in Energy Research & Social Science journal: the transition to a fossil-free steel sector [110] and decentralised energy in the United Kingdom [111]. Specifically, we sought secondary materials with direct quotations or references to events relevant to HPS's activities and operations, as suggested by Ruggiano and Perry [112]. Overall, the approach capitalises on vast amounts of open data that has been collected, compiled, and archived. The search results were analysed manually, and 37 data sources were selected for the narrative analysis, covering 2008 to 2020.

Concerning the primary data collection, the first three days of field work were spent at HPS's headquarters. The researchers also spent seven days in four villages to conduct further interviews and field research. The company recommended the villages based on our research requirements. The trip included 5 semi-structured long-form interviews with the HPS management team, 10 open interviews with HPS employees in the villages, and 22 interviews with HPS customers and non-customers. The purpose of the long-form interviews was to understand how HPS operates in rural BoP market of Bihar. We interpreted the consumer interviews to substantiate affordability and reliability and thus omitted them from the organisational narratives. Moreover, non-customer interviews provided essential information on the socio-technical implementation of mini-grids. The semi-structured interviews were asked the same questions, while additional questions were asked dependent upon the interviewee's occupation. The common questions asked were as follows:

- What are the main challenges with mini-grids using rice husk and hybrid mini-grids in terms of installation and operations?
- What are the main technical challenges of mini-grids using rice husk in contrast to hybrid mini-grids, and how are these challenges addressed?
- What are the main differences between biomass-based mini-grids and hybrid mini-grid?
- What is the primary objective behind the training centre concerning human resources?
- How does HPS perceives its strategies concerning different business models?
- What is the role of external stakeholders in the progress of HPS as a social enterprise?
- What is HPS's future strategy for mini-grids expansion in India and Africa?

These questions mainly concerned respondents' working experiences regarding socio-technical aspects of mini-grid operations and the future prospects. The semi-structured interviews were designed to allow open-ended responses, enabling interviewees to explore respondents' experiences with the installation, maintenance and operations of mini-grids. The interviews conducted at company headquarters, specifically with upper management, focused on business development, business models, and organisational strategies. All interviews were recorded and transcribed. The transcribed primary data and secondary data were systematically analysed using ATLAS.ti, a qualitative data analysis tool. Table 2 presents information related to respondents.

5. Results and analysis

This section analyses how the HPS founders and other interview respondents narrated their on-site experiences and their understanding of firm-level processes within the five MLP regimes corresponding to the socio-technical configuration, the rural BoP market, and the business model. Our narrative analysis illustrates how the company has begun to align its business activities with the rural BoP market and to attempt to improve business viability. Three major narrative strands became apparent through the interviews concerning how HPS has maintained its business activities and ensured operational sustainability. First, the social enterprise has adapted to inherent socio-technical complexities in its pursuit of affordable and sustainable solutions to serve low-income customers. Second, the company continues to remain viable in rural BoP markets because of continuous organisational alignment. Finally, successful partnerships with stakeholders have helped the social enterprise overcome resource constraints to create meaningful social impact.

5.1. *Customer affordability and business viability: a paradox*

Customer affordability and business viability are often conflicting forces in an enterprise setting. However, the subsistent nature of energy access in rural BoP markets and their resource-constrained environment forces companies like HPS into a paradoxical situation. In these markets,

Table 2
Narrative respondents.

Title	Identifier	Language(s) of narrative
Co-founder 1	A	English
Co-founder 2	B	English
Co-founder 3	C	English
Head of business development	D	English
Head of operations	E	English
HR manager	F	English and Hindi
Technical head	G	English
Senior engineer	H	English and Hindi
Solar engineer (first hybrid plant)	I	Hindi
Head of training centre	J	Hindi
Plant operator (Manjahara)	K	Hindi
Plant operator (Tamkuha)	L	Hindi
Plant operator (Samastipur)	M	Hindi

commercial and social objectives coexist and clash. Social objectives are aimed creating social impact, whereas commercial objectives are intend to help identify a sustainable business model. Two of the company's social objectives – affordable rural electrification and the creation of local employment – are closely related to the SDGs. In particular, finding an affordable rural electrification solution is critical to achieving both social impact and business viability, given that HPS serves low-income customers. Based on the narrative analysis presented below, the mismatch between customer affordability and business viability originates from the interdependence between technological, and user and market regimes. The narratives presented below illustrate how HPS managers, employees, and founders continue to navigate and negotiate this conflict in low-income rural settings.

Customer affordability and business viability are at the forefront of HPS's approach. Respondent A, the current CEO, stated in an interview from 2009: 'What we want is to enhance people's lives by providing affordable local and sustainable energy solutions' [113]. In essence, HPS's choices are dictated heavily by its users' ability and willingness to pay for electricity to cater to the user regime. A technician explained the affordability of mini-grid solutions compared with kerosene as follows: 'We help cut down on 50 per cent of the customer's expenditure on kerosene. This makes a huge difference' [114]. In other words, the HPS solution provides economic incentive and attracts new customers. This incentive overlaps with business viability, as affordability is a positive way to mobilise the user regime.

HPS's mini-grid plants need to demonstrate business viability to succeed in the market regime. The company must therefore minimise the capital and operational costs of socio-technical configuration. The configuration encompasses the social and technical aspects of the mini-grid, viewed from a holistic perspective. HPS considered a number of different socio-technical designs before opting for gasification technology for electricity generation and recruitment of local workers for plant operations. According to one of the company's co-founder (Respondent B): 'We originally thought that some super high-tech solution would fix the problem. We were proven wrong' [115]. Instead, explained the co-founder, the electricity generation and distribution process was simplified 'so much that even a high school educated villager could be trained and run our power plants.' The company simplified gasification process, removing everything non-essential in order to decrease capital costs and improve business viability [116], thereby demonstrating a frugal approach. For example, bamboo poles were utilised to distribute electricity. The local electricity act supports this frugal approach, by providing exemptions for organisations like HPS. The narratives clearly illustrate socio-technical configuration's importance for achieving business viability in rural BoP markets.

The following narratives suggest that the company has been effectively utilising the rural BoP context. In 2007, HPS opted to use local resources: rice husk and a rural workforce. This approach, utilising local resources, benefits businesses like HPS [117]. Respondent A explained the company's choice of rice husk: 'The reason we started looking at rice and rice husks was because the villages within the Bihar area have an abundance of rice production' [118]. The co-founder continued: 'We dabbled with solar at the start, which was turning out too expensive at the time. So, instead, we decided to mobilise local resources and arrived upon biomass as the way to go.' This remark emphasises that solar power was cost-intensive compared with biomass gasification in terms of capital; it also required skilled technicians, which restricted opportunities for local workers. Moreover, the use of a local workforce guaranteed lower operational costs and facilitated cohesion with local communities. Community cohesion is essential, as Respondent A explained, through being 'dependent on the local population both to obtain material for the biomass and to avoid theft and sabotage' and 'above all we want to have an open and close relationship' with the local community [119]. These narratives provide insights into HPS's efforts to capitalise on the user and market regime to improve business viability. Capitalisation of local resources is a key part of the technological and market regimes.

As the above narratives show, a strategic balance existed between customer affordability and business viability during the company's early years. This strategic balance aided the company's growth due to a frugal socio-technical configuration: a cost-effective biomass gasification system operated without specialised technicians. The growth is apparent from the investments received and the number of plants installed between 2008 and 2012. However, this design strategy created operational challenges for the company relating to the technological regime. Regarding technical difficulties, Respondent G stated: 'We faced many [technical] challenges with earlier gasification technology.' Respondent H expressed a similar view from a technical perspective. These narratives imply a trade-off between technological simplicity and reliability. As noted above, HPS recruited a workforce from local villages with limited skills and training. However, this strategy resulted in operational challenges as the workforce could not handle timely technical maintenance and faults within the technology and science regimes, according to Respondent G. Subsequently, the company experienced organisational challenges in terms of business viability during 2013–2014. Consequently, HPS scaled down its operations to reduce financial losses. In addition to these challenges, the biomass mini-grid plants operated only after sunset and did not provide on-demand electricity during the daytime as required by the user regime corresponding to the energy ladder. These challenges demanded a transition strategy in order for the company to achieve business viability. As a result, HPS adopted a new socio-technical configuration to improve business viability.

To overcome the technical and operational challenges threatening business viability, HPS piloted a new hybrid mini-grid using solar power and biomass gasification in 2015. This pilot project was part of a strategic shift from the earlier frugal socio-technical design towards a new technology-dominant socio-technical configuration. The technological dominance of the new configuration is evident from the more sophisticated technologies using in hybrid mini-grids, including energy storage and smart energy meters. This strategic transition improved long-term sustainability prospects and addressing the company's organisational challenges to a major extent. When asked about the transition, Respondent E answered: 'We continue to face challenges despite ten years in the business with gasification'. The respondent continued, 'we have to actually define and redefine strategies from time to time.' This statement highlights that the company must continuously adapt and improve its technical and organisational capabilities to respond to challenges originating from different socio-technical regimes.

However, the company's strategic transition in power generation has resulted in high capital costs due to the technological dominance of the new socio-technical configuration. This is at odds with customer affordability as the company serves low-income customers. As a result, high capital costs threaten business viability because of economic tensions inside the user and market regime. When asked about the conflict between high capital, customer affordability, and business viability, Respondent E stated:

I would say, additional burden on account of technology not being passed on to the customer, like the smart meters.… No additional burden is put onto the customers because of high-tech solutions …. The hybrid plant, in case we start recovering from the [domestic] customers, they will not buy our electricity.

Respondents D and G expressed similar views concerning capital costs and customer affordability. By adopting a customer-centric approach with regard to affordability, the company has remained true to its social objectives as a social enterprise. Nevertheless, subsidising the capital costs has threatened business viability. Overall, these circumstances have created a conflict between customer affordability and business viability in the new socio-technical configuration. When asked about how HPS is dealing with this market conflict, Respondent G, the technical head of the company, acknowledged the capital costs as sunk costs and emphasised the potential revenues from commercial customers due to the availability of uninterrupted electricity. As the next section on organisational alignment reveals, however, this customer differentiation approach has created social tensions in the user regime, provoked by the company's preference for commercial consumers over households. The preferential treatment of commercial customers thus threatens to undermine the social objective allied with rural electrification. In addition, financial judgment suggests that the high capital costs of the hybrid mini-grid will undermine business viability in low-income markets.

The technological transition to hybrid generation has also created a paradoxical situation for local recruitment as the new socio-technical design requires formal training. This disturbed social cohesion in the village where the pilot project was conducted as the local plant operator became a sub-ordinate to the non-local recruit. When asked about the conflicting social impact about employing locals for plant operations, Respondent D, explained:

> For a solar, we have no option, but to hire people with a minimum degree or diploma qualification with electrical or mechanical or electronics, train them and then put them in plants.

Respondent G, echoed that hybrid plant operations require qualified technicians and that the company has thus been forced to find skilled workers. Respondent F also admitted that there were limited opportunities for recruiting workers from local communities in the new socio-technical design. Through these narratives, it became apparent that technological advancements have limited HPS's ability to recruit from local communities and compromised its inclusiveness as a social enterprise. Overall, the narratives and the analysis presented thus far reveal that despite adapting high-cost and low-cost socio-technical system designs, HPS continue to deal with paradoxes in the rural BoP market, which originated mainly from the interdependence between technological and user and market regimes.

The company's frugal approach, a low-cost socio-technical design, successfully served customers in low-income settings and contributed to organisational expansion during the early years. This approach, therefore, appears to offer a sustainable solution to energy access. In addition, the company was able to display inclusiveness by recruiting locals for plant operations. Nonetheless, this frugal design approach resulted in organisational challenges, as employees had limited skills to ensure technological reliability. The frugal design also resulted in managerial complexity, arising mainly from the difficulties of managing decentralised plant operations involving local workforces with limited skills. On the other hand, the technology-dominant design has improved technological reliability and thereby decreases the managerial complexity associated with the rural BoP market. However, this approach also threatens long-term business viability and financial sustainability owing to its high capital costs. Moreover, the technology-dominant design has required the company to seek out commercial customers to complement the domestic energy needs in order to improve business viability. This approach, however, has jeopardised the social objective of rural electrification, especially in areas with exclusively domestic energy needs.

Overall, therefore, social enterprises like HPS need to manage a continuous conflict between customer affordability and business viability. The mismatch between the two rooted mainly in the following aspects: the identification and development of cost-effective technology tailored for rural BoP, the need to ensure technological reliability, and the need to work with resource constraints to identify sustainable business models. These three aspects create socio-technical complexities and threaten organisational sustainability.

5.2. *Organisational alignment for temporal sustainability*

Sustainability is the central aspect of the MLP framework from a transition perspective. Despite their adoption of different socio-technical configurations, low-income settings challenge private enterprises like HPS. Our narrative analysis revealed that organisation alignment was determinantal to the sustainability of HPS, spearheaded by all five regimes corresponding to the socio-technical configuration, the rural BoP market, and the business model. The organisational alignment strategy used by HPS is similar to an approach examined by Dees [120] in the case of a social enterprise: engaging in a process of continuous innovation, adaptation, and learning. With continuous adaptation and learning, HPS has successfully addressed technical challenges resulting from the biomass gasification process. However, the following analysis indicates that the technology transition has affected the company's organisational growth and social objectives.

5.2.1. *The frugal socio-technical system: 2007–2015*

In the early years, the company successfully innovated and adapted local technologies and identified a frugal socio-technical configuration as a solution to cater to rural BoP markets. This kind of configuration capitalises on local skills and resources as an organisational alignment strategy in resource-constrained settings. Respondent B explained this strategy as follows: 'What we do well is combine many pieces [referring to gasification technology and a local skillset] together in a way that works efficiently and lowers overhead and expenses. [121]. Respondent B further articulated the value of the frugal configuration in the quest for business models: 'Once we get the [cost-effective] technology working, we started working on the exact business model, the pricing and everything' [122]. The frugal configuration worked well for HPS in terms of organisational expansion, with the company installing 10 to 15 new plants every year, giving it a portfolio of 84 mini-grid plants by 2013 [70]. This rate of expansion implies the existence of institutional voids within the socio-cultural regime characterised by the rural BoP market supported by the market regime. Adopting a frugal configuration at an early stage allowed the company to succeed in organisational growth, as mini-grids were optimised for low-income contexts to cater to the user regime.

The frugal socio-technical configuration led to technical breakdowns, however, resulting in technical challenges for the company. Respondent E expressed the magnitude of these challenges in the following comment: 'It's [referring to the gasifier unit] like a patient in an intensive care unit. You have to really maintain day in and day out to run it smoothly'. This indicates that the frugal design caused unintended consequences and diminished the company's gains, as the gasifier unit required regular maintenance. Technical breakdowns destabilised the company's technological regime. Respondent C summed up the technical challenges by stating: 'It is pretty hard to make economical electricity at a very small level' [123]. Based on on-site experiences, the company introduced maintenance procedures for frequent faults to overcome technical challenges.

Despite introducing the maintenance procedures, supply disruptions continuously affected the company. Respondent G noted: 'if you skip any [regular] maintenance then this tar can enter into the generator-set', explaining that this was one reason behind the disruptions. He also mentioned that 'some operators do not follow maintenance instructions' as mandated by the company. This account reveals some of the operational challenges associated with the implementation of plant maintenance procedures. The implementation was arduous as the local workforce lacked formal skills and training. Consequently, supply interruptions negatively impacted the user regime, who narrated stories of supply outages. These outages, in turn, decreased sustainability prospects, as the supply interruptions created social tension with end-users. Respondent K described the social tension he witnessed at regular intervals, stating: 'Users come and argue with me about electricity disruptions'. Respondent G, meanwhile, observed that HPS continues to experience operational challenges with ground-level staff. Management had limited oversight, he explained, because plant operations were decentralised and the company lacked the means to monitor operations remotely. These narratives further illustrate the paradoxical nature of the frugal configuration in the realm of the socio-cultural regime.

HPS adopted a partnership strategy to address these technical and operational challenges. As part of the science regime, the partnership strategy allowed access to resources embedded in a network of stakeholders. For example, the company did not have the in-house technical expertise needed to improve the efficiency of the gasifier; nor could it invest financial resources into providing training for the unskilled workforce to fill the institutional voids in this area. Partnerships with different stakeholders improved technological reliability and stabilised the technological regime. Respondent H, a senior engineer, stressed the technical improvements brought about by the involvement of technological partners: 'Earlier they [plant operators] need[ed] to clean [the] filtration system every day. Some days we [used to] do it many times. Now we do it two times a month.' This example underlines the significant improvements made in gasification technology. Three plant operators (Respondents K, L and M) and two other respondents (G and J) expressed similar views during the interviews. These narratives demonstrate that the science regime improved technological reliability along a transition trajectory.

As mentioned above, HPS experienced challenges due to the limited skill sets of local workers. With the help of Shell Foundation and the International Finance Corporation, HPS established a training centre to educate mechanics and operators from local communities [124]. Respondent J framed his narration on the company's training activities as follows: 'We train mechanics and operators at this centre. Our training program lasts up to three months. Here, they get hands-on experience with plant operations and troubleshooting'. Respondent F gave a similar narrative on the training centre and emphasised its importance for providing formal training to local workers. The training streamlined mini-grid operations and reduced technical and organisational challenges from the company's perspective. From an alignment perspective, the training centre was a way to maintain sustainability, as the company was able to ensure employees had the skills required for troubleshooting and regular maintenance. The training centre strengthened the technology regime as a result.

Another essential element of HPS's organisational alignment strategy was identifying business models appropriate for the user and market regime. The company experimented with three business models as part of its expansion strategy: BOOM, BM, and BOM (see Section 3.1). HPS owned and invested 100% and 90% of the capital costs in the case of the BOOM and BOM models, respectively. In the case of BOM, an independent owner-operator is responsible for total costs incurred. The narratives presented thus far illuminated the challenges associated with the BOOM business model in particular. Three BM plants were in operation during the interviews, while HPS discontinued the BOM model as finding suitable local partners had proved difficult. This indifference to the BM and BOM models suggests that HPS has struggled to scale operations. The market indifference can be attributed to the inherent risks, primarily those of an operational and financial nature, of the rural BoP market environment, despite a 50% subsidy on capital costs, which represents a favourable policy regime.

To demonstrate the viability of the BM business model, HPS initiated a risk-sharing strategy with owner-operators. The company offered a flexible financial agreement with owner-operators. When asked about the financial risk, Respondent D said:

> We shared it [the financial risk].… It definitely adds a little bit of more pressure as a company on us.… In fact not sharing I would say major part we are taking on us and a little bit is left on them [owner-operators]. So ultimately the subsidy would come, maybe it would take time.… We take the majority of the risk because we know that we have been in this market for a pretty long time, that [subsidy] part is definitely released but it would take some time as per the [implementation] procedure.

The above narrative underlines the financial risks associated with the market regime from the company's perspective. Conceptually, the BOOM and BM models entail minimal financial risk and should support organisational growth owing to the 50% capital subsidy. Due to delays in this subsidy being made available, however, these business models have been exposed to greater financial risk and have been susceptible to policy implementation. These delays indicate the inefficiency of the policy regime. This financial risk has intensified resource constraints and threatened the technological transition of mini-grids. While responding limited success in identifying owner-operators to invest in BM business model, despite 50% capital subsidy:

> It has taken a long time to actually nurture him [referring to a successful owner-operator].… If you think that you will make overnight profit or it will do something like, that's not possible actually.… So we really look forward to many more such sort of business partners. … It would have been much better if [we find] few more like Shambuji [a successful owner-operator].

This narrative concerning business models indicates that endurance is required to operate in rural BoP markets, and that companies need to persuade stakeholders to invest in mini-grid technology. Moreover, the above description illustrates the limited scope of business models in the existing market and policy regimes. A efficient policy regime would mitigate financial risk and supplement market imperfections for enterprises like HPS, as risk is determinantal to organisational sustainability in low-income settings.

The company's leadership faced a power vacuum as three co-founders left the company in 2010, 2013, and 2014. During the same period, HPS incurred financial losses resulting from aggressive decentralised expansion. Consequently, some of the loss-making plants were closed to improve business viability. This situation ultimately led to organisational alignment. Respondent A described 2014 situation in the *Economic Times as follows*:

> Neither the investors were happy nor the people in the team.… It was very difficult for me to ensure that everyone was able to look up to me as a leader who can take things forward.… Efficiency and professionalism is much easier if it is one person at the helm. Dealing with a co-founder is almost like dealing with a spouse. I did not want to deal with more spouses to fix the problems that we were facing.

While Respondent A was clearly making light of the power struggles faced by the leadership, his comments indicate that leadership was determinantal to ensuring the confidence of investors. In addition, this narrative illustrate the tensions associated with the market regime. Subsequently, as part of its organisational alignment efforts, HPS reduced the workforce and adopted a hybrid system of solar and biomass gasification for electricity generation as a transition strategy. Once the new head taken over, according to Respondent D, the transition process began to function as follows:

> We have shut down loss making plants for operational reasons.… We were basically using biomass technology to supply electricity for a limited period.… We have set up a solar AC grid with our biomass model.… Now the people who actually wish to move up the energy ladder, wish to have a continuity of electricity throughout the day, they now have the provision to do so.

Overall, the frugal approach – a socio-technical configuration powered by a simple biomass gasification system using a local workforce – resulted in limited technical reliability and threatened business viability. Therefore, organisational alignment was necessary to address aforementioned operational and technical challenges. On-site experiences therefore played an essential part in enabling the company to learn and adapt to changes within three niches. The above narratives make it apparent that a learning and adaptation strategy positively affects social enterprises operating in rural BoP markets. This strategy mainly supported the technology regime during the years 2007–2015.

5.2.2. The technology-dominant socio-technical configuration: 2015–present

In October 2015, the first hybrid plant powered by solar energy and biomass gasification began operations. HPS had adopted a technology-dominant socio-technical configuration contrary to its earlier frugal approach. Company representatives cited the decreasing costs of solar power and an increasing need for on-demand electricity as the rationale for this transition. The transition resulted in a significant increase in capital costs due to the addition of supply-side technology, including a battery bank and other auxiliary devices required for solar-biomass integration. Smart-metering solutions installed as part of the distribution infrastructure resulted in additional capital costs. The company recruited a skilled workforce for the new hybrid plants. Subsequently, the hybrid system has improved technical reliability, based on the interview evidence, as the mini-grids have become capable of providing uninterrupted supply. On the other hand, the transition to a resource-intensive socio-technical configuration has created a mismatch with the long-term sustainability of a social enterprise. Moreover, the capital-intensive nature of this kind of configuration limits the ability of social enterprises like HPS to serve low-income customers. Specifically, its capital-intensive nature threatens the affordability for customers in the rural BoP market environment reflecting, thus causing a paradox as the following narratives reveal.

All interviewees emphasised the hybrid plants' reliability due to their technological advancements. However, the transition has had a negative impact on organisational growth. The negative implications became apparent as the number of new installations decreased after 2015. When asked about future expansion plans citing stagnated growth, Respondent E explained:

> Our business model is going to be hybrid in the near future. From now on we are going to put up hybrid [plants], and all profitable plants are being converted into hybrid, balancing the loss-making plants.

This narrative represents HPS's new organisational alignment strategy, reflecting changes to the socio-technical configuration. The company intends to upgrade profitable power plants with new configuration. Echoing this idea, Respondent G highlighted lower capital costs of hybrid plants compared with solar mini-grids of same capacity and explained the advantages of HPS's new technology regime:

> The OpEx [referring to operational expenditure] of solar technology is less. CapEx [referring to capital expenditure] is more. The OpEx is less [for solar], whereas in biomass, the CapEx is less; OpEx is more. The recurring cost in case of biomass is much more. We combined both advantages.

This response provides a positive interpretation of the technology regime. Despite the lower capital cost of hybrid plants compared with solar mini-grids, the capital cost of hybrid plants is exponentially higher than that of biomass plants. The organisational ability to expand business activities therefore diminishes with increases in capital costs. The higher capital costs restrict private-sector participation in rural markets as business viability is tied to external financial support. In sum, the new technology regime has restricted the wider diffusion of mini-grids.

The transition to a technology-dominant socio-technical configuration created a new dilemma for HPS: whose 'energy needs' should have priority, those of domestic or those of commercial customers? Households and commercial customers benefit differently from energy access. HPS has prioritised commercial customers in the case of hybrid plants to increase business viability and load factor. Respondent E explained: 'Commercial customers used to pay directly every month, and small-scale industries also pay every month, but some customers like 20 – 30 % people they cannot pay every month.' As a result, some households did not get electricity connection from HPS when the first hybrid plant was installed. The end-user interviews revealed social tensions in the village. When asked about this social tension, Respondent E stated: 'We are waiting for meters as of now, because we are importing smart meters from the US [referring to the company that supplies smart meters].' Respondent G echoed this, acknowledging the high costs of metering as the main hindrance for domestic users. Overall, these narratives touch on impact-related dilemmas experienced by HPS within the user regime.

Given the rapid expansion of the national grid in India and the unfavourable policy regime in the country, HPS has adopted a new organisational alignment strategy: expansion to Africa in search of new markets. Concerning India, based on previous experiences with the BOM model, the company has stated it will attempt to expand using BOOM rather than the BM model for hybrid plants, as per the narratives. Moreover, the company also considers the policy regime in India hostile in comparison with that in Africa. Respondent A, explained the difference in the policy environments as follows during an interview with Indian business daily [125]:

> They [referring to Tanzania and Uganda] have clearer policies for small energy producers and provide exclusive rights for 8 to 10 years, while we commit to the tariff. There is no such assurance in India, making investors wary.

In other words, a conducive policy environment is necessary for social enterprises operating in rural BoP markets. Due to a favourable policy regime, the company ventured into business operations in Tanzania in 2014–2015 with biomass plants and experienced limited success. When asked about expansion plans for Africa, citing this relative lack of success, Respondent D stated:

> We are scaling up in Africa.… Biomass technology is a work in progress because of various issues.… It can't be scaled in a stand-alone mode. So we are basically putting up a hybrid system where we feel that we should be able to scale up, and it is scalable, and we have proven it.

This narrative indicates HPS's focus on a technology-dominant socio-technical configuration for its organisational expansion in Africa. Echoing this, Respondent A, summarised the company's expansion plans in Africa in a TV interview in 2020 [126]:

> We pioneered this mini-grid sector in my home country India.… The ability to scale is all about people.… It [the business model] is highly replicable.… This population needs to have high quality power and reliable power … so growth potential primarily because of that.

Thus, HPS's focus on Africa, owing to favourable policy regimes in the region, bolsters its social objective to serve energy needs in rural BoP markets. The strategic shift to the African market further demonstrates the way in which the company's approach – a continuous process of adaptation and learning – enables it to identify new opportunities in the quest for new markets. Moreover, the narrative emphasises that HPS's approach is replicable in other market regimes. Overall, the narratives presented in this section further illustrate the paradoxical nature of working in rural BoP markets due to the capital-intensive nature of the socio-technical configuration. The narratives hint at the impact-related dilemmas faced by HPS within the user regime. In addition, the extent of financial risk discourages the market regime from a transition perspective. Given this context, overcoming these challenges requires a favourable policy regime to encourage private-sector participation.

5.3. Partnerships: an essential tool for business viability

Our qualitative data analysis also reveals that for HPS, stakeholders play a crucial role in strengthening technology and science regimes. The company has established strong partnerships with stakeholders working in rural BoP markets. As a strategy, these partnerships have helped HPS reframe limitations with the support of stakeholders for organisational sustainability to create social impact [127,128]. Stated differently, partnerships, as a strategy, are an effective risk mitigation tool for social enterprises. The positive effects of partnerships are evident in the way they have allowed HPS to overcome technical challenges. Respondent E articulated how a partnership strategy has helped the company overcome the problem of insufficient gasification with the design of a new filter:

> For last 3–4 years, we are doing some research [concerning gasification technology] with the help of IIT Chennai and IIT Bombay. These are very reputed institutions in India.… Now we can maintain the system after 15 days with a new filter [referring to a new filter developed with collaboration].

Respondent H expressed a similar idea, and mentioned that he had undergone three months of technical training in an academic institution to design a new filter to improve the gasification process. These partnerships remain important as HPS lacks the in-house technical expertise to address technical challenges. Resources are essential for sustainable transitions in the technology and science regimes. Often, mini-grid enterprises like HPS lack resources while serving rural BoP markets and leaving themselves susceptible to a variety of risks (see [43,44]).

In 2018, the company decided to move its headquarters to Colorado State University's Energy Institute as an enterprise partner. This partnership involves collaboration and cooperation. Respondent A stressed the importance of working together with the academic institution to access resources embedded within the ecosystem: 'To solve this massive problem [referring to innovative solutions to energy challenges], you need a whole ecosystem to reach the goal of impacting as many people as you can' [129]. This narrative suggests that partnerships are critical to overcoming resource constraints associated with off-grid energy access. Respondent A referred to an 'ecosystem' as a means of strengthening the science and technological regimes in the context of the MLP framework. These ecosystems may support organisational sustainability in rural BoP markets, as suggested by Surie [53].

Financial institutions are a vital part of the market regime for sustainable transitions in low-income markets. In principle, the institutions are strategic partners in the case of social enterprises like HPS. For social enterprises, partnership with financial institutions, those working for social impact, has a significant effect on business viability. Although the company was initially successful during 2007–2012 in receiving funding opportunities from different stakeholders [63], HPS found that it had to focus on organisational alignment over the following decade to ensure sustainability. Respondent A stated the following in an interview with *Forbes* [130], when asked about how the social enterprise has secured $20 million in funding in 2018:

> Evidence matters when talking to investors. Focus on your core business model and build results, backed by data. Validation is the biggest proof point and translates stories into evidence.… For Husk, it took multiple iterations, layoffs, and a restructuring of the team to find the winning formula.

This narrative emphasises the importance of adapting to changing circumstances to appeal to the market regime. Moreover, it reiterates that organisational alignment − continuous innovation and adaptation − is essential for attracting financial institutions with similar social objectives. Partnerships to finance operations of social enterprises come in different forms, namely debt, equity and grant, to finance operations [131]. Respondent A explained the need for different types of capital concerning the market regime [132]:

> While Series A financing positions HPS to exponentially scale its modular energy solution, it is paramount to understand that such scaling would be practically impossible without the right mix of capital that consists of equity and debt capital and equally importantly grant capital necessary to address systemic issues like training rural employees and discovering a low-cost smart metering and grid solution.

The emphasises the need for the right mix of capital to ensure the organisational sustainability of a company and allow it to continue to operate in rural BoP markets. The right combination of capital, in other words, ensures the diffusion of mini-grids to overcome operational challenges. Appealing to the market regime thus assist mini-grid organisations in effectively overcoming financial constraints. The narratives presented in this section indicate that positive social impact requires drawing the attentions of stakeholders. In practical terms, partnership facilitates risk mitigation for mini-grid enterprises and supports organisational sustainability. Stakeholders also strengthen the technological, science, and market regimes. Lastly, the private sector requires different financial partner to finance mini-grid operations in rural BoP markets.

6. Discussion

This article has used the longitudinal case study of HPS to probe the research question: how and to what extent a mini-grid-based social enterprise can resolve the technical and organisational challenges associated with providing electricity in a rural BoP environment. We have drawn on on-site experience and firm-level processes to understand entrepreneurial efforts in low-income settings to answer this research question using narrative analysis. Narrative analysis facilitated the chronological arrangement of qualitative data, allowing us to identify meaningful patterns related to mini-grids operations. As the narratives revealed, HPS's endeavours reflect facets of the social entrepreneurship framework, which helps us understand how the company has remained viable in rural BoP markets. In addition, the narrative analysis demonstrated the usefulness of the MLP paradigm for differentiating mini-grid operations using organisational activities across three niches: the socio-technical configuration, the rural BoP market, and the business model. This differentiation allowed us to organise the qualitative data using narrative analysis and identify recurring themes described bellow.

The narrative analysis reveals the following from a social entrepreneurship perspective. First, the narratives emphasised the conflict faced by a social enterprise like HPS between customer affordability and business viability. The degree of conflict depends on the socio-technical configuration of mini-grid operations. The conflict is entrenched within the user and market regime in low-income settings and limits the scope of social enterprises. Second, continuous organisational alignment supports the company's sustainability in the long-run. The company must engage in constant innovation, adaptation, and learning to overcome technical and operational challenges. This alignment strengthens the technological and science regimes. Finally, the company need to forge successful partnerships with stakeholders to overcome resource constraints. These partnerships strengthen the technological and science regimes and mitigate market imperfections in rural BoP markets. Moreover, the assistance of impact-oriented stakeholders is necessary to address the inherent challenges to support social enterprises. For example, HPS partnered with academic institutions to design a new filtering system, thereby improving technological reliability.

From a Multi-Level Perspective (MLP), HPS took advantage of its initial frugal socio-technical configuration to serve BoP markets driven by economies of scale, and experienced significant growth during the early years. This frugality, however, created technical challenges and destabilised the technological regime. The narratives also suggest that the company experienced difficulties managing the social aspects of the frugal system (e.g., the local workforce with a limited skill set, and the company's decentralised operations) in the rural BoP market. Consequently, the company opted for organisational alignment in the form of continuous innovation, adaptation, and learning to address overarching problems associated with the frugal socio-technical configuration. The narrative analysis indicates that organisations like HPS will be able to design, manage and operate mini-grids in resource-scarce contexts to meet the needs of user regime and fill the voids in the market regime. Overall, the frugal mini-grids configuration could be a solution for universal electrification, but social enterprises require refined technical and organisational capabilities to balance business viability and technological reliability.

As a transition strategy, HPS adopted a technology-dominant socio-technical configuration to serve low-income customers in rural areas. This shift was due to the decreased cost of solar power and technological improvements in gasification systems. The transition resulted in a significant increase in capital costs due to supply-side technology and installation of smart meters. Technological dominance has indeed contributed to the technological reliability of mini-grid operations. However, higher costs impacted organisational growth and restricted the company's ability to serve domestic customers. In low-income rural BoP settings, therefore, promoting a technology-dominant socio-technical system requires substantial financial support and interventions to encourage private sector participation compared with the external support required to promote a frugal system. Moreover, the capital-intensive nature of technology-dominant mini-grids may be counterproductive to the temporal sustainability of social enterprises because it overlooks the broader social conditions of rural BoP markets, especially in last-mile territories. Furthermore, by transitioning from a frugal socio-technical design to a technology-dominant system, companies may inadvertently restrict their ability to fulfil social objectives.

The main contribution of this article is in its integration of on-site experiences and firm-level processes with mini-grid literature based on a longitudinal case study. Narrative analysis indicates that mini-grid social enterprises cannot actively resolve challenges in the rural BoP environment. They must forge a variety of partnerships to overcome resource constraints. The narratives present a potentially insoluble relationship between socio-technical configuration, rural BoP market, and business models. For example, identifying business models for low-income customers will be challenging if the capital cost of the socio-technical configuration is high, but the company must ensure commercial feasibility to secure business viability. Similarly, frugal socio-technical designs suffer from technical and operational challenges, while technological sophistication limits the private sector's ability to operate in low-income markets. Finally, customer affordability and business viability are in continuous conflict in rural BoP markets. This conflict creates socio-technical complexities and threatens organisational sustainability.

The main findings of this case study illustrate the importance of utilising interdisciplinary understandings of mini-grid analysis that combine social and technical perspectives with organisational narratives. The combination of social and technical perspectives reveals otherwise invisible nuances of mini-grid operations [13]. This longitudinal case study demonstrates that organisational narratives are helpful for identifying overlapping themes in a contextual setting. This finding corroborates the usefulness of narrative analysis in energy research and social sciences [78]. The narrative analysis reveals the following overarching themes concerning the sustainability of mini-grids in rural BoP markets with regard to the socio-technical configuration: socio-technical design, organisation alignment, business viability, policy landscape, and partnerships for capacity building.

An in-depth analysis of this case study has general implications for the literature on mini-grids and promises to help accelerate private sector participation in rural BoP markets. To augment the findings of previous studies on business models (see [33,34,45,49,51]), we propose a new business model framework (see Table 3) that takes into account the on-site experiences and HPS's firm-level processes. This framework embraces entrepreneurial efforts, as suggested by Park [48]. Furthermore, unlike user-centric business models (e.g., [133]),the framework adopts an organisational perspective. This will help identify socio-technical complexities limiting private-sector participation, as this case study has demonstrated. We acknowledge the limitations of the proposed framework, particularly the fact that its conceptualisation

Table 3
Business model framework for rural BoP markets.

	Business element	Functionality	Characteristics
Socio-technical configuration of mini-grids	Socio-technical design	Technological set-up	Suitable for rural BoP context
		Technological reliability	Reduces power disruptions
		Capital and operational costs	Determines economic viability
		Technical and operational knowledge	Essential for management of mini-grids
		Revenue model	Return on investment
		Customer value proposition	Reliable and affordable supply of electricity
	Partnerships for capacity development	Financial partners	Support is essential for universal electrification
		Technology partners	Support ensures technological reliability
	Organisational alignment	Organisational challenges	Managerial hindrance to mini-grid operations
		Technical challenges	Affects reliability of mini-grids
		Temporal sustainability	Supports diffusion of mini-grids
	Business viability	Willingness to pay	Corresponds to customer affordability
		Return on investment and social impact	Essential for appealing to financial partners
		Productive loads	Improves economic viability
	Policy landscape	Supporting policies	Creates a favourable business environment
		Ecosystem for mini-grids	Facilitates risk mitigation

comes from a single case study. Further empirical studies will be able to validate and improve the framework.

Socio-technical design: The transition trajectory of a mini-grid enterprise depends predominantly on how the socio-technical aspects of the mini-grid are managed and operated in rural markets, aided by different partnerships. The primary design objective is to identify cost-effective technology suitable for low-income contexts to ensure customer affordability and technological reliability. Technical and organisational knowledge supports the managerial and operational aspects of mini-grids.

Partnerships for capacity development: Given resource constraints in rural BoP settings, partnerships are crucial for overcoming financial and technical challenges. Financial support is essential for universal electrification efforts and serves the subsistence needs of mini-grid enterprises, resulting from uncertain returns on investment in rural BoP markets.

Organisational alignment: To overcome technical and organisational challenges, enterprises must engage in continuous innovation, adaptation, and learning. This alignment strategy necessitates access to resources embedded in a network of partners. This strategy aids the temporal sustainability of social enterprises operating in rural BoP markets.

Business viability: This is an essential aspect of the socio-technical configuration concerning mini-grid operations. Social and commercial objectives determine business viability because economic goals alone do not guarantee the diffusion of mini-grids in rural BoP settings. As this case study indicates, a conflict exists between business viability and customer affordability. The policy landscape must address this conflict in low-income settings.

Policy landscape: From an organisational perspective, the policy landscape serves two purposes with regard to private-sector participation. First, a conducive environment encourages private-sector participation in the pursuit of universal electrification. Second, the policy landscape should facilitate the ecosystem of stakeholders in safeguarding against the multifaceted and complex risks associated with operating mini-grids in rural settings. The ecosystem of stakeholders supports risk mitigation through knowledge transfer and economic incentives.

7. Conclusion

In conclusion, private-sector participation is key to achieving universal energy access in rural BoP markets, especially in the case of mini-grids. This article fills a research gap in the energy access literature relating to on-site experiences and firm-level processes [8], to improve understanding of business models [7,33], and to issue a call for more empirical studies on this topic [54,55]. Social enterprises have a potential position in rural BoP markets due to market imperfections and low-income consumers. As this case study reveals, social enterprises need to manage the challenges of mini-grid operations, in the context of a paradoxical relationship between customer affordability and business viability. This contradiction appears to originate from the socio-technical configuration of mini-grids, based on the narratives analysed in this article. Therefore, the organisational sustainability of a social enterprise depends on how the socio-technical aspects of the mini-grid are designed, managed, and operated. Without organisational alignment and stakeholder collaboration, a company's business viability may spiral into a detrimental state due to resource constraints inherent in rural BoP markets.

We have proposed a business model framework based on an in-depth analysis of HPS. This framework represents an amalgamation of social and technical perspectives, as suggested in the literature [13,33]. Moreover, the framework takes into account the on-site experiences and firm-level processes of a social enterprise [8]. The framework consists of five interdependent elements of the socio-technical configuration concerning mini-grid operations in rural BoP markets. The five elements are socio-technical design, organisation alignment, business viability, policy landscape, and partnerships for capacity building. These interdependent elements determine how and to what extent a mini-grid-based social enterprise can resolve the technical and organisational challenges associated with providing electricity in a rural BoP environment.

Despite the limitations of a single case study [16] (p. 183–186), this article is a practical example of how a mini-grid enterprise engages in rural electrification and displays long-term sustainability. Analysing the experiences of HPS provides insights into business viability in an extremely challenging market, where the national grid is expanding fast, and customers' willingness to pay is low. The findings of this study has practical implications for practitioners and policymakers. For policymakers, the narratives presented underline one of the paradoxes of private sector participation: if existing socio-technical solutions can alleviate energy poverty, why is the energy transition slower than expected in rural BoP markets? We would argue that this paradox is deeply rooted in how the socio-technical configuration of mini-grid are designed, operated, and managed. The wider socio-technical ramifications must be considered in order to develop viable business models. In support of practitioners, this research illuminates the trials and tribulations of mini-grid operations in rural BoP markets, which appear to stem from the continuous conflict between customer affordability and business viability. Our analysis suggests that this conflict originates from the interdependence between socio-technical design, technological reliability, and business models in a low-income setting.

Our results indicate a number of directions for further research. The first aspect of these could involve a large-scale analysis of multiple case studies from various countries to further validate and expand upon this study's conclusions. Additionally, a continuous assessment of business viability and socio-technical system design elements through an interdisciplinary lens would provide new understandings of the risk elements and roadblocks affecting mini-grid expansion in rural BoP markets. Lastly, the inclusion of further micro-level narrative analyses of field actors (employees, managers, and business owners) would broaden our perspectives on universal electrification and private sector participation.

Declaration of competing interest

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

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References

[1] ESMAP, Mini Grids for Half a Billion People: Market Outlook and Handbook for Decision Makers, World Bank, Washington DC, 2019. https://openknowledge.worldbank.org/bitstream/handle/10986/31926/Mini-Grids-for-Half-a-Billion-People-Market-Outlook-and-Handbook-for-Decision-Makers-Executive-Summary.pdf?sequence=1&isAllowed=y. (Accessed 3 February 2021).
[2] Inter-agency Task Force on Financing for Development, Financing for Development: Progress and Prospects 2018, United Nations. https://developmentfinance.un.org/iatf2018, 2018. (Accessed 12 July 2021).
[3] C.K. Prahalad, Fortune at the Bottom of the Pyramid: Eradicating Poverty Through Profits, First Printing edition, Dorling Kindersley Pvt Ltd, Dehli, 2006.
[4] S. Goyal, B.S. Sergi, M.P. Jaiswal, Understanding the challenges and strategic actions of social entrepreneurship at base of the pyramid, Manag. Decis. 54 (2016) 418–440, https://doi.org/10.1108/MD-11-2014-0662.
[5] J. Mair, I. Martí, Social entrepreneurship research: a source of explanation, prediction, and delight, J. World Bus. 41 (2006) 36–44, https://doi.org/10.1016/j.jwb.2005.09.002.
[6] V. Bandi, T. Sahrakorpi, J. Paatero, R. Lahdelma, Touching the invisible: exploring the nexus of energy access, entrepreneurship, and solar homes systems in India, Energy Res. Soc. Sci. 69 (2020), 101767, https://doi.org/10.1016/j.erss.2020.101767.
[7] M.B. Pedersen, W. Wehrmeyer, I. Nygaard, Commercial yet social: the practices and logics of bringing mini-grid electricity to rural villages in Kenya, Energy Res. Soc. Sci. 68 (2020), 101588, https://doi.org/10.1016/j.erss.2020.101588.
[8] M. Moner-Girona, M. Solano-Peralta, M. Lazopoulou, E.K. Ackom, X. Vallve, S. Szabó, Electrification of sub-Saharan Africa through PV/hybrid mini-grids: reducing the gap between current business models and on-site experience, Renew. Sust. Energ. Rev. 91 (2018) 1148–1161, https://doi.org/10.1016/j.rser.2018.04.018.
[9] J. Austin, H. Stevenson, J. Wei-Skillern, Social and commercial entrepreneurship: same, different, or both? Entrep. Theory Pract. 30 (2006) 1–22, https://doi.org/10.1111/j.1540-6520.2006.00107.x.
[10] F.W. Geels, Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study, Res. Policy 31 (2002) 1257–1274, https://doi.org/10.1016/S0048-7333(02)00062-8.
[11] A. Mills, G. Durepos, E. Wiebe, Encyclopedia of Case Study Research, SAGE Publications, Inc., 2455 Teller Road, Thousand Oaks California 91320 United States, 2010, https://doi.org/10.4135/9781412957397.
[12] F.W. Geels, Disruption and low-carbon system transformation: Progress and new challenges in socio-technical transitions research and the multi-level perspective, Energy Res. Soc. Sci. 37 (2018) 224–231, https://doi.org/10.1016/j.erss.2017.10.010.
[13] B.K. Sovacool, D.J. Hess, S. Amir, F.W. Geels, R. Hirsh, L. Rodriguez Medina, C. Miller, C. Alvial Palavicino, R. Phadke, M. Ryghaug, J. Schot, A. Silvast, J. Stephens, A. Stirling, B. Turnheim, E. van der Vleuten, H. van Lente, S. Yearley, Sociotechnical agendas: reviewing future directions for energy and climate research, Energy Res. Soc. Sci. 70 (2020), 101617, https://doi.org/10.1016/j.erss.2020.101617.
[14] D.M. Boje, Narrative methods for organizational and communication research, Sage, 2001.
[15] M. Moezzi, K.B. Janda, S. Rotmann, Using stories, narratives, and storytelling in energy and climate change research, Energy Res. Soc. Sci. 31 (2017) 1–10, https://doi.org/10.1016/j.erss.2017.06.034.

[16] R. Piekkari, C. Welch, Rethinking the Case Study in International Business and Management Research, Reprint edition, Edward Elgar Pub, Cheltenham, 2012.
[17] H. Snyder, Literature review as a research methodology: an overview and guidelines, J. Bus. Res. 104 (2019) 333–339, https://doi.org/10.1016/j.jbusres.2019.07.039.
[18] P. Alstone, D. Gershenson, D.M. Kammen, Decentralized energy systems for clean electricity access, Nat. Clim. Chang. 5 (2015) 305–314, https://doi.org/10.1038/nclimate2512.
[19] S. Mandelli, J. Barbieri, R. Mereu, E. Colombo, Off-grid systems for rural electrification in developing countries: definitions, classification and a comprehensive literature review, Renew. Sust. Energ. Rev. 58 (2016) 1621–1646, https://doi.org/10.1016/j.rser.2015.12.338.
[20] P. Arranz-Piera, F. Kemausuor, L. Darkwah, I. Edjekumhene, J. Cortés, E. Velo, Mini-grid electricity service based on local agricultural residues: feasibility study in rural Ghana, Energy 153 (2018) 443–454, https://doi.org/10.1016/j.energy.2018.04.058.
[21] C.L. Azimoh, P. Klintenberg, F. Wallin, B. Karlsson, Illuminated but not electrified: an assessment of the impact of solar home system on rural households in South Africa, Appl. Energy 155 (2015) 354–364, https://doi.org/10.1016/j.apenergy.2015.05.120.
[22] S.C. Bhattacharyya, Mini-grid based electrification in Bangladesh: technical configuration and business analysis, Renew. Energy 75 (2015) 745–761, https://doi.org/10.1016/j.renene.2014.10.034.
[23] A.K. Bhandari, C. Jana, A comparative evaluation of household preferences for solar photovoltaic standalone and mini-grid system: an empirical study in a costal village of Indian Sundarban, Renew. Energy 35 (2010) 2835–2838, https://doi.org/10.1016/j.renene.2010.05.006.
[24] C.L. Chambon, T. Karia, P. Sandwell, J.P. Hallett, Techno-economic assessment of biomass gasification-based mini-grids for productive energy applications: the case of rural India, Renew. Energy 154 (2020) 432–444, https://doi.org/10.1016/j.renene.2020.03.002.
[25] A. Micangeli, R. Del Citto, I.N. Kiva, S.G. Santori, V. Gambino, J. Kiplagat, D. Viganò, D. Fioriti, D. Poli, Energy production analysis and optimization of mini-grid in remote areas: the case study of Habaswein, Kenya, Energies 10 (2017) 2041, https://doi.org/10.3390/en10122041.
[26] S. Graber, T. Narayanan, J. Alfaro, D. Palit, Solar microgrids in rural India: Consumers' willingness to pay for attributes of electricity, Energy Sustain. Dev. 42 (2018) 32–43, https://doi.org/10.1016/j.esd.2017.10.002.
[27] M. Alam, S. Bhattacharyya, Are the off-grid customers ready to pay for electricity from the decentralized renewable hybrid mini-grids? A study of willingness to pay in rural Bangladesh, Energy 139 (2017) 433–446, https://doi.org/10.1016/j.energy.2017.07.125.
[28] S.D. Comello, S.J. Reichelstein, A. Sahoo, T.S. Schmidt, Enabling mini-grid development in rural India, World Dev. 93 (2017) 94–107, https://doi.org/10.1016/j.worlddev.2016.12.029.
[29] J. Peters, M. Sievert, M.A. Toman, Rural electrification through mini-grids: challenges ahead, Energy Policy 132 (2019) 27–31, https://doi.org/10.1016/j.enpol.2019.05.016.
[30] D. Palit, K.R. Bandyopadhyay, Regulating off-grid electricity delivery: exploring the grey areas, Econ. Polit. Wkly. 50 (2015) 46–52.
[31] A. Korkovelos, H. Zerriffi, M. Howells, M. Bazilian, H.-H. Rogner, F. Fuso Nerini, A retrospective analysis of energy access with a focus on the role of mini-grids, Sustainability 12 (2020) 1793, https://doi.org/10.3390/su12051793.
[32] M. Ogeya, C. Muhoza, O.W. Johnson, Integrating user experiences into mini-grid business model design in rural Tanzania, Energy Sustain. Dev. 62 (2021) 101–112, https://doi.org/10.1016/j.esd.2021.03.011.
[33] J. Knuckles, Business models for mini-grid electricity in base of the pyramid markets, Energy Sustain. Dev. 31 (2016) 67–82, https://doi.org/10.1016/j.esd.2015.12.002.
[34] P.R. Krithika, D. Palit, Participatory business models for off-grid electrification, in: S. Bhattacharyya (Ed.), Rural Electrification Decentralised -Grid Syst. Dev. Ctries, Springer London, 2013, pp. 187–225, https://doi.org/10.1007/978-1-4471-4673-5_8.
[35] Sustainable Energy for All, BloombergNEF, State of the Global Mini-grids Market Report 2020, Mini-Grids Partnership (MGP). https://www.seforall.org/system/files/2020-06/MGP-2020-SEforALL.pdf, 2020 (accessed December 22, 2021).
[36] C.M. DaSilva, P. Trkman, Business model: what it is and what it is not, Long Range Plan. 47 (2014) 379–389, https://doi.org/10.1016/j.lrp.2013.08.004.
[37] C. Baden-Fuller, S. Haefliger, Business models and technological innovation, Long Range Plan. 46 (2013) 419–426, https://doi.org/10.1016/j.lrp.2013.08.023.
[38] D. Palit, B.K. Sovacool, C. Cooper, D. Zoppo, J. Eidsness, M. Crafton, K. Johnson, S. Clarke, The trials and tribulations of the village energy security programme (VESP) in India, Energy Policy 57 (2013) 407–417, https://doi.org/10.1016/j.enpol.2013.02.006.
[39] V. Kagimu, T.S. Ustun, Novel business models and policy directions based on SE4ALL global framework for minigrids, in: 2016 IEEE Int. Conf. Emerg. Technol. Innov. Bus. Pract. Transform. Soc. EmergiTech, 2016: pp. 251–256. doi:https://doi.org/10.1109/EmergiTech.2016.7737348.
[40] A. Chaurey, P.R. Krithika, D. Palit, S. Rakesh, B.K. Sovacool, New partnerships and business models for facilitating energy access, Energy Policy 47 (Supplement 1) (2012) 48–55, https://doi.org/10.1016/j.enpol.2012.03.031.
[41] B. Tenenbaum, C. Greacen, T. Siyambalapitiya, J. Knuckles, From the bottom up: how small power producers and mini-grids can deliver electrification and renewable energy in Africa, The World Bank (2014), https://doi.org/10.1596/978-1-4648-0093-1.
[42] M. Fowlie, Y. Khaitan, C. Wolfram, D. Wolfson, Solar microgrids and remote energy access: how weak incentives can undermine smart technology, Econ. Energy Environ. Policy 8 (2019), https://doi.org/10.5547/2160-5890.8.1.mfow.
[43] S.C. Bhattacharyya, Mini-grids for the base of the pyramid market: a critical review, Energies 11 (2018) 813, https://doi.org/10.3390/en11040813.
[44] A. Malhotra, T.S. Schmidt, L. Haelg, O. Waissbein, Scaling up finance for off-grid renewable energy: the role of aggregation and spatial diversification in derisking investments in mini-grids for rural electrification in India, Energy Policy 108 (2017) 657–672, https://doi.org/10.1016/j.enpol.2017.06.037.
[45] V.L. Ausrød, V. Sinha, Ø. Widding, Business model design at the base of the pyramid, J. Clean. Prod. 162 (2017) 982–996, https://doi.org/10.1016/j.jclepro.2017.06.014.
[46] T.S. Schmidt, N.U. Blum, R. Sryantoro Wakeling, Attracting private investments into rural electrification — a case study on renewable energy based village grids in Indonesia, Energy Sustain. Dev. 17 (2013) 581–595, https://doi.org/10.1016/j.esd.2013.10.001.
[47] M.B. Pedersen, I. Nygaard, System building in the Kenyan electrification regime: the case of private solar mini-grid development, Energy Res. Soc. Sci. 42 (2018) 211–223, https://doi.org/10.1016/j.erss.2018.03.010.
[48] J. Park, Clean energy entrepreneurship in sub-Saharan Africa ☆, in: Glob. Entrep. Past Present Future, Emerald Group Publishing Limited, 2016, pp. 257–277, https://doi.org/10.1108/S1571-502720160000029015.
[49] S. Goyal, M. Esposito, A. Kapoor, M.P. Jaiswal, B.S. Sergi, Linking up: inclusive business models for access to energy solutions at base of the pyramid in India, Int. J. Bus. Glob. 12 (2014) 413–438, https://doi.org/10.1504/IJBG.2014.062843.
[50] S. Ghosh, J. Rajan, The business case for SDGs: an analysis of inclusive business models in emerging economies, Int. J. Sustain. Dev. World Ecol. 26 (2019) 344–353, https://doi.org/10.1080/13504509.2019.1591539.
[51] M. Yunus, B. Moingeon, L. Lehmann-Ortega, Building social business models: lessons from the Grameen experience, Long Range Plan. 43 (2010) 308–325, https://doi.org/10.1016/j.lrp.2009.12.005.
[52] F. Perrini, C. Vurro, Social entrepreneurship: innovation and social change across theory and practice, in: J. Mair, J. Robinson, K. Hockerts (Eds.), Soc. Entrep, Palgrave Macmillan UK, London, 2006, pp. 57–85, https://doi.org/10.1057/9780230625655_5.
[53] G. Surie, Creating the innovation ecosystem for renewable energy via social entrepreneurship: insights from India, Technol. Forecast. Soc. Change. 121 (2017) 184–195, https://doi.org/10.1016/j.techfore.2017.03.006.
[54] P. Kumar, N. Tiwary, Role of social enterprises in addressing energy poverty: making the case for refined understanding through theory of co-production of knowledge and theory of social capital, Sustainability 12 (2020) 8533, https://doi.org/10.3390/su12208533.
[55] M.T. Hackett, Solving 'social market failures' with social enterprises? Grameen Shakti (village energy) in Bangladesh, J. Soc. Entrep. 7 (2016) 312–341, https://doi.org/10.1080/19420676.2016.1188324.
[56] A. Mishra, V. Mishra, Is there conditional convergence in the per capita incomes of BIMAROU states in India? Econ. Model. 70 (2018) 429–437, https://doi.org/10.1016/j.econmod.2017.08.017.
[57] P. Pal, J. Ghosh, Inequality in India: a survey of recent trends, United Nations (2007), https://doi.org/10.18356/0af507bb-en.
[58] G. Rasul, E. Sharma, Understanding the poor economic performance of Bihar and Uttar Pradesh, India: a macro-perspective, Reg. Stud. Reg. Sci. 1 (2014) 221–239, https://doi.org/10.1080/21681376.2014.943804.
[59] Government of India, Census of India 2011: Houses Household Amenities and Assets: Source of Lighting, Ministry of Home Affairs, Government of India, New Dehli, 2011. http://censusindia.gov.in/2011census/hlo/Data_sheet/India/Source_Lighting.pdf (accessed December 20, 2019).
[60] M. Puri, E. Tavoletti, C. Cerruti, Business model innovation in emerging economies: leveraging institutional voids, in: R. Lèbre La Rovere, L. de Magalhães Ozório, L. de Jesus Melo (Eds.), Entrep. BRICS Policy Res. Support Entrep, Springer International Publishing, Cham, 2015, pp. 143–161, https://doi.org/10.1007/978-3-319-11412-5_9.
[61] P. Soni, R.T. Krishnan, Frugal innovation: aligning theory, practice, and public policy, J. Indian Bus. Res. 6 (2014) 29–47, https://doi.org/10.1108/JIBR-03-2013-0025.
[62] J. Levänen, M. Hossain, T. Lyytinen, A. Hyvärinen, S. Numminen, M. Halme, Implications of frugal innovations on sustainable development: evaluating water and energy innovations, Sustainability 8 (2015) 4, https://doi.org/10.3390/su8010004.
[63] R. Gupta, A. Pandit, A. Nirjar, P. Gupta, Husk power systems: bringing light to rural India and tapping fortune at the bottom of the pyramid, Asian J. Manag. Cases. 10 (2013) 129–143, https://doi.org/10.1177/0972820113493690.
[64] A. Raval, Big Oil Venture Funds Target Green Investments, Financ. Times. https://www.ft.com/content/80152644-c8ba-11e9-af46-b09e8bfe60c0, 2019 (accessed February 5, 2021).
[65] M. Sinha, Seeking an end to energy starvation: innovations case narrative: husk power systems, Innov. Technol. Gov. Glob. 6 (2011) 71–83, https://doi.org/10.1162/INOV_a_00083.
[66] Asian Development Bank, How Inclusive is Inclusive Business for Women?: Examples from Asia and Latin America, Asian Development Bank, 2016.
[67] T. Sahrakorpi, V. Bandi, Empowerment or employment? Uncovering the paradoxes of social entrepreneurship for women via husk power systems in rural North India, Energy Res. Soc. Sci. 79 (2021), 102153, https://doi.org/10.1016/j.erss.2021.102153.
[68] K.C. Rao, H. Natarajan, K. Doshi, Power from rice husk for rural electrification (Bihar, India), in: K.C. Rao, S. Gebrezgabher (Eds.), Energy Recovery Org. Waste -

Sect. II, International Water Management Institute, 2018. https://ageconsearch.umn.edu/record/284238 (accessed December 24, 2021).
[69] D. Palit, G.K. Sarangi, Renewable Energy-Based Rural Electrification: The Mini-Grid Experience from India, 2014.
[70] S.C. Bhattacharyya, Viability of off-grid electricity supply using rice husk: a case study from South Asia, Biomass Bioenergy 68 (2014) 44–54, https://doi.org/10.1016/j.biombioe.2014.06.002.
[71] S. Bhattacharya, D. Palit, G.K. Sarangi, Towards Scaling Up of Electricity Access: Summary and Policy Recommmendations from OASYS South Asia Project, The Energy and Resources Institute. https://www.teriin.org/files/oaysis/mobile/index.html#p=10, 2015. (Accessed 24 December 2021).
[72] K. Pokar, S. Chaurasia, R. Maheshwari, Innovation at Bottom of Pyramid - Husk Power System: Electrifying Rural India (A Case Study), Social Science Research Network, Rochester, NY, 2012, https://doi.org/10.2139/ssrn.2029639.
[73] O. Kayser, V. Budinich, Lighting, in: Scaling Bus. Solut. Soc. Probl, Palgrave Macmillan UK, London, 2015, pp. 43–54, https://doi.org/10.1057/9781137466549_6.
[74] T. Lyytinen, Sustainable business models of small-scale renewable energy systems: two resource-scarce approaches for design and manufacturing, in: G. Campana, R.J. Howlett, R. Setchi, B. Cimatti (Eds.), Sustain. Des. Manuf. 2017, Springer International Publishing, Cham, 2017, pp. 493–504, https://doi.org/10.1007/978-3-319-57078-5_47.
[75] J.C. Picken, From startup to scalable enterprise: laying the foundation, Bus. Horiz. 60 (2017) 587–595, https://doi.org/10.1016/j.bushor.2017.05.002.
[76] S.C. Bhattacharyya, D. Palit, G.K. Sarangi, V. Srivastava, P. Sharma, Solar PV mini-grids versus large-scale embedded PV generation: a case study of Uttar Pradesh (India), Energy Policy 128 (2019) 36–44, https://doi.org/10.1016/j.enpol.2018.12.040.
[77] Government of India, Census of India 2011: Particiapation in Economy, Ministry of Home Affairs, Government of India, New Dehli, 2011. http://www.mospi.gov.in/sites/default/files/reports_and_publication/statistical_publication/social_statistics/Chapter_4.pdf (accessed December 20, 2019).
[78] B.K. Sovacool, J. Axsen, S. Sorrell, Promoting novelty, rigor, and style in energy social science: towards codes of practice for appropriate methods and research design, Energy Res. Soc. Sci. 45 (2018) 12–42, https://doi.org/10.1016/j.erss.2018.07.007.
[79] J.H. Miller, S.E. Page, Complex Adaptive Systems: An Introduction to Computational Models of Social Life, Princeton university press, 2009.
[80] P.A. Dacin, M.T. Dacin, M. Matear, Social entrepreneurship: why we don't need a new theory and how we move forward from here, Acad. Manag. Perspect. 24 (2010) 37–57, https://doi.org/10.5465/amp.24.3.37.
[81] C. Seelos, J. Mair, Social entrepreneurship: creating new business models to serve the poor, Bus. Horiz. 48 (2005) 241–246, https://doi.org/10.1016/j.bushor.2004.11.006.
[82] P. Muñoz, J. Kimmitt, Social mission as competitive advantage: a configurational analysis of the strategic conditions of social entrepreneurship, J. Bus. Res. 101 (2019) 854–861, https://doi.org/10.1016/j.jbusres.2018.11.044.
[83] C.M. Fiol, M.A. Lyles, Organizational learning, Acad. Manag. Rev. 10 (1985) 803–813, https://doi.org/10.5465/amr.1985.4279103.
[84] M.E. Porter, What is strategy? Harv. Bus. Rev. 74 (1996) 61–78.
[85] R.E. Freeman, Strategic Management: A Stakeholder Approach, Cambridge University Press, 2010.
[86] G.T. Lumpkin, T.W. Moss, D.M. Gras, S. Kato, A.S. Amezcua, Entrepreneurial processes in social contexts: how are they different, if at all? Small Bus. Econ. 40 (2013) 761–783, https://doi.org/10.1007/s11187-011-9399-3.
[87] C.R. Meyer, J. Gauthier, Navigating challenging fitness landscapes: social entrepreneurship and the competing dimensions of sustainability, J. Soc. Entrep. 4 (2013) 23–39, https://doi.org/10.1080/19420676.2012.725086.
[88] P. Brown, Narrative: an ontology, epistemology and methodology for pro-environmental psychology research, Energy Res. Soc. Sci. 31 (2017) 215–222, https://doi.org/10.1016/j.erss.2017.06.006.
[89] D. Geiger, E. Antonacopoulou, Narratives and organizational dynamics: exploring blind spots and organizational inertia, J. Appl. Behav. Sci. (2009), https://doi.org/10.1177/0021886309336402.
[90] J. Fereday, E. Muir-Cochrane, Demonstrating rigor using thematic analysis: a hybrid approach of inductive and deductive coding and theme development, Int J Qual Methods 5 (2006) 80–92, https://doi.org/10.1177/160940690600500107.
[91] C.K. Riessman, Narrative Methods for the Human Sciences, SAGE, 2008.
[92] B. Czarniawska, A Narrative Approach to Organization Studies, SAGE Publications, Inc., 2455 Teller Road, Thousand Oaks California 91320 United States of America, 1998, https://doi.org/10.4135/9781412983235.
[93] E. Vaara, S. Sonenshein, D. Boje, Narratives as sources of stability and change in organizations: approaches and directions for future research, Acad. Manag. Ann. 10 (2016) 495–560, https://doi.org/10.5465/19416520.2016.1120963.
[94] J. Martin, M.S. Feldman, M.J. Hatch, S.B. Sitkin, The uniqueness paradox in organizational stories, Adm. Sci. Q. 438–453 (1983).
[95] L. Hermwille, The role of narratives in socio-technical transitions—Fukushima and the energy regimes of Japan, Germany, and the United Kingdom, Energy Res. Soc. Sci. 11 (2016) 237–246, https://doi.org/10.1016/j.erss.2015.11.001.
[96] A. Dzebo, B. Nykvist, A new regime and then what? Cracks and tensions in the socio-technical regime of the Swedish heat energy system, Energy Res. Soc. Sci. 29 (2017) 113–122, https://doi.org/10.1016/j.erss.2017.05.018.
[97] L. Kanger, Rethinking the multi-level perspective for energy transitions: from regime life-cycle to explanatory typology of transition pathways, Energy Res. Soc. Sci. 71 (2021), 101829, https://doi.org/10.1016/j.erss.2020.101829.
[98] F.W. Geels, The multi-level perspective on sustainability transitions: responses to seven criticisms, Environ. Innov. Soc. Transit. 1 (2011) 24–40, https://doi.org/10.1016/j.eist.2011.02.002.
[99] A. Smith, J.-P. Voß, J. Grin, Innovation studies and sustainability transitions: the allure of the multi-level perspective and its challenges, Res. Policy 39 (2010) 435–448, https://doi.org/10.1016/j.respol.2010.01.023.
[100] J. Köhler, F.W. Geels, F. Kern, J. Markard, E. Onsongo, A. Wieczorek, F. Alkemade, F. Avelino, A. Bergek, F. Boons, L. Fünfschilling, D. Hess, G. Holtz, S. Hyysalo, K. Jenkins, P. Kivimaa, M. Martiskainen, A. McMeekin, M. S. Mühlemeier, B. Nykvist, B. Pel, R. Raven, H. Rohracher, B. Sandén, J. Schot, B. Sovacool, B. Turnheim, D. Welch, P. Wells, An agenda for sustainability transitions research: state of the art and future directions, Environ. Innov. Soc. Transit. 31 (2019) 1–32, https://doi.org/10.1016/j.eist.2019.01.004.
[101] M.E. Wainstein, A.G. Bumpus, Business models as drivers of the low carbon power system transition: a multi-level perspective, J. Clean. Prod. 126 (2016) 572–585, https://doi.org/10.1016/j.jclepro.2016.02.095.
[102] D. Rosenbloom, H. Berton, J. Meadowcroft, Framing the sun: a discursive approach to understanding multi-dimensional interactions within socio-technical transitions through the case of solar electricity in Ontario, Canada, Res. Policy 45 (2016) 1275–1290, https://doi.org/10.1016/j.respol.2016.03.012.
[103] S. Breschi, F. Malerba, L. Orsenigo, Technological regimes and Schumpeterian patterns of innovation, Econ. J. 110 (2000) 388–410, https://doi.org/10.1111/1468-0297.00530.
[104] M. Gibbons, C. Limoges, H. Nowotny, S. Schwartzman, P. Scott, M. Trow, The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies, SAGE Publications Ltd, 1 Oliver's Yard, 55 City Road, London EC1Y 1SP United Kingdom, 2010, https://doi.org/10.4135/9781446221853.
[105] P.J. May, A.E. Jochim, Policy regime perspectives: policies, politics, and governing: policy regime perspectives, Policy Stud. J. 41 (2013) 426–452, https://doi.org/10.1111/psj.12024.
[106] A. Rip, R. Kemp, Technological change, Hum. Choice Clim. Change. 2 (1998) 327–399.
[107] R. Debnath, S. Darby, R. Bardhan, K. Mohaddes, M. Sunikka-Blank, Grounded reality meets machine learning: a deep-narrative analysis framework for energy policy research, Energy Res. Soc. Sci. 69 (2020), 101704, https://doi.org/10.1016/j.erss.2020.101704.
[108] Qualitative Secondary Data Analysis: Ethics, Epistemology and Context - Sarah Irwin, 2013, (n.d.). https://journals.sagepub.com/doi/full/10.1177/1464993413490479 (accessed January 20, 2022).
[109] Narrative analysis, in: SAGE Encycl. Commun. Res. Methods, SAGE Publications, Inc, 2455 Teller Road, Thousand Oaks California 91320, 2017, https://doi.org/10.4135/9781483381411.n368.
[110] A. Öhman, E. Karakaya, F. Urban, Enabling the transition to a fossil-free steel sector: the conditions for technology transfer for hydrogen-based steelmaking in Europe, Energy Res. Soc. Sci. 84 (2022), 102384, https://doi.org/10.1016/j.erss.2021.102384.
[111] C. Walker, P. Devine-Wright, M. Rohse, L. Gooding, H. Devine-Wright, R. Gupta, What is 'local' about smart local energy systems? Emerging stakeholder geographies of decentralised energy in the United Kingdom, Energy Res. Soc. Sci. 80 (2021), 102182, https://doi.org/10.1016/j.erss.2021.102182.
[112] N. Ruggiano, T.E. Perry, Conducting secondary analysis of qualitative data: should we, can we, and how? Qual. Soc. Work QSW Res. Pract. 18 (2019) 81–97, https://doi.org/10.1177/1473325017700701.
[113] GSBI, 2009 - Manoj Sinha (Husk Power Systems). https://www.youtube.com/watch?v=h54OavIGSuo, 2009 (accessed April 1, 2021).
[114] P.K. Chaudhary, Husk Lights Up Champaran | Patna News - Times of India, Times India. https://timesofindia.indiatimes.com/city/patna/Husk-lights-up-Champaran/articleshow/6806574.cms, 2010. (Accessed 9 April 2021).
[115] J. Nerenberg, Husk Power Systems Wants to Lead "a Revolution in Electricity,", Fast Co., 2011. https://www.fastcompany.com/1714395/husk-power-systems-wants-lead-revolution-electricity. (Accessed 25 September 2020).
[116] D. Bornstein, A Light in India, Opinionator. https://opinionator.blogs.nytimes.com/2011/01/10/a-light-in-india/, 2011. (Accessed 1 April 2021).
[117] A. Steiner, S. Teasdale, Unlocking the potential of rural social enterprise, J. Rural. Stud. 70 (2019) 144–154, https://doi.org/10.1016/j.jrurstud.2017.12.021.
[118] B. Sims, Giving Back | Biomassmagazine.com, Biomass Mag. http://biomassmagazine.com/articles/2065/giving-back, 2015. (Accessed 1 April 2021).
[119] B. Shah, How these innovators lit up over 500 villages with just pine needles and rice husk, YourStory.Com. https://yourstory.com/2015/11/innovators-lit-500-villages-just-pine-needles-rice-husk, 2015. (Accessed 25 September 2020).
[120] J.G. Dees, The Meaning of Social Entrepreneurship. http://faculty.fuqua.duke.edu/centers/case/files/dees-SE.pdf, 1998.
[121] T. Elsen, Environmental Entrepreneurs: India's Husk Power Systems Converts Rice Husks into Energy, World Resour. Inst., 2011. https://www.wri.org/blog/2011/03/environmental-entrepreneurs-indias-husk-power-systems-converts-rice-husks-energy (accessed September 25, 2020).
[122] Ashden, Husk Power Systems, Electricity From Crop Waste - Ashden Award winner. https://www.youtube.com/watch?v=d0XcoeqVoaI, 2011. (Accessed 23 August 2020).
[123] N.G. Raj, Green' Electricity for Bihar Villages, the Hindu. https://www.thehindu.com/opinion/op-ed/lsquoGreenrsquo-electricity-for-Bihar-villages/article16893843.ece, 2009. (Accessed 1 April 2021).
[124] S. Joshi, E. Röhrig, Moving Innovation Forward Case Studies: 10 Sustainable and Inclusive Business Models, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, New Dehli, 2014. https://www.giz.de/en/dow

nloads/giz2014-en-moving-innovation-forward-india.pdf (accessed May 13, 2021).
[125] P. Mehra, Plugging into Farm Waste for Power, Hindu Bus. Line, 2015. https://www.thehindubusinessline.com/news/solutions-and-co/plugging-into-farm-waste-for-power/article7888239.ece (accessed September 25, 2020).
[126] CGTN Africa, Mini Grids: Solving Power Issues in Africa, n.d. https://www.youtube.com/watch?v=2B2miOUxFH8 (accessed May 23, 2021).
[127] J. Hall, S. Matos, L. Sheehan, B. Silvestre, Entrepreneurship and innovation at the base of the pyramid: a recipe for inclusive growth or social exclusion? J. Manag. Stud. 49 (2012) 785–812, https://doi.org/10.1111/j.1467-6486.2012.01044.x.
[128] G. George, A.M. McGahan, J. Prabhu, Innovation for inclusive growth: towards a theoretical framework and a research agenda, J. Manag. Stud. 49 (2012) 661–683, https://doi.org/10.1111/j.1467-6486.2012.01048.x.
[129] R. Goodier, Inevitable Change: How Husk Power Embraced Adaptability, Demand. https://demandasme.org/husk-power/, 2018. (Accessed 26 September 2020).
[130] E. Chhabra, How this Social Enterprise Just Closed $20 Million in Funding, Forbes. (n.d.). https://www.forbes.com/sites/eshachhabra/2018/01/29/how-this-social-enterprise-just-closed-20-million-in-funding/ (accessed September 4, 2020).
[131] D.R. Young, M.C. Grinsfelder, Social entrepreneurship and the financing of third sector organizations, J. Public Aff. Educ. 17 (2011) 543–567, https://doi.org/10.1080/15236803.2011.12001661.
[132] B. Gupta, Husk Power Systems Raises $5M in Series a Funding Led by Acumen Fund and Bamboo Finance, VCCircle. https://www.vccircle.com/renewable-energy-firm-husk-power-systems-raises-5m-funding, 2012. (Accessed 25 September 2020).
[133] S.J.D. Schillebeeckx, P. Parikh, R. Bansal, G. George, An integrated framework for rural electrification: adopting a user-centric approach to business model development, Energy Policy 48 (2012) 687–697, https://doi.org/10.1016/j.enpol.2012.05.078.