

BUSINESS MODEL INNOVATIONS ENSURING RESILIENCE: CASE STUDIES

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EFFICIENCY FOR ACCESS COALITION



This report is part of a series of publications derived from the Business Model Innovations for Productive Use and Cooking Appliance Access research project. The report focuses on business model innovations that can help overcome challenges in providing rural, off-grid communities with productive use and electric cooking appliances. It was commissioned by the Low Energy Inclusive Appliances (LEIA) programme.

Efficiency for Access is a global coalition working to promote high-performing appliances that enable access to clean energy for the world's poorest people. It is a catalyst for change, accelerating the growth of off-grid appliance markets to boost incomes, reduce carbon emissions, improve quality of life and support sustainable development. The Low Energy Inclusive Appliances programme is Efficiency for Access' flagship initiative.

Efficiency for Access consists of 15 Donor Roundtable Members, 10 Programme Partners, and more than 30 Investor Network members. Current Efficiency for Access Coalition members have programmes and initiatives spanning 44 countries and 22 key technologies. The Efficiency for Access Coalition is coordinated jointly by CLASP, an international appliance energy efficiency and market development specialist not-for-profit organisation, and UK's Energy Saving Trust, which specialises in energy efficiency product verification, data and insight, advice and research.

About this report

This report includes five case studies examining companies offering off-grid appliances in off- and weak-grid areas, which pursue innovative practices that make their businesses more resilient to external shocks.

Other publications and tools derived from this research project include an **analytical report** summarising the research findings, a **database containing about 110 companies** engaged in innovative business models, a **report** documenting case studies on the theme of environmental sustainability and circularity, a **report** documenting case studies on the theme of resilience, and **three podcasts** featuring experts' views on the various innovation-related themes that have guided the research.

The research project overall explores **business model innovations (BMIs) relating to a variety of different themes**, thus featuring up to five case studies for each of the following thematic areas: 1) environmental sustainability and circularity, 2) affordability, and (3) resilience to regional and global shocks.

This research project was conceived by Richa Goyal. This specific report was authored by Claudia Knobloch, Christian Pirzer and Benjamin Hötzel (all Endevo), Rustam Sengupta, Komal Makkad, and Akanksha Khurana (all Boond) as well as Richa Goyal and Andrew Tod of Energy Saving Trust.

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IKEA Foundation



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ABBREVIATIONS

Acronym	Meaning
B2B	Business-to-business
B2C	Business-to-consumer
BASE	Basel Agency for Sustainable Energy
BMS	Battery management system
BMI	Business model innovation
CaaS	Cooling-as-a-service
CEO	Chief Executive Officer
COO	Chief Operating Officer
DC	Direct-current
EV	Electric vehicle
FLDG	First-loss default guarantee
GSM	Global System for Mobile Communications
Hp	Horsepower
IDCOL	Infrastructure Development Company Limited
JLG	Joint liability group
kWp	Kilowatt peak
LEIA	Low Energy Inclusive Appliances Programme
MFA	Mobility for Africa
MFI	Micro finance institution
NGO	Non-governmental organisation
PAYGo	Pay as you go
RBL	Ratnakar Bank
USD	US Dollar
USSD	Unstructured Supplementary Service Data

THE SUSTAINABLE DEVELOPMENT GOALS

The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future. At its heart are the 17 Sustainable Development Goals (SDGs), which are an urgent call for action by all countries – developed and developing – in a global partnership. They recognise that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth – while tackling climate change and working to preserve our oceans and forests. Source: <https://sdgs.un.org/goals>



No Poverty

End poverty in all its forms everywhere



Zero Hunger

End hunger, achieve food security and improved nutrition and promote sustainable agriculture



Good Health and Well-being

Ensure healthy lives and promote well-being for all at all ages



Quality Education

Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all



Gender Equality

Achieve gender equality and empower all women and girls



Clean Water and Sanitation

Ensure availability and sustainable management of water and sanitation for all



Affordable and Clean Energy

Ensure access to affordable, reliable, sustainable and modern energy for all



Decent Work and Economic Growth

Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all



Industry, Innovation and Infrastructure

Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation



Reduced Inequalities

Reduce inequality within and among countries



Sustainable Cities and Communities

Make cities and human settlements inclusive, safe, resilient and sustainable



Responsible Consumption and Production

Ensure sustainable consumption and production patterns



Climate Change

Take urgent action to combat climate change and its impacts



Life below Water

Conserve and sustainably use the oceans, seas and marine resources for sustainable development



Life on Land

Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss



Peace, Justice and Strong Institutions

Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels



Partnerships for the Goals

Strengthen the means of implementation and revitalise the Global Partnership for Sustainable Development

RESILIENCE IN THE OFF-GRID APPLIANCE SECTOR



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Resilience is defined as an enterprise's ability to handle and engage with a crisis successfully, and afterwards return to pre-crisis levels or the status quo¹. Companies operating in emerging and low-income markets have developed a broad spectrum of business model innovations that will help make them more resilient in the face of external shocks. The business model innovations identified in the course of this research project focus on opportunities that help enhance resilience, including product innovations that help meet the needs of last-mile customers, supply-chain adjustments that increase flexibility and stability, financial instruments that enable service models, and cross-functional partnerships with stakeholders along the value chain.

The threat of external shocks

Changing market demands, consumer behavioural shifts, technology innovations, and shifts in government policy have always forced companies to adapt to changing environment and parameters. Most successful enterprises incorporate business practices intended to increase their resilience, as they typically rely on vulnerable external supply chains, and sell products or services across multiple geographies with different risk profiles.

In 2020, however, the unprecedented scenario of COVID-19 lockdowns and restrictions had pushed resilience strategies to their limits. The coronavirus pandemic has highlighted

the need for a clear and consistent resilience strategy as an essential element of any business model, even for startups.

Unfortunately, developing countries have been disproportionately affected by the coronavirus outbreak, with a collective income loss of nearly USD 220 billion.² According to the OECD (The Organisation for Economic Co-operation and Development) estimates,³ the shock of the coronavirus pandemic on small businesses has been complex and severe, with the business failure rate jumping from 4.5% to over 12%. For the off-grid energy industry, this meant that a lot of their customers could no longer afford to buy new energy system or even pay the instalments of already sold systems.

A recent survey by Sustainable Energy for All⁴ identified liquidity as one of the biggest problems for off-grid companies, following concerns related to human resources and operational continuity. Companies in this sector often have comparatively critical cashflow, with around 70% of off-grid firms functioning with reserves covering only two months or less of operating expenses. The survey also found these companies to have concerns about their supply chains, as last-mile energy access companies are often forced to implement processes of above-average complexity in order to import needed goods.

1 Entrepreneur India Magazine, 2020

2 COVID-19 - UNDP's Integrated Response

3 OECD COVID 19 and Business Failures, 2020

4 Sustainable Energy for All, Data Presentation, April 2020

Business model innovations to achieve resilience

The most promising and popular approaches to improving a company's resiliency include the use of a product-as-a-service model to increase access to productive-use appliances, development of last-mile agent networks to encourage strong community engagement, and introduction of product innovations suitable for customers in remote off-grid areas that have comparatively low-capacity needs. The most relevant and innovative such solutions are listed below and in the table at the end of this chapter. The companies associated with each specific BMI are identified in brackets. Case studies in the next chapter provide details on these selected companies and their innovations.

- **Cross-functional partnerships to activate the e-cooking market** (ABF): Many factors hinder the adoption of electric cooking in rural, low-income communities. The sector is still in its early development stage and hence has limited examples of resilient companies. Factors limiting business growth and resilience include the lack of reliable and affordable electricity access in such areas, the unavailability of suitable electric cooking appliances, and end users' disinclination to change their traditional practices.

The research conducted for this report identified that the Ajummary Bikas Foundation (ABF) as having a promising business model innovation that seeks to overcome these challenges by creating an enabling and resilient business environment for sustainable, market-driven solutions that are relevant to the local community. The business model is sensitive to local needs, and connects with such as governments, electricity providers, appliance manufacturers, financial institutions, and development partners. Referred to as cross-sectoral partnerships, these relationships help produce a shared vision for change, in which the entire network's resources can be leveraged to overcome market barriers. In so doing, they help enhance the enterprise's resilience in the face of external shocks.

- **Product-service system model for on-demand irrigation** (Claro Energy): For smallholder farmers in India, gaining access to timely and affordable irrigation can be a significant challenge, given the high cost of equipment combined with these small growers' lack of capital and individual inability to operate irrigation infrastructure at utilisation rates that would justify the systems' costs. A product-service system model in which irrigation is provided as a service with the asset shared between multiple farmers, works best under these conditions. This approach helps to make access to the appliance more affordable, with the shared use ensuring that it is used at or near maximum capacity.

In product-service system models, customers pay for a service instead of purchasing and owning an appliance. The service provider retains ownership of the appliance and bears responsibility for the equipment's installation, operations, and maintenance either performing these



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functions itself, or contracting with a third party to do so. This helps to increase last-mile adoption, while also enhancing resilience in the company's business model, as the shared usage reduces default risk and ensures consistent cash flows, often with a higher profit margin than would be possible by selling the appliance outright. The Indian renewable-energy company, Claro Energy, has taken an innovative approach of this kind, offering a pay-per-use mobile irrigation service that utilises a portable solar pump. In doing so, it provides affordable, convenient, and on-demand irrigation services, meeting the needs of farmers who do not own their own pumps.

- **Development of market-linked microenterprises** (DESI Power); In an agrarian and developing economy such as India, the fragmented nature of agricultural supply chains and the unreliability of last-mile grid power together pose a strong challenge to rural off-grid companies. For farmers to be able to generate the maximum value from their farm produce, public and private entities need to work together to improve the food-processing infrastructure and expand market access.

For companies selling productive appliances, one such business strategy is to develop local food-processing microenterprises. These units can function continuously despite the unreliability of the power grid, serving as buyers for the farmers' produce. These microenterprises, or the productive-appliance companies themselves, can then in turn sell the aggregated or processed intermediate goods onward to downstream markets. This integrated model brings predictability to the business operations at a local level, thus enhancing resilience for the organisation, supply chain, and community.

DESI Power has entered the food-processing sector with an integrated business model that spans the entire value chain, from procurement to sales. This localised business



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model innovation has ensured that farmers have access to processing services and markets even during periods of external shock, while additionally providing village consumers with access to the processed products.

- **User-centric design – low-capacity cooling solutions to decentralise the supply chain** (Promethean Power Systems): Due to India’s fragmented fresh-produce supply, most storage and quality-control technologies are used at the intermediate points in the supply chain at which small farmers’ produce is aggregated. The lack of refrigeration facilities at the village level means that small farmers have limited access to the formal supply chain; moreover, the produce loses its quality by the time it reaches the cooled storage points, with a high rate of food spoilage due to extended unrefrigerated transportation times.

While established companies already provide high-capacity chilling solutions for the centralised storage and transportation of the produce, there is currently a market gap for decentralised, village-level refrigeration. For a business model to establish itself and demonstrate resilience under such conditions, an integrated operational structure that intervenes across the value chain is needed. This could entail product innovations that address last-mile customer needs (e.g., low-capacity devices that function under off-grid conditions), a service model that increases technology adoption, or flexible payment methods that allow low-income last-mile customers to afford the appliances.

India-based Promethean Power Systems has introduced a product with chilling technology that can run consistently despite the unreliability of grid-supplied power in remote rural settings. The product called the rapid milk chiller is smaller in size to meet the lower capacity refrigeration needs of remote rural villages. To increase the adoption of the technology and help it scale its solution, Promethean offers cooling as a service to its customers. This integrated approach has enhanced the company’s resilience and has further encouraged it to venture into new sectors and product lines.

- **Last-mile agent network** (Resham Sutra): Business models focusing on low-income consumers in remote areas should consider implementing cost-effective after-sales customer-engagement solutions that are rooted in the local context (e.g., culturally sensitive). Engaging in deep, regular community interaction, with a relatively short feedback loop, allows last-mile companies to be nimble and enhances their resilience in the face of external shocks.






Resham Sutra has taken a fresh approach to this model by using last-mile agent networks to provide end-to-end support to low-income women silk weavers in remote rural areas. The company uses its community-based agent networks to provide technology and support services including capacity building, appliance maintenance, and the development of market linkages. Over time, the community agents have become even more than Resham Sutra’s eyes, and ears on the ground, helping the company manage last-mile quality control while reducing defects and other issues that might otherwise appear further downstream in the value chain. The agent network has also enabled Resham Sutra to penetrate hard-to-reach areas, opening up diverse new markets for the company, enhancing its resilience, and allowing it to scale its operations. The local agents have also allowed the company to live up to its service commitments and continue operations in a manner as close to normal as possible even during suspensions of travel and transport (as during the coronavirus lockdown).

OVERVIEW OF CASE STUDIES IN THIS REPORT

The research on resilient business models identified 29 companies engaged in innovative practices within this area. The largest share was active in South Asia, with a smaller

proportion based in South-East Asia. Table 1 gives an overview of the four case studies selected for this study.

Overview of cases studied under the resilience theme

	Organisation	Business model innovation	Productive appliance	Region
	Ajummery Bikas Foundation	Cross-functional partnerships to activate the e-cooking market	E-cooking	Nepal
	Claro Energy	Service Model for on demand irrigation	Portable solar water pumps (0.5 and 1 HP)	Bihar and Chhattisgarh, India
	DESI Power	Development of market-linked micro-enterprises	Food-processing units (including dryers, fans, heaters, pumps, grinders, and packaging machines)	Bihar, India
	Promethean Power Systems	User-centric design – low-capacity cooling solutions to decentralise the supply chain	Thermal-based rapid milk chiller (500 – 2,000 litres)	India, Bangladesh, and Sri Lanka
	Resham Sutra	Last-mile agent network	Silk reeling machines	Sikkim, Jharkhand, Bihar, Orissa, and Chhattisgarh, India

CROSS-SECTORAL PARTNERSHIPS TO ACTIVATE THE E-COOKING MARKET



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Key challenges

About three billion people worldwide rely on traditional biomass fuels such as wood or charcoal for cooking and heating.⁵ These practices have severe negative implications for health, gender relations, economic livelihoods, and climate change. Electric cooking offers a safe and environmentally friendly solution for cooking. To date, however, no commercially viable e-cooking company has managed to offer clean cooking technology at scale to customers in off-grid areas. The use of electricity for cooking in off-grid areas has been hampered by a number of barriers, including difficulties in gaining access to electricity, power providers' load-shedding⁶ practices, weak grids, the high cost of electricity, and a lack of suitable cooking appliances.⁷ Even if reliable electricity access is available, users are often hesitant to switch to e-cooking devices because they distrust the technology, have different cooking behaviours, or lack access to high-quality products.⁸ This environment makes it difficult for companies in this space to find investors and enhance their technologies. Consequently, the market for e-cooking appliances has largely remained underdeveloped, even though it could improve the lives of millions of low-income customers.

About the innovation

Cross-sectoral partnerships can help to improve the business environment for e-cooking, encouraging the development of the market. Such partnerships help create a shared vision for change, leverage resources, and jointly generate activities

CASE STUDY COMPANY

Ajummary Bikas Foundation

PRODUCTIVE APPLIANCE

Electric cooking appliances including electric pressure cookers, induction stoves, infrared e-cookstoves, and rice cookers

that can overcome market barriers. Ultimately, an enabling business environment is needed to create sustainable, market-driven solutions that are embedded in local structures and resilient to shocks.

Ecosystem facilitation, which entails connecting relevant players and making cross-sectoral partnerships work, is a critical role in this regard. In the e-cooking sector, the most important actors include:

- Governments, which create policies, regulations and quality standards for the sector.
- Electricity providers and electrification entities, who manage national grids.
- Appliance manufacturers, distributors and local retailers.
- Financing partners such as banks and microfinance institutions.
- Industry networks such as the Clean Cooking Alliance and academic institutions that aggregate and share lessons learned within the sector.
- Civil society organisations and development partners that have established relationships of trust with local communities.

The ecosystem-facilitation role is often played by a neutral actor that works to align diverse players behind a shared goal. The facilitator may be an international organisation such as the United Nations Development Programme (UNDP), a business network, or a specialised consulting firm that is deeply rooted in the sector and has close connections to key ecosystem players.

5 K. Ekouevi and V. Tuntivate, "Household Energy Access for Cooking and Heating: Lessons Learned and the Way Forward." World Bank, Washington, DC, 2012 [Online]. Available: <http://elibrary.worldbank.org/doi/book/10.1596/978-0-8213-9604-9>.

6 Load shedding, or load reduction, is a controlled intervention intended to protect the electric power system from a total blackout.

7 Modern Energy Cooking Services (MECS). [Online]. Available: <https://mece.org.uk>. [Accessed: 10-Feb-2021]

8 Modern Energy Cooking Services (MECS). [Online]. Available: <https://mece.org.uk>. [Accessed: 10-Feb-2021]

In Nepal, for example, the Ajummary Bikas Foundation (ABF) has launched several initiatives designed to enhance the country's e-cooking market. ABF leads the National Electric Cooking Campaign, a multistakeholder initiative seeking to create a sustainable e-cooking market in Nepal.⁹ The group also links

local retailers with large international manufacturers, seeking to increase rural residents' access to high-quality e-cooking appliances, and works with development partners to change the perception of e-cooking within rural communities through behaviour-change interventions. ABF's involvement along the entire e-cooking value chain in Nepal plays an essential role in creating a resilient local e-cooking market.

9 ABF, NACEUN, and Radio Sagarmatha, "National Campaign on Market-led Promotion of Electric Cooking in CREE Areas". 2019 [Online]. Available: http://ajummary.com.np/resource/8553_Campaign%20Paper_Electric%20Cooking%20Promotion_NACEUN_ABF_Final%20English.pdf

A short history of electric cooking in Nepal

Nepal's renewable energy sector has expanded rapidly over the course of recent decades, in large part because the Nepalese government has prioritised the development of hydropower and electricity access. In 2015, around 94% of the urban population and 61% of the rural population had access to electricity.¹⁰ However, despite the rapid electrification, most Nepalese were at that time still cooking with firewood (60%) or liquefied petroleum gas (LPG; 26%).¹¹

In 2015, something unexpected happened that helped e-cooking gain momentum and traction. Nepal was subject to an economic blockade, leading to a shortage of LPG fuels.¹² People from urban areas started switching to e-cooking appliances for the first time, primarily using induction and infrared cookers. However, Nepal's e-cooking pioneers were still hampered by weak power grids and load-shedding practices. The environment was not conducive to e-cooking, and people were forced to change their traditional cooking behaviours. For example,

people had to change the time of cooking according to the hours they had electricity. Hence, the economic blockade and LPG fuel shortage did not result in a steady increase in the prevalence of e-cooking in the country. But it did put electric cooking on the radar of the Nepalese government and others in the sector. It also helped ecosystem actors and end users gain first-hand experience with the new technology.

Since that time, high electrification rates and energy surpluses have slowly helped to advance e-cooking, making it more popular among end users. Several local governments and international organisations, including GIZ EnDev, the Clean Cooking Alliance, and the Practical Action and Winrock International NGOs have launched pilot initiatives to test and promote e-cooking technology within Nepal (with funding from the Modern Energy Cooking Services programme).

Despite these efforts, only about 5% of Nepalese households today use electric cookstoves as either their primary or secondary mode of cooking.¹³ About 85% of the rural population still uses biomass (mainly firewood) as cooking fuel, while around 19% uses LPG for cooking.¹⁴ The e-cooking market remains immature, with e-cooking as a practice still at an early stage. One of the main tasks in the coming years will be to create conditions conducive to scaling the use of e-cooking appliances throughout the country.

10 R. Bhandari and S. Pandit, "Electricity as a Cooking Means in Nepal—A Modelling Tool Approach", Institute for Technology and Resources Management in the Tropics and Subtropics, TH Köln, Cologne, Germany, 2018 [Online]. Available: <https://www.mdpi.com/2071-1050/10/8/2841/htm>

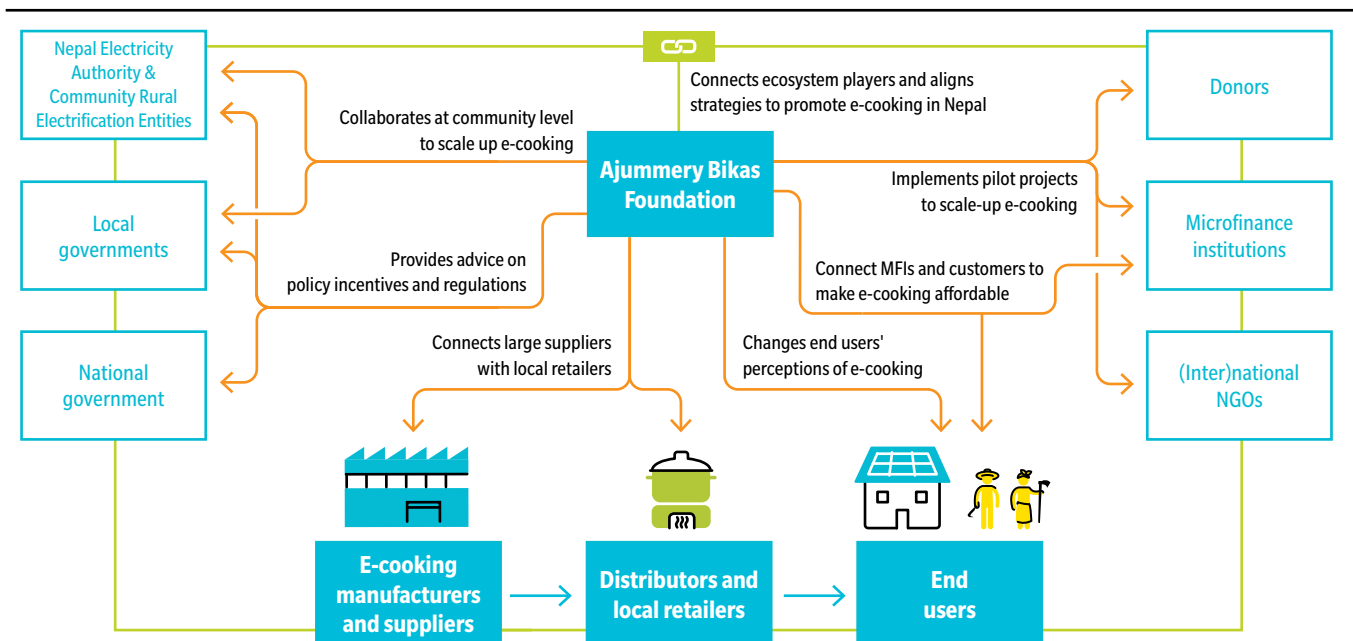
11 R. Bhandari and S. Pandit, "Electricity as a Cooking Means in Nepal—A Modelling Tool Approach", Institute for Technology and Resources Management in the Tropics and Subtropics, TH Köln, Cologne, Germany, 2018 [Online]. Available: <https://www.mdpi.com/2071-1050/10/8/2841/htm>

12 B. Pant, "Socio economic impact of undeclared blockade of India on Nepal", Research Nepal Journal of Development Studies, vol. 1, p. 18, Oct. 2018, doi: 10.3126/rnjds.v1i1.21270.

13 According to the Ajummary Bikas Foundation, an estimated 25,000 households in Nepal regularly cook with electricity (electric stove as main cooking stove), although more than 500,000 electric cookstove units have been sold in the country.

14 R. Bhandari and S. Pandit, "Electricity as a Cooking Means in Nepal—A Modelling Tool Approach", Institute for Technology and Resources Management in the Tropics and Subtropics, TH Köln, Cologne, Germany, 2018 [Online]. Available: <https://www.mdpi.com/2071-1050/10/8/2841/htm>

Illustration of business model innovation



CASE STUDY

AJUMMERY BIKAS FOUNDATION

Facilitating partnerships to foster Nepal’s e-cooking market

Please provide high res versions of photos featured in manuscript (Word file)

© Source

The ABF pilot initiative promoted e-cooking in Baluwa district in 2017

ABF at a glance

The Ajummary Bikas Foundation (ABF) is a private limited company that provides advisory services in the renewable energy sector and facilitates partnerships with the goal of developing Nepal's e-cooking market.

ABF actively promotes e-cooking through activities that range from facilitating cross-sectoral partnerships and linking local retailers with international suppliers to awareness-raising campaigns in rural communities. By connecting relevant actors along the e-cooking value chain, ABF helps foster the local e-cooking market and increases market resilience by helping to create a sustainable demand for e-cooking appliances.

ABF’s work to promote e-cooking in Nepal

The Ajummary Bikas Foundation (ABF) was founded in Nepal in 2013 by renewable energy and clean cooking specialists. The company’s mission is to promote renewable energy development and drive innovation in the energy sector through research, consulting, and implementation. Through its work, ABF has made contacts with numerous key players in the energy sector, ranging from government institutions and rural community organisations to private sector companies and development partners.

ABF is an electric cooking pioneer in Nepal. In 2013, ABF started exploring hybrid biomass e-stoves and quickly grasped the scale of e-cooking’s potential to improve people's lives and

Key figures

- Key geographies: Based in Kathmandu, Nepal
- Team: 11-50 staff members, including freelancers
- No. of beneficiaries: Has helped over 1,200 households access e-cooking technology (2020)
- Year founded: 2013

Business model innovation

- Service: Market building and facilitation of multistakeholder partnerships
- BMI: Cross-sectoral partnerships to activate e-cooking market
- SDGs addressed:



Contact details

- Website: www.ajummary.com.np
- Subarna Kapali, managing director

“We realised that we have to go beyond biomass cooking to leverage the full potential of health benefits for people.”

Subarna Kapali, managing director, ABF



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health. In 2017, ABF started a small pilot initiative. This project allowed the company to assess the market potential for electric cooking, which – because Nepal has ample hydropower resources, and a government that has identified electrification as one of its core objectives – remains strong.

ABF's pilot projects (and those of other players that invested in the sector) generated market insights, but ultimately did not scale. One of the main reasons was that the business environment for market-driven e-cooking solutions in Nepal is challenging.

In 2018, load shedding officially ended in Nepal. Consequently, controlled power cuts are no longer carried out, and electricity consumers can expect a steady, reliable electricity supply. However, although the reliability of the electricity supply and the quality of grid connections in Nepal's peri-urban and rural areas improved significantly after 2017, many challenges for e-cooking remain. These include limited knowledge and experience with e-cooking among government officials, and limited access to high-quality e-cooking appliances for end users in most peri-urban and rural parts of the county. The appliances' upfront costs are still too high for many Nepalese people to afford as a lump sum. More generally, the country has low levels of social acceptance and awareness of e-cooking. Thus, the challenging business environment continues to undermine the potential for business-driven e-cooking solutions in Nepal.

"We started several partnerships along the value chain of e-cooking to activate the local market."

Subarna Kapali, managing director, ABF

"Despite the improvement in energy access, the e-cooking market in Nepal remains underdeveloped." "

Subarna Kapali, managing director, ABF

ABF has launched several cross-sectoral partnerships along the e-cooking value chain, with the goal of overcoming some of these market barriers and spurring innovation within the local market. In these partnerships, ABF plays the role of facilitator, connecting the various stakeholders and contributing its supply-chain management expertise and knowledge about end users. The organisation's key initiatives with regard to developing the market and increasing demand for e-cooking in Nepal include:

- Aligning key players' strategies in the e-cooking sector:** Working closely with the National Association of Community Electricity Users-Nepal (NACEUN), ABF is one of the leading forces behind the National Electric Cooking Campaign. This multistakeholder initiative was created in 2019 with funding from the Nepalese government. Its mission is to promote e-cooking in Nepal, with the goal of equipping 150,000 households with functioning e-cooking devices and reliable power by 2023. The campaign unites key players in the e-cooking sector, including the Nepal Electricity Authority, local government partners, international development organisations, private sector, and community rural electrification entities from over 50 districts.
- Connecting suppliers and local retailers, so as to increase access to high-quality appliances in rural areas:** Nepal has no local e-cooking appliance manufacturing industry. Products are imported from India, China, and the Middle East. ABF works with big international suppliers, helping them establish links to local distributors and retailers. This in turn helps to increase access to high-quality e-cookers in peri-urban and rural parts of the country. ABF also imports products on behalf of local suppliers, and in some cases even offers local retailers a buyback option that reduces their investment risk. The company is currently planning to launch an independent business platform that will more effectively link large suppliers with local retailers.
- Encouraging behavioural changes, seeking to improve social acceptance and awareness at the grassroots level:** To help improve acceptance and awareness of e-cooking in rural communities, ABF works with civil society organisations to design and implement behaviour-change interventions. These activities include live cooking demonstrations with electric cooking appliances and the publication of user manuals in local languages, with the goal of enabling a smoother transition from traditional to electric cooking. Such activities also help forge connections between local actors, and make them more effective in advocating a context-specific strategy for promoting e-cooking.



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- **Facilitating access to finance, thus lowering the entry barriers to e-cooking:** ABF links individual customers and women’s groups with microfinance institutions (MFIs), with the goal of bridging the financing gap associated with e-cooking appliances. Having worked with a number of MFIs in the past on other clean and improved cookstove projects, ABF is now seeking to leverage its connections in order to foster the e-cooking market.
- **Providing policy advice, with the goal of increasing incentives for e-cooking and improving the market’s tariff structure:** Lifecycle costs for e-cooking largely depend on the cost of electricity. There is a need for electricity tariffs that will help e-cooking compete successfully with the use of LPG or solid fuels such as wood or charcoal. ABF is working with Nepal’s government to design adequate electricity tariff structures for domestic consumers, while additionally providing feedback on policies and advice on upcoming e-cooking initiatives.

Today, a number of government agencies, including the Federal Ministry of Energy, Water Resources and Irrigation as well as provincial and local governments, are actively promoting e-cooking in the country. The Nepalese national government’s interest in promoting electric cooking is primarily driven by recent increases in the country’s hydropower-generation capacity, and its interest in reducing the consumption of imported fuel, which in turn is expected to lower the country’s trade deficit.

Customers can buy a large variety of e-cooking appliances in Kathmandu markets, including electric pressure cookers, induction e-stoves, infrared e-stoves, electric hotplates, and rice cookers costing between NRP 3,000 and NRP 12,000 (USD 25 – USD 100). The most popular devices are priced between NRP 4,000 and NRP 6,000 (USD 35 – USD 50).

Despite recent improvements in the e-cooking sector, many challenges and market barriers remain. Most importantly, more work needs to be done to increase the social acceptance of e-cooking, and in providing end users with incentives to switch from traditional fuels to electricity. Cross-sectoral partnerships such as ABF’s initiatives should represent only a starting point for more extensive collaboration aimed at expanding e-cooking in Nepal.

“We are one of the pioneer institutions to start the national discussion about e-cooking, which brought a big government push..”

Subarna Kapali, Managing Director at ABF

Spotlight: Interview with an ecosystem partner

Interview with Pooja Sharma, theme lead, Practical Action Nepal

Practical Action is an international development organisation that works on the issue of clean energy access in Nepal. It is part of the National Electric Cooking Campaign, and is collaborating with ABF on a research project that aims to explore Nepalese cooking practices along with the viability and acceptance of efficient electric cooking appliances in the country. The research project is funded by the Modern Energy Cooking Services (MECS) programme.

Why did Practical Action partner with ABF on consumer behaviour activities?

Pooja Sharma: In our current research project with ABF, we analyse cooking behaviours and monitor the use of electricity for cooking with electric pressure and induction cookers in 45 households in the Kavre district of Bagmati province. Can traditional meals be easily cooked with new appliances? Are people willing to increase their electricity bill to appreciate the benefits of electric cooking? These are critical questions that will help inform the appliances’ technical specification and create the right policy incentives to scale e-cooking in the country. Our insights will also inform the National Electric Cooking Campaign. We are partnering with ABF because they have led the national campaign, and have first-hand experience with how research can influence policy and drive the clean cooking agenda.

What do you see as crucial success factors in driving e-cooking in Nepal?

Pooja Sharma: Women are the primary cooks in Nepal. Investing household money for new cooking appliances is still a big challenge in Nepal, and is much more difficult than the decision to purchase a new television. If we want to scale e-cooking in Nepal, we need to incentivise the private sector, de-risk investments, and reduce electricity costs.

Impact

Community: In recent years, ABF has engaged in several cross-sectoral partnerships intended to push Nepal's e-cooking market forward. As a result of the work of these partnerships and their initiatives, over 1,200 households in the country started using e-cooking appliances between 2018 and 2020.

Electric cooking has numerous societal benefits compared to traditional cooking with biomass, including improvements in gender equality and health conditions. As in many regions, women in Nepal bear primary responsibility for cooking and collecting fuel; thus, e-cooking can give women more time to engage in other productive and leisure activities.¹⁵ Globally, indoor air pollution generated by traditional cooking practices causes 4 million premature deaths every year, which could be prevented by e-cooking.¹⁶ Overall, the use of solid fuels such as wood and charcoal for cooking generates an estimated USD 123 billion in annual costs to human health, the environment, and local economies.¹⁷

From an economic perspective, recent studies show that e-cooking can be a cost-effective option today and is likely to become increasingly effective over time.¹⁸ The cost of e-cooking with a solar home system ranges between USD 18 and USD 65 per month for a five-person household.¹⁹ The costs of e-cooking with a grid connection are already comparable to those associated with the use of firewood or charcoal (between USD 4 and USD 38 per month).²⁰ Especially in a country such as Nepal with abundant renewable energy sources and an ambitious electrification agenda, lifecycle costs for e-cooking are likely to decrease further over time.

Organisational: As a consulting company, ABF generates revenues by implementing projects such as behaviour-change interventions on behalf of development partners, or by providing strategic advice to the government. In addition, it receives consulting fees from development partners, and success fees when linking large international e-cooking appliance providers with local retailers. ABF expects its business platform to facilitate connections between more than 20 partners in 2021, with a transaction volume of approximately 5,000 devices.

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20 J. David and T. Couture, "Beyond Fire: How to achieve electric cooking", Hivos, World Future Council, Hamburg, Germany, 2019 [Online]. Available: https://www.worldfuturecouncil.org/wp-content/uploads/2019/05/Beyond-Fire_-How-to-achieve-electric-cooking.pdf

Spotlight on beneficiaries: How awareness can change cooking behaviour

Kundu Maya Tamang (63) lives in the Timal Rural Municipality in Nepal's Kavrepalanchowk district. She lives with her husband, and all her children have moved to Kathmandu. Firewood is the main form of cooking fuel in the Timal area. Until early 2019, no one in the community engaged in electric cooking.

In August 2019, after participating in one of the live cooking demonstration events jointly organised by ABF and NACEUN, Kundu's husband bought an induction stove through the Electric Cooking Promotion Project. The project was implemented by a consortium led by ABF and NACEUN, with support from the GIZ EnDev Programme.

Kundu did not respond positively when she first saw the new cooking appliance in their kitchen. She preferred to continue cooking with firewood because she was concerned about safety (electric shocks) and the additional cost of fuel.

During one of ABF's monitoring visits, she told the project employee that she felt unsafe using the induction stove. The staff member inspected the home's wiring, and installed a new power socket in her kitchen. He also taught Kundu the basics of electrical safety and provided tips on how to operate the induction stove.

A few weeks later, when the same project staff member revisited the village, Kundu told him that she had used the induction stove regularly after his visit. She also said that when her daughter came to visit during the Dashain festival, the daughter gave her tips for cooking different types of food on the induction stove. Kundu subsequently started using the stove to prepare tea, and now feels confident even when cooking rice, lentil soup, and noodles.

Crucial interventions in promoting behavioural change among new users of electric cooking devices have included a locally accessible mechanism for collecting and addressing consumers' concerns and grievances, as well as training on the use and operation of the devices. Today, Kundu finds the induction stove easier to use, more efficient, safer and cleaner than other cooking options. She acknowledges that e-cooking has reduced the amount of time she spends collecting firewood and kindling. "If the reliability of electricity supply is ensured, I would love to use the induction stove more often," Kundu says.



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Replication and scalability

E-cooking technology has the potential to revolutionise Nepal's cooking sector, while make cooking safer, more environmentally friendly, and in the long run, more economical compared to traditional cooking practices. Necessary preconditions for a functioning e-cooking market are highlighted below. Cross-sectoral partnerships, such as those initiated and facilitated by ABF, can play an important role in improving these preconditions and supporting the scale-up of electric cooking in Nepal.

- Reliable electricity supply at an affordable price:** Electricity supply is still unreliable in some parts of Nepal, especially in rural areas. However, the government has invested significant resources in recent years to expand electricity access and strengthen the power-grid infrastructure. To further promote e-cooking in Nepal, electricity tariffs should be set in a way that reduces the overall lifecycle cost of e-cooking, and increases its competitiveness as compared to the use of LPG fuels.
- Institutional readiness:** Local entities that manage community-level power grids can play a critical role in creating a resilient and sustainable market for e-cooking appliances. These institutions are well connected to the communities they serve, are experienced in promoting electricity access, and can help advocate for e-cooking within these communities. Community-based grassroots organisations focusing on healthcare, forestry, or gender issues can also be powerful allies.
- Social acceptance of e-cooking:** Improving the acceptance and awareness of e-cooking at the grassroots level is a key prerequisite for expanding the use of the technology. Market-research findings from ABF indicate that the availability of after-sales service is a big concern within local communities, although only 10% of products need after-sales service within four years of their purchase. Suppliers should consider including such services in their service offering as a way of strengthening customer relations.
- Quality standards for technology:** In 2019, Nepal's government approved efficiency standards for electric induction stoves. However, there is still no entity today that has the mandate to enforce these standards. As a consequence, local retailers and end users have to rely on the reputations of company brands. To improve the reliability of and trust in e-cooking appliances, certified testing centres should be established, which can ensure that electrical safety and efficiency standards are being met.

PORTABLE SOLUTIONS FOR ON-DEMAND IRRIGATION AS A SERVICE

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Key challenges

Agriculture provides livelihoods for more than two-thirds of India's rural working population. Around 80% of these farmers own less than two hectares of land,²¹ and earn less than USD 1,100 a year. One of the critical requirements for increasing their income and the agricultural yield per hectare is access to water, making innovations in irrigation technologies particularly important.

Smallholder farmers are often unable to obtain productive-use appliances such as water pumps due to a lack of sufficient capital for the purchase, and the inability to operate them individually at profitable utilisation rates given small farm sizes²². While some financial institutions extend credit for the purchase of water pumps, most smallholder farmers are excluded from such offers due to their perceived high credit risk. Hence, in many northern states of the country, most farmers rely on irrigation using rented diesel-powered pumps. Rental costs vary based on location and price of fuel, but short-term (less than one week) rates can range up to USD 120/day (INR 8,000/day) for a 5 HP pump.²³ This rented diesel-pump model makes farmers dependent on unregulated intermediaries and cartels that effectively control the farmers' profit margins; moreover, this model produces emissions that exacerbate the health conditions of the farmers and climate change.

21 FAO, <http://www.fao.org/india/fao-in-india/india-at-a-glance/en/>

22 CEEW – Financing Solar for Irrigation in India

23 Diesel Engine Pump Rental Service, in Shivane, Pune, Sanas Engineering Services | ID: 14471033497 (indiamart.com)

CASE STUDY COMPANY

Claro Energy

PRODUCTIVE APPLIANCE

Portable solar water pumps (0.5 & 1 HP)

SIMILAR BUSINESS MODEL INNOVATIONS

Selco, Boond, Jain Irrigation

About the innovation

Irrigation-technology innovations able to enhance crop productivity while optimising costs are essential in order to improve farm productivity. Rental models for diesel pumps work well when access to finance for end users is an issue; however, these are often prohibitively expensive. Yet companies offering solar-powered pumps still face sales challenges due to the equipment's size and immovability.

The Indian renewable energy company - Claro Energy, identified that smallholder farmers often need pumps for relatively short periods, and do not generate adequate income to pay the monthly or quarterly loan instalments required for the purchase of their own pumps. Hence, payments based on time used (e.g., an hourly charge) do not work effectively. The company's innovative approach to solving this problem is to offer a pay-per-use mobile irrigation service that employs a proprietary portable solar pump that also supports internet-of-things (IoT) functionality. The portable design provides affordable, convenient, and on-demand irrigation, meeting



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the needs of farmers who do not own their own pumps. This model also works better for farmers whose properties are too small to justify individual pump ownership. Payments can be made using a PayGoAY card, mobile money, cash deposits, or through a local microfinance institution. Claro’s proprietary IoT features enable remote monitoring of these portable pumps. The company provides flexible booking and scheduling services via smartphones or a toll-free phone number.

Background

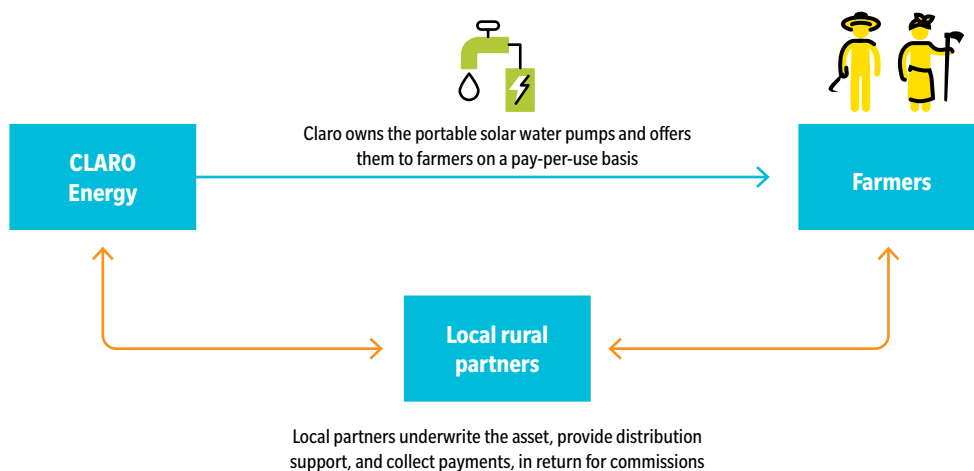
India currently has close to 21 million pumps connected to the primary fossil-fuel-based national grid, along with 8.8 million diesel-powered pumps²⁴. To date, only about 130,000 solar pumps have been installed; however, the technology

is expected to play a significant role in replacing the diesel-powered devices in particular. Policymakers believe that the nation could achieve 38% of its renewable energy generation target by shifting from conventional pumps to solar-powered irrigation pumps. To this end, the Indian government has launched schemes such as Pradhan Mantri Kisan Urja Suraksha Evam Utthan Mahabhiyan (PM-KUSUM), which provides subsidised low-interest loans to help the farmers install solar pumps.

According to Ashok Gulati, an agriculture expert at the Indian Council for Research in International Economic Relations, “India has to live with its small-sized farms for the next two decades, and the way out is to provide them access to the best technology and markets.”

24 <https://ieefa.org/wp-content/uploads/2018/08/Indias-Vast-Potential-in-Solar-Powered-Irrigation-.pdf>

Illustration of business model innovation



CASE STUDY

CLARO ENERGY

Portable solar pump with integrated pay-per-use technology, providing affordable, on-demand irrigation



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Claro at a glance

Access to timely and affordable irrigation is one of the biggest constraints faced by smallholder farmers in India.

Claro provides off-grid solar-powered pumping solutions to power-deficient regions in India. The company offers water-pumping solutions for various applications such as irrigation, agriculture, and drinking water, in both rural and urban settings.

Claro has taken a bottom-up approach to ensure that its solar pumps' type and size match its target communities' needs. The result is a portable design that offers irrigation as a service for smallholder farmers.

Portable solutions for on-demand irrigation as a service

Claro has been selling solar-powered water pumps since 2011, both directly to farmers and in partnership with rural banks. However, by 2015, the company realised that it was missing out on a large market segment, comprising smallholder farmers who did not have sufficient land to use solar water pumps cost-effectively throughout the year.

Claro went through several iterations of its design and business model to tailor it to the specific needs of smallholder farmers. The company began by mounting solar panels on a heavy tractor that was driven from one location to another. However, this initial design had limitations. For one, it proved

Key figures

- Key geographies: India
- Team: 120 staff members
- Turnover: USD 4.7 million (2020)
- Installed systems: Claro Energy has installed 11,700 stationery pumps and over 138 portable pumps, all of which are currently being used in irrigation fields and serve 30-40 farmers per day.
- Year founded: 2011
- No. of beneficiaries: 125,000 (2020)

Business model innovation

- Product: Mobile solar pumps
- BMI: On-demand irrigation as a service model
- SDGs addressed:



Contact details

- Website: <https://claroenergy.in>
- Kartik Wahi, cofounder and CEO

uneconomical for Claro to buying tractors as it scaled up, making the tractors' availability the limiting constraint. It also was difficult to manoeuvre the tractor through the narrow lanes common in villages, and the diesel-fuel cost for the tractor was relatively high. Nevertheless, this prototype did help Claro validate the underlying concept of a portable solar



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“Using solar energy to pump water for irrigation makes a lot of sense, as there is not only a productive use from the energy generated, but the daytime use for irrigation also eliminates the need for a solar battery, which further makes the system robust and affordable.”

According to Claro cofounder Karan Wahi

pump and the pay-per-use business model. The company subsequently continued its innovation journey and created the second version of its pump, which is now mounted on an electric rickshaw powered by solar panels. This iteration did gain some commercial traction, as it was compact, easy to operate, and cheaper than its predecessor. However, it still faced many mechanical problems due to the e-rickshaws’ frequent breakdowns as they navigated rugged rural terrain and damaged roads. By 2018, lightweight solar panels had become cost-effective, presenting a compelling solution for the exponential reduction of the solar panels’ weight. For example, polymer-based flexible solar panels are nearly 80% less bulky than conventional panels. Claro’s latest portable design is in the form of a backpack that weighs less than 10 kgs. It is light enough that the solar panels and the variable frequency drive inverter can be carried on the shoulders or like a suitcase. This innovation enabled farmers to carry the product themselves instead of requiring the trolleys or r-rickshaws. Initially, Claro operators trained the farmers to use the devices, but after several uses, farmers proved able to perform the necessary technical installation independently. This self-reliance has enabled a significant reduction in the system’s cost and removed the model’s dependence on Claro resources. With this innovation, Claro can now reach farmers who do not have access to a road.

Claro has since developed the product further, offering multiple configurations ranging from one to 10 horsepower. It offers submersible and surface pumps that can operate on AC or DC power, for uses involving on-field irrigation, drinking water, fisheries, or aeration. Claro has deployed 50 of its backpack units in five districts in Bihar and one district in Uttar Pradesh. Forty-two are currently being used for irrigation, while the rest have been deployed for floodwater-management purposes in Bihar. The company believes that this solution is exceptionally well-suited for post-disaster recovery, as it is easy to transport, rapidly deployable, and operationally affordable.

To respond to regional variations in agricultural parameters such as crop and soil types, water requirements, and water-table depths, the company partners with local organisations that have in-depth knowledge about the area. Typically, Claro owns the underlying assets, such as the water pumps and solar panels, but collaborates with the local organisation to underwrite the asset and for organising distribution and collection of payment, in exchange for a small fee. Currently, farmers pay around USD 1 per hour for solar pumping, compared to USD 2.2 per hour for diesel-operated pumps. Farmers can book, pay, and schedule irrigation through a smartphone app or by calling a toll-free number. The data collected through the app helps Claro refine the pricing model and project an accurate estimated cost for the farmer. The new solutions have been invaluable in helping the company to scale up.

According to the company, two key innovations in particular have shown high rates of market adoption, while leading to increased resilience:

1. Pricing based either on water usage (litres used) or total land irrigated (per “kattha”²⁵) is best suited to small-scale farmers. The company claims that farmer expenses using

²⁵ A kattha is a unit describing an area of land that is widely used in many states of India. However, values differ regionally. In Bihar, one kattha represents 1,361 square feet. This model is better understood by farmers, as they are traditionally very familiar with payments linked to growing area and crop.



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the Claro systems are less than half of what would be paid to other water-pump rental agents. Water usage is measured by a flow meter attached to the pump. Claro estimates the water usage and proposes a price using its proprietary algorithm and software tools. Payment is made through PayGo cards given to the farmers, which are also useful for identification, transaction monitoring, and other data-enabled services such as complaint registration.

2. Local organisation underwrite the solar pump (ensuring that the farmers pay Claro in time for its usage) in exchange for a commission eases the task of asset management and mitigates the risk for Claro. The local partners sometimes also act as distributors, renting the units out to farmers on a monthly or daily basis depending on their needs. These partners are then responsible for the system's operation and the performance risk, and Claro often holds a deposit for the pumps that have been loaned out. The pump remains on Claro's balance sheet (e.g., remains a company asset) and is depreciated over a period of five years. In some cases, the local partners also buy the pumps from Claro and then rent them out to the farmers themselves.

Success factors for Business Model Innovation

A number of success factors have emerged in the course of Claro's work:

- 1) The experience of working with farmers over the past ten years has enabled Claro to identify the needs of smallholder farmers accurately, and aggregate data regarding water utilisation per acre.
- 2) The patient capital provided during USAID's Powering Agriculture programme enabled Claro to take a risk and innovate for a population of farmers who needed a solution of this kind.

- 3) Partnerships with local organisations have enabled the company to reduce the risk associated with the assets, and to collect farmer feedback accurately and consistently.
- 4) Subsidy support from the Indian government has reduced the company's capital expenditure and increased affordability for the end users (smallholder farmers).

Impact

Community: Claro's intervention has helped farmers save 50% on irrigation costs, and using it effectively to boost their agricultural yields by 10% to 12%. The company has observed that farmers are now diversifying from cultivation of single grains or pulses to vegetables and other higher-value items, enabling them to generate higher year-round incomes. The extra income has also enabled farmers to purchase higher-quality seeds and other equipment that has increased productivity.

The farming community is thus becoming more resilient and progressive thanks to improved access to on-demand irrigation at a lower cost and is no longer dependent on diesel-pump intermediaries.

Organisational: Claro presently has about 120 staff members. Irrigation as a service has created a compelling case for Claro's business model, and the company is expecting to break even in 2022. Additionally, the portable pump model that fulfils the demand of a traditionally untapped market segment has enabled Claro to realise economies of scale and resiliency. The company has also collected a significant amount of data that it can now use for research and development purposes, with the ultimate aim of providing additional value-added services.

Environmental: The solar pumps have led to a reduction of CO₂ emissions. The company estimates that the pumps currently in use result in an annual CO₂ offset of 3,073 tonnes.

“USAID and GIZ have been long-standing partners for Claro Energy in terms of extending support to us as we attempt to solve this difficult problem, which has the potential to benefit millions of small landholder farmers once deployed at scale. Their contribution across all aspects of product development and deployment has been immense, and without their support, we would not have come this far.”

Kartik Wahi, cofounder and CEO, Claro Energy

Spotlight on beneficiaries

“The availability of electricity with these solar solutions is highly beneficial to us. Floods are frequent, and during those times, there is water all around, snakes often come close to our houses, and we remain unaware and scared in the dark. With the portable solar backpack systems, there is light in the village, and we feel safer. There are 50 – 60 people in our cluster, and all of us benefit from the common area lighting. The kids can study and play, and we can charge our mobiles.” Manohar Saini, Chulari village, Sitamarhi district, Bihar

“Because of the solar pump’s portable nature, we can now use it across our three pieces of land far from each other. We are making more money on every crop from savings on diesel.” – Bhoolmati Devi, Dikauli village, Shravasti district, Uttar Pradesh

Spotlight on partnerships

To develop the portable solar pump, Claro partnered with and received patient capital from USAID’s Powering Agriculture programme. The vision underlying Powering Agriculture is that investing in clean energy technologies leads to improved incomes for farmers, decreased reliance on fossil fuels, and better food security globally. The programme managers saw the portable solar pumps as a relevant innovation that tackles various challenges faced by smallholder farmers.

Role of partners in the business model innovation:

Agency	Type	Role
USAID, GIZ, Tata Trust	Funding organisations	▶ Provided patient capital for the development and deployment of the different iterations of portable solar pumps
Grassroots NGOs	Non-profit	▶ Manage daily operations and underwrite rental-model performance risk
Farmer producer groups (FPOs)	Private organisation	▶ Take out leases as groups of smallholder farmers



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DEVELOPMENT OF MARKET-LINKED MICRO-ENTERPRISES



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Key challenges

A significant proportion of India's small-scale vegetable and spice farmers are unable to extract their products' full market value. The lack of local storage and processing capabilities, as well as their inability to bargain due to their low individual volumes, often forces them to sell their goods at low prices. These hurdles could be significantly lowered if the growers were able to process their farm produce into higher-value items that could be stored for longer durations of time. Yet this requires extensive and expensive machines and trained people. To meet and repay operational costs, productive-use machines such as food-processing units must operate at relatively high rates of utilisation. While individual farmers do not produce the volumes necessary to ensure this, the problem can be overcome if a group of farmers shares use of the facility, and collectively takes on responsibility for paying for its operations.

The Indian government has identified the development of last-mile microenterprises as a key means of enhancing the agricultural-product value chain in rural areas. However, despite government incentives and policy support, it has been challenging to scale-up last-mile processing units, due to a number of factors such as a lack of awareness of the benefits of such facilities, limited financial aid, and insufficient market linkages. These issues are compounded further by the fragmented supply of farm produce, which prevents the aggregation of resources, and lowers farmers' negotiating power to pay for the high cost of productive-use appliances.

Limited access to reliable energy has also constrained the development of local processing facilities. This has impaired

CASE STUDY COMPANY

Decentralised Energy Systems India (DESI Power)

PRODUCTIVE APPLIANCE

Food-processing units (including dryers, fans, heaters, pumps, grinders, and packaging machines)

SIMILAR BUSINESS MODEL INNOVATIONS

Mlinda, OMC Power, Oorja Development

farmers' ability to maximise crop yields, and reduced their resilience to external shocks, as their perishable produce is fully exposed to market-price volatilities. By contrast, processed agricultural produce can be stored for longer durations, thus potentially fetching higher prices than when in its unprocessed state.

About the innovation

Food processing is a key part of the agricultural value chain, as it increases food security and reduces losses due to wastage. It facilitates the availability of a broader range of food products for extended periods of time, additionally expanding market penetration to locations distant from the source of production. Among the key drivers for the processing industry's growth have been innovations in productive-use appliances and access to power based on renewable energies. A number of organisations are working on last-mile distribution of technologies that can benefit smallholder farmers. For example, rural minigrid operators such as Mlinda



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(Jharkhand, India) and OMC Power (UP, India) have ventured into food processing, installing appliances such as dryers, flour processers, and oil expellers. However, these firms have not reached large scales or generated substantial market traction. Similar models have also emerged in Africa from companies such as Jumeme and Standard Microgrid but remain in the early stages of development.

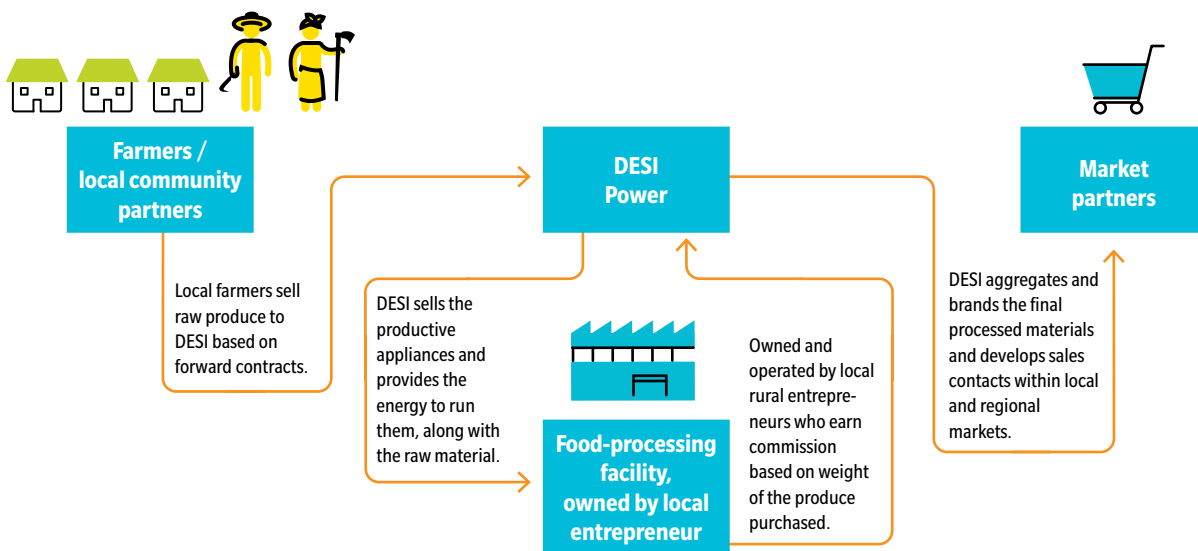
Most food-processing appliances require a continuous energy source – both thermal, for instance for dryers to dry the farm produce, and electrical, to operate fans, heaters, water pumps, grinders, and packaging units. Unfortunately, even though energy access has significantly improved in India, the quality and reliability of grid-based power in many rural areas continues to be inadequate to support the profitable operation of a commercial-sized food-processing unit. One solution to this problem, as advocated by the government and other institutions, is shared community ownership and usage of electricity-generation facilities. Unfortunately, the lack of clear

accountability for operating and maintaining such machines has prevented the expansion of the community ownership model. DESI Power has sought to overcome this challenge by bringing together multiple parties in the value chain, including farmers, productive-use appliance companies, energy-access enterprises, and market linkage experts.

DESI Power has been working in rural Bihar for the past 24 years, setting up biomass and solar-powered minigrids. The company has now entered the food-processing sector with an integrated business model that aggregates the whole value chain, from procurement to sales. DESI Power focuses on only a few food products. This integration and specialisation have reduced the overall operational costs for the processing unit, and made the company more resilient overall, as its diversified portfolio of products has freed it from dependence on income from farmers' energy consumption. The business unit that produces the food-processing machinery is now profitable, and these processing facilities provide the company's minigrids with fixed loads and consistent utilisation rates. Moreover, diversification into this new product line has reduced some operational risks and given the company a strong competitive advantage compared to other minigrid companies.

DESI Power has enhanced communities' resilience to external shocks by allowing farmers to enhance the value of their produce; this takes place by assuring them the purchase of their produce at an agreed price, decoupling them from market-price volatilities. The company has also created strong downstream sales links, ensuring continuous demand for the processed food at local markets within nearby villages and towns, at wholesale markets in cities, at large stores in big towns, and on online sales platforms. DESI Power has obtained the necessary registrations and certification for the products, and brands them as required.

Illustration of business model innovation



CASE STUDY

DECENTRALISED ENERGY SYSTEMS INDIA (DESI POWER)

Building profitable last-mile business units for food processing using productive-use appliances

Please provide high res versions of photos featured in manuscript (Word file)

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DESI Power at a glance

DESI Power is an energy-access pioneer with nearly 24 years of history, with an extensive portfolio of products and services that includes solar lanterns, solar home systems, water pumps, and customised application-specific installations. Through its EmPower (Employment and Power) Partnership Programme, DESI Power creates an ecosystem supporting business entities that employ productive-use appliances for the purposes of food processing in villages. DESI Power's food-processing unit, which has been in operation since 2019, concentrates on turmeric, ginger, and mushrooms. The company has selected these products due to their widespread use and well-established value proposition. The company uses natural and locally well-known processing techniques involving washing, sizing, boiling, and drying at low temperatures.

The company sells and maintains the processing machines, while additionally procuring raw materials directly from the farmers and marketing and branding the end products. This is possible thanks to the contacts it has established with retail shops in local villages, wholesale markets in nearby cities, and online platforms. DESI Power also trains the entrepreneurs who own and operate the processing units and helps them obtain funding.

These micro-processing business units are provided with a source of electricity through DESI Power's mini-grid system.

Key figures

- Key geographies: India (state of Bihar)
- Team: 30 staff members
- No. of beneficiaries: More than 200,000 (2020)
- Year founded: 1996.

Business model innovation

- Food-processing unit (consisting of dryers, grinders, and packaging machines)
- BMI: Development of market-linked micro-enterprises
- SDGs addressed:



Contact details

- Website: www.desipower.com
- Aklavya Sharan, director

The pricing methodology used for the productive appliances is unique, with DESI taking a proportion of the total sale rather than utilising a more traditional kWh pricing structure. The company developed the business model in partnership with Fichtner Consulting Engineers, an Indo-German firm, and today works closely with farmers and local entrepreneurs to create a self-sustaining last-mile supply-and-demand ecosystem.



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Strengthening the agricultural value chain with productive microenterprises and supply-chain linkages

DESI Power installs solar-powered minigrids- and sells productive-use appliances such as food-processing machinery to rural entrepreneurs. The company also procures unprocessed agricultural produce from local farmers and various last-mile networks, aggregating the produce, processing it in the food processing units and facilitating onward sale. Aggregation of the produce across multiple farmers increases transactional volumes unlocking better margins (part of which are shared with the farmers). It also ensures that the processing units have high utilization rates contributing to their commercial viability. It establishes contacts within local and regional markets to facilitate the sale of the processed outputs. DESI Power has identified turmeric- and ginger-processing units as the equipment best suited for its community of customers, due to the widespread demand for these processed products, and the DESI's customers proximity to the areas in which these crops are produced. The farmers are also encouraged to shift to organic farming practices in order to enhance their market value proposition. The food-processing units are provided with a constant supply of electricity from the minigrids owned by DESI Power. . The food-processing units involve a suite of machines consisting of two types of solar-power hybrid dryers; thermal components for cleaning, sizing and boiling turmeric and ginger; a grinding

“In the COVID-19 lockdown period, our food-processing unit was quite helpful to the villagers, as we could preserve their raw materials by drying and processing them. Otherwise, those would have been wasted due to the lack of demand.”

Aklavya Sharan, director, DESI Power

unit; and storage facilities. DESI Power is also developing electric trolleys for transportation and packaging, as well as labelling machines as a part of the processing unit and trains the entrepreneurs on quality-management practices.

DESI Power has optimised the functioning of the processing units and fine-tuned their operation through robust testing to ascertain the exact time required for drying turmeric and ginger, and the specific granularity used in the grinding process to obtain the highest-quality end product. The company also provides food-processing entrepreneurs training and capacity-building services, thus helping to ensure smooth operations.

The company procures the processed products from the entrepreneurs at more favourable rates than those offered by other intermediaries and sells them in the market under a common brand, supported by extensive marketing.

For instance, processed natural turmeric and ginger have a higher market value than the comparable raw products, providing farmers with more income and allowing the company to improve its margins. The value added through the use of solar-powered processing units (for 1 kg of turmeric) is shown below:

Activity	Costs (1 USD = INR 70)
Raw turmeric price during the season	INR 8-10/kg
Cost incurred for producing marketable dried turmeric powder:	
▶ Raw turmeric required to get 1kg dry	6kgs
▶ Cost of raw turmeric	INR 60/kg
▶ Cost of power and other inputs for boiling and drying	INR 10/kg
Total cost of production	INR 70/kg
Selling price	INR 90/kg
Profit generated, to be shared with farmer	INR 20/kg (USD 0.30/kg)



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Success factors for business model innovation

- **Community engagement:** Close engagement with the farmers ensures regular access to raw materials, as well as a clear understanding of which locally grown agricultural products offer opportunities for value addition through processing. Over the past 24 years, DESI has built a strong relationship with the community through its energy-access work. The community has welcomed the company's pivot to agricultural technology.
- **Strong market linkages:** The company has created robust partnerships that facilitate the sale of processed goods. These dependable market links allow for a regular cash flow and a predictable level of demand, factors that have been essential in allowing the company to sign forward contracts with the farmers.
- **Focus on quality:** DESI other than being a renewable energy productive appliance company also operates as a food processing company focusing largely on quality, thus providing better margins to farmers (even more for those who use organic farming practices). This has helped the company differentiate itself sustainably in the market.
- **Training and support provided to food-processing facility operators:** The company has spent considerable time training and mentoring the entrepreneurs running the food-processing units, which has reduced losses and improved adherence to quality standards.

Impact

Community: The benefits go directly to the local communities that supply the farm produce. The company can presently offtake 15,000-20,000 kgs of farm produce per month. More than 100 farmers are currently engaged in the project, providing raw material to the company. The model also provides income to 20 entrepreneurs who operate the processing units. There is a provision to expand to more sites if demand increases.

The innovative business model has provided significant benefits to many beneficiaries, including:

- Farmers, by generating higher yield, increasing the sustainability of farm operations, and lowering risk.
- Consumers, by increasing product variety, lowering prices, and offering new organic products.
- Industry and market partners, by creating new business opportunities and increasing overall demand.
- The economy and government, by generating employment and helping to reduce rural outmigration.

Organisational: The DESI team has grown, and now possesses agriculture and food-processing expertise. Partnerships with more extensive sales networks and e-commerce entities have enabled the company to deepen its relationships with other actors in the agricultural value chain, increasing the company's resilience.

Spotlight on beneficiaries

Most of DESI Power’s beneficiaries are smallholders who lease or rent the land used for farming. Each farmer has one or two acres of land, and can earn approximately USD 54 to USD 67 per acre, per month, by selling raw produce. The business model innovation that provides them with access to processing units and markets benefits them significantly, as they can sell their produce at higher prices than before. DESI Power has observed that farmers’ income has increased by 15% to 20% as a result of the processing services and the elimination of other intermediaries.

Quotes from the farmers:

“Thanks to the DESI Power plant, now we can sell our spices and also process our finished masalas (spices) within the village.” – Parvathy Devi, farmer, Chakai Village

“I operate a rice huller and an oil expeller. I only process farm produce of the villagers, and depend on the farmers to bring their produce. During the crop season, my business is good. Otherwise, during the off-season, it is slow. If I can process my own product and get market linkages, I can run my business throughout the year. This will help me to increase my income as well.” – Md. Kasim, a local entrepreneur and DESI Power customer.

“I am one of the old customers of DESI Power, getting irrigation water [when needed]. DESI Power has piloted turmeric and ginger growing, and they invited farmers from the village to train us and showcase the technology, and encouraged us to grow the same [products]. I am personally very much interested in starting to grow at my place. I have learned a lot from DESI Power’s initiative. They have assured me that they will provide seeds, and they will also buy raw materials from me. This will create a good income source for me, and I am thankful to them.” – Tilak Chand Mandal, a progressive farmer living in Chakai village



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Replication and scalability

DESI Power currently supports 20 entrepreneur-operated processing units, and is in the process of scaling the initiative in other parts of the country. The company believes that food-processing units of this kind can be set up across India. The company is currently raising capital to support its expansion plans.

To enhance the ecosystem further and help it to scale up and replication, the following will also be necessary:

a) Awareness must be increased. Awareness-raising campaigns among consumers and farmer groups should highlight the advantages of long-term business viability and the economic benefits of food security. The government can play a role in this regard through its own programmes, while

encouraging NGOs and self-help groups to promote such initiatives through their channels. Financial institutions such as the National Bank for Agriculture and Rural Development (NABARD) and cooperative banks can simplify their loan processes, thus making it easier for entrepreneurs interested in developing food-processing units obtain credit.

b) Links with various government programmes must be established: The government offers subsidies to promote the development of food-processing units. If DESI Power’s integrated approach could be linked to existing financial-support programmes, this would greatly ease the task of large-scale replication.

USER CENTRIC DESIGN – LOW-CAPACITY COOLING SOLUTIONS TO DECENTRALISE THE SUPPLY CHAIN

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Key challenges

According to the UN Food and Agriculture Organisation, about one-third of the food produced globally is wasted. In India alone, perishable food items worth around USD 14 billion spoils every year due to flaws in the cold supply chain. The dairy industry is particularly vulnerable, as 80% of animals are kept on small farms with an average of one to three animals) This forces dairies to collect small quantities of milk from numerous small and geographically dispersed villages, making the collection of high-quality milk time-consuming and costly. smallholder farmers have little access to the formal supply chain, a fact that gives them minimal negotiating power and low margins. Moreover, due to the fragmentation in this supply chain, most storage, and quality-control technologies function at the aggregated level (e.g., with refrigeration infrastructures of greater than 10,000 litres/day). The lack of refrigeration facilities at the village level affects the quality of the milk collected, and additionally exposes the industry to external shocks. For example, closures or other problems affecting the plants at which milk is chilled (which aggregate milk from hundreds of villages) percolate down to the smaller milk producers, undermining their economic stability.

The production of high-quality milk with low levels of bacteria and high levels of fat content is possible if milk is chilled near the source within four hours of extraction. Spending just two hours at ambient temperature can triple the bacterial count in a can of milk. However, the unreliability of India's electric grid poses a major challenge in this regard. Dairies with centralised chilling centres currently use diesel-based backup power to

CASE STUDY COMPANY

Promethean Power Systems

PRODUCTIVE APPLIANCE

Thermal-based rapid milk chiller (500 – 2,000 litres)

SIMILAR BUSINESS MODEL INNOVATIONS

Ecozen, Inficold

operate large bulk milk chillers (BMCs), which adds to the energy cost in addition to having a negative environmental impact.

About the innovation

The conventional hub-and-spoke model of milk collection is inefficient and energy-intensive, with its economically viable capacity often exceeding 50,000 litres/day. The solution is to bring chilling facilities closer to the small villages, optimising their size and thus decentralising the cold chain to reach the last mile.

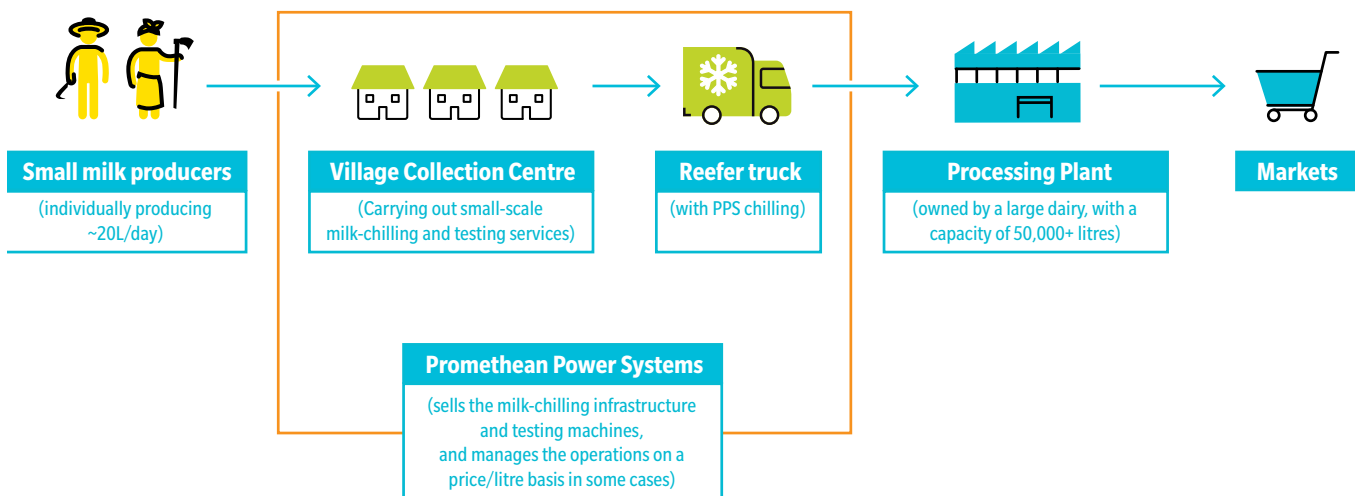
An essential pre-requisite is the development of small-scale milk-chilling equipment with quality-testing functions that can operate reliably despite the inconsistent nature of the grid-supplied power in rural, remote settings. Promethean Power Systems has developed a renewable energy powered chilling solution that can run under inconsistent grid conditions and is of lower capacity (500-2000L) to suit the needs of the end customers.

Rapid Milk Chiller (RMC) based on thermal storage system (TSS)

The product called the Rapid Milk Chiller (RMC), is based on the principle of thermal storage system (TSS), a patented technology that functions as the core of the company’s refrigeration products. The TSS stores energy derived both from the intermittent grid power and solar energy in the form of a phase-changing material, and slowly releases it as needed. The system is a combination of a phase-changing material that stores energy, a fluid that transfers energy,

a mechanical design that increases energy density, and electronics that increase the discharge time. A full four-hour charge can cool 500 litres, the volume of milk that a typical small village produces in a single day. Using the stored energy from the TSS, the RMC cools the raw milk to 4°C within a few seconds, arresting bacteria growth and retaining its high original quality.

Illustration of business model innovation



The business model essentially operates with dairy companies identifying new or existing catchment areas, and then establishing village-level collection centres fitted with chilling solutions powered by renewable energy. These chillers are provided by companies like Promethean Power Systems. Each centre is operated by a community member designated by the dairy who owns the physical space of the collection centre and receives income in the form of commission from the dairy based on per litre of milk collected. This last-mile collection, aggregation, and refrigeration point gives farmers an assured demand and income stream, and provides the centre operator with increased savings due to the elimination of diesel generators. The dairies benefit as well, as these centres are now cost- and energy-efficient, resulting in a dramatic increase in milk quality; this in turn can allow the dairies to create products with higher added value, increasing their profit margin.

A typical dairy farmer in India has between one to three cattle producing 5 to 10 litres of milk per cow per day, with most villages’ average surplus daily production ranging as low as 200 litres.

For many years, India’s government focused its interventions in this area on increasing milk-sector productivity through animal breeding and feed services. However, over the course of the last decade, there has been a shift in governmental

strategy towards policy support and subsidies that encourage cold-chain innovations.

Commercial refrigeration in the agribusiness and dairy sectors in India is a niche market, and few entities offer renewable-energy solutions in rural areas. Big companies such as IDMC, Delaval, and Fabtech provide diesel-based commercial refrigeration systems for dairy producers. Given that their products require extensive investment, entail high operating costs, and support high volumes, their customers are primarily big dairies. Product capacities are in the range of 5,000 to 10,000 litres per tank. Companies such as Tessol,²⁶ by contrast, are working with fuel-free, renewable energy based refrigeration systems in India, seeking to enhance the cold chain with last-mile distribution systems such as trucks, small vehicles, and last-mile delivery boxes. Ecozen²⁷ is another player that provides an end-to-end solution designed to preserve agricultural produce after harvesting.

26 <https://www.tessol.in/segments-at-a-glance/>

27 <https://www.ecozensolutions.com/#>

CASE STUDY

PROMETHEAN POWER SYSTEMS

Making cold chain more efficient by decentralising milk collection with the help of thermal storage refrigeration



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Promethean Power Systems at a glance

Promethean Power Systems designs and manufactures rural refrigeration systems for commercial cold-storage applications in off-grid and partially electrified areas of low-income countries. The thermal storage based chilling solutions enable food suppliers to refrigerate perishable food items such as milk, fruits, and vegetables, without the need for expensive and polluting diesel-powered generators.

Promethean’s chilling solutions are based on a thermal storage system suited for off-grid villages. Milk and other produce can be chilled faster and at the source (village level), and subsequently be transported directly to the processing centre, thus reducing food spoilage, and making the supply chain more efficient in a green and sustainable manner.

Promethean’s clients include established dairies such as Amul, Hutsun, ITC, Mother Dairy, Parag, and Nestle, who prefer to buy the product outright. The company also signs long-term contracts with clients such as Akhsyakalpa, an organic dairy company and Licious, a meat delivery company who lease machines on a cost-per-litre basis. Promethean then acts as an implementation and service partner to these clients. In 2019, the company achieved a turnover of USD 3 million, and installed 330 units across India. It also exports cooling units to Tanzania, Bangladesh, and Sri Lanka.

Key figures

- Key geographies: India, Bangladesh, and Sri Lanka
- Staff: 60 staff members
- Turnover: USD 3 million (2019),
- Number of units: 1,700 units.
- No. of customers: 40 (25-30 active)
- No. of beneficiaries: 75,000 farmers (2020)
- Year founded: 2007 (Boston); Indian operations started in 2012

Business model innovation

- Product: Chilling solution with thermal storage system
- BMI: User centric design – Low-capacity cooling solutions to decentralize the supply chain
- SDGs addressed:



Contact details

- Website: <https://cooelectrica.com/>
- Jofi Joseph, managing director



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Eliminating food spoilage using thermal-based chillers

Promethean Power Systems is transforming cold chain technology, enabling dairies to chill their raw materials closer to the source. In doing so, the company is penetrating a currently untapped market at an affordable cost, using clean energy. Retrofitted to function with existing infrastructure (if required, the company's thermal-based refrigeration system), is designed to chill milk rapidly at low volumes, which dramatically reduces milk spoilage. The system also eliminates the constraint of an intermittent supply of grid power, as the renewable-energy-based supply provides a complementary source of energy for the cooling system. This small-scale chilling equipment provides considerable flexibility, unlocking higher margins for Promethean's customers and providing farmers with increased incomes and regular payments. This in turn, enhances resiliency for the organisation.

Promethean cofounders Sam White and Sorin Grama met in 2007 during an MIT entrepreneurship competition focused on clean-energy interventions in developing nations. Their field studies revealed significant opportunities for reducing transport and logistics costs in the cold chain of India's milk industry. The company's first solar refrigeration system which used photovoltaic solar panels with electrical battery storage, received low sales due to its high setup costs and a design that proved difficult to transport. The company subsequently pivoted to thermal storage systems, transforming the technology to use the intermittent supply of grid power when possible, while providing solar-powered backup as needed, eliminating expensive and heavy lead-acid batteries to the greatest extent possible. The first pilot was carried out in 2013 with a large southern Indian dairy, Hutson Agro; this proved

“Energy and related operating costs are among the most significant costs and barriers to cold-chain adoption. We work with leading food companies to accelerate the adoption of the sustainable and decentralised cold chain from the first mile to the last mile via cooling as a service to preserve quality and reduce food loss.”

Jiten Ghilani, CEO, Promethean Power Systems

successful, and led the company to launch a manufacturing and testing facility for the construction of its systems.

Promethean has a product line of thermal storage based cooling solutions with tank capacities varying from 500 to 2,000 litres. The chilling system costs on an average USD 7000, which is 36% lower than the diesel based chilling solutions available in the market. Promethean's systems further increase affordability and value creation by enabling a 75% reduction in chilling cost, 31% more energy savings and almost nil food wastage. The company has also developed a cold-storage solution for fruits and vegetables, and micro-sized milk chillers for reefer (refrigerated) trucks. Another exciting pilot is currently underway involving mobile thermal-energy-based microchillers that can carry four 40-litre cans of milk at a time directly to the dairy processing facility. Here, milk is chilled at the village level with the same performance level as that shown



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by the larger conventional BMCs; however, this system instead uses cans that can be directly transported to the processing plant. This eliminates the need for additional capital investment in chilling-centre infrastructure, increases the ability to trace specific milk deliveries back to their village of origin, and further reduces the carbon footprint by eliminating the diesel generator from a conventional village level chilling facility.

Market studies conducted by industry experts estimate the market for thermal-storage-based milk chilling at around INR 7,000 crores²⁸ (USD 1 billion) in India alone, with around 200,000 units currently in operation. Since 2013, Promethean has installed over 1,700 systems in India, Bangladesh, and Sri Lanka. The company offers tailored solutions to each of its customers. To position itself as a preferred B2B choice, Promethean is shifting from a product-focused to a service-focused sales strategy. The service-oriented business model offers a pay-by-use option to the dairy clients, with contract periods ranging from 36 to 60 months. Under this model, Promethean sets up, manages, and monitors the operations,

²⁸ Thermal storage system for Indian cold chain. <https://innovate.mygov.in/innovation/thermal-storage-system-for-indian-cold-chain/>

and charges the client per litre of milk chilled, with a minimum volume commitment. This model has been implemented with five dairies to date.

By providing end-to-end cold-chain solutions to dairy and agriculture companies, combined with asset-management functions and a service-delivery model, Promethean raises the barrier to entry for other industry players. This makes the company more resilient. In 2019, Promethean reported 3 million turnover and raised USD 2 million in funding (with an equal share contributed by Acumen and the Total Energy Foundation) to cover R&D costs on innovations such as microchillers and reefer trucks. It has also won a number of awards and recognitions; for example, it was named a World Economic Forum Pioneer (2013), won the Venture Well / Lemelson Sustainable Practice Award (2015), and was named to the Food Logistics – Top Green Providers list in the Alternate Fuel category (2020).

Success factors for business model innovation

- **Strong product expertise:** The company adapted its product to meet the industry's needs by working closely with mature market players and focusing on their key pain points. Bringing clean energy and off-grid storage solutions to the last mile at an affordable cost have also helped to increase community resilience, and increased potential customers' willingness to invest.
- **Integrated supply-chain support:** The company's product strategy and provision of service along the entire supply chain (from farm to market) is resulting in resilient and organic growth. Promethean is working towards becoming a one-stop solution for chilling in the dairy and agriculture sector, with a portfolio of innovative, green products and a dedicated service team for last-mile installation and maintenance.

“We believe that the best way to eliminate food loss and improve farmer livelihoods is to bring the cooling infrastructure as close to the farmer as possible. To achieve this, we will constantly be innovating both on our products and business model to ensure a seamless cold chain from the farmer to the consumer.”

Jofi Joseph, Managing Director, Promethean Power Systems



Impact

Promethean’s products produce benefits in many areas, by improving food security, helping communities, protecting the environment, and helping the company itself grow.

Food security: BRAC, the largest NGO in Bangladesh, wanted a solution that could reduce milk spoilage by rapidly chilling farmers’ milk at the collection centre. The solution needed to be cost-effective, eco-friendly, sustainable, and scalable over many villages. After installing Promethean’s systems, the company reports that BRAC has reduced milk spoilage rates by over 90%. Similar results have been seen at established Indian dairies such as Amul, Hatsun, Mother Dairy, and ITC. Parag Milk Foods, one of India’s leading dairies, has lowered its energy costs from 46 paise to 20 paise per litre (one paise is 1/100 of a rupee, or about USD.00014).

Community: Promethean’s use of thermal energy storage technology to create a cost-effective energy-backup solution for the cold chain has benefitted more than 75,000 farmers. According to the company, most of the farmers with access to its systems have reported an average income increase of around 20%. Farmers are now increasingly confident that they can sell their produce without fear of spoilage, thus freeing them from intermediaries in the open market. With this increased income, farmers are investing in buying better breeds of cattle, thus increasing their milk production by 30% to 40%. With dairies now focusing on high-quality milk, farmers are prioritising the quality of feed and improving their animals’ health. Thus, technological intervention and the business model innovation have helped customers and end users alike increase their resiliency, giving the company a pivotal role in the dairy value chain.

Organisation: Since 2014, Promethean has grown from a small team producing a single product to a 60-member team with multiple product lines, with half of its operations dedicated to front-end services and over 1,700 units installed.

One of the changes on an organisational level has been the shift from a product focus to a service model and orientation. This has shifted the discussions with stakeholders from a focus on cost to the issue of quality retention and elimination of food spoilage.

Environment: The company's thermal-battery refrigeration system is a green alternative to diesel generators. According to Promethean, the Rapid Milk Chiller brings down cooling costs significantly, reduces users’ carbon footprints by 15% to 30%, and has prevented the use of over 3 million²⁹ litres of diesel since its introduction. Additionally, the compressors use R-404 gas, which has a lower global warming potential (GWP) than the compressors based on R-22 gas more typically used within the industry. In its new products, Promethean is experimenting with the use of compressors based on R-448 gas, which has an even lower GWP.

Carbon footprint calculation (1,000-litre bulk milk chiller unit)

Description	Units	Regular bulk milk chiller	Promethean bulk milk chiller
Grid usage	hour (h)	4.875	8.0
Compressor run time	h	6..5	8.0
Diesel generator (DG) usage	h	1.625	0
Electricity consumption	kWh	13.65	22.4
Diesel consumption	litre (l)	3.25	0
CO ₂ from grid usage	kg	9.5	15.7
CO ₂ from DG usage	kg	8.7	0
CO₂ emitted/day	kg	18.2	15.7

Notes: CO₂ / kWh: 700g (Source: Clean Air Asia)
 CO₂ / l diesel: 2.68kg (Source: myclimate.org)
 Diesel / h for 10kVA DG: 2l (Source: Manufacturer Specs)
 Assumptions: DG usage: 25%; Connected Load: 2.8kW

29 Promethean website - <https://coolelectrica.com/>

Spotlight on beneficiaries

Promethean works with dairy and agricultural companies in India and Bangladesh that primarily work with smallholder farmers residing in partially electrified or off-grid rural areas. These farmers have an average of one to three animals used for dairy purposes, and two to five hectares of land.

“Earlier, we had a regular bulk milk cooler which we used to operate most of the time on diesel, entailing a monthly expense of USD 135. With Promethean’s bulk milk cooler, which was installed roughly a year ago, we are now

spending only USD 68 a month on electricity.” – Devadnya Dilip Wagh, Amul Chilling Centre, Pahad Dhara village

“Sometimes, the milk that I sold would be returned as it would [spoil] without proper refrigeration. But now I do not face this issue, as the company has installed a new machine at the milk collection point in our area, which prevents milk from [spoil] fast.” – Afzal Hossain, PRAN Dairy (BRAC), Bangladesh

Spotlight on partnerships

Promethean transforms the fresh-produce supply chain with innovative interventions at multiple points. It has won grant-based support from partners including USAID, UNIDO, and the Efficiency for Access Research and Development Fund, which it has primarily applied towards market development, digitising the chilling infrastructure, and developing or improving innovative product lines such as reefer trucks and microchillers (portable small-capacity chillers). These advances will help Promethean become a one-stop partner for cold-chain solutions in agriculture and allied industries.

ITC, one of India’s largest fast-moving consumer goods companies, has set up a milk-procurement network in rural areas of Bihar and West Bengal (north-eastern India). These parts of the country have particular problems with an irregular supply of grid power. Therefore, the solution required had to work efficiently even with intermittent power. In 2017, ITC joined with Promethean to set up thermal-based rapid milk chillers in 85 villages (65 in Bihar and 20 in West Bengal), with capacities ranging from 500 to 1,000 litres. These customised chillers, with double compartments separating cow and buffalo milk, helped ITC launch additional product lines such as cow ghee and cow milk, while using the buffalo milk for pasteurised milk packets. Following this success, ITC is expanding its operations in remote villages, bringing additional farmers into the formal dairy supply chain and helping to build dynamic local economies.

“Association with Promethean has helped us procure high-quality milk at a competitive cost, allowing the separate chilling of cow and buffalo milk in the same tank simultaneously, that fits our unique requirements. Our energy costs have fallen despite operating at a smaller scale, and remote, real-time performance monitoring enables agility in the supply chain.”

Sachin Sharma, General Manager Channel Operations (agribusiness), ITC



Success factors for replication and scalability

- **Targeting large, quality-focused companies:**

Promethean’s vision is to eliminate food loss in low-income countries by providing end-to-end cold-chain solutions. Promethean is currently working with 15 large customers, including top Indian dairies Amul, Hatsun, ITC, Mother Dairy, Fonterra, Parag, online fresh-meat supplier Licious, Green Tokri, and the Akshayakalpa organic dairy. Along with focusing on the top 40 dairies in India and Bangladesh, Promethean plans to increase its activities in other segments of the cold chain, including reefer trucks, cold rooms, and temperature-controlled delivery boxes. With these solutions, the company plans to target online delivery businesses for perishables, such as Licious or Akshayakalpa, along with fresh-dairy-product companies such as Epigamia.

- **Constant innovation:** The company believes that continuous technological improvement of the product and of the company’s services will produce remarkable results. Promethean invests considerable efforts in making its products easy to operate and are more efficient. The goal is for customers to make Promethean products and services a vital part of their core operations, thus allowing the company to achieve greater scalability and resiliency.

LAST-MILE AGENT NETWORK

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Key challenges

Textile production is the second-largest generator of rural employment in India, after agriculture and women making up most of the workforce. Working conditions in the silk production sector are often arduous, for example, due to the practice of thigh silk reeling, a traditional technique that frequently results in hand and thigh injuries. The process itself is inefficient, and the outcome unpredictable. Additionally, the lack of market linkages³⁰ for raw material procurement and sale of finished goods, and insufficient information about broader market conditions prevent weaver communities from moving beyond reeling to capture a larger share of the value chain.

Large productive-use appliances such as power looms and weaving machines require electricity, regular and intensive maintenance, and customer service. Gaining access to such services is difficult in rural areas, as communities lack an efficient ecosystem of service providers that offer these services. Companies selling these machines thus need to find ways to ensure the provision of last-mile customer support, servicing, and customer education. Companies working in rural areas often provide such services as an aspect of their product offerings; unfortunately, this adds to their costs and reduces margins and inhibits growth prospects over time. This approach also limits the resilience of the local communities, as they become dependent on the operators.

Innovative organisations such as SEWA Lucknow have produced new technologies such as highly efficient power looms that can help these weaver communities increase their output. However, enormous gaps in distribution, after-sales support, and the

³⁰ The market linkage refers to trade relationships between the target population - small producers, local firms and cooperatives, and the external market.

CASE STUDY COMPANY

Resham Sutra

PRODUCTIVE APPLIANCE

Silk reeling machines

SIMILAR BUSINESS MODEL INNOVATIONS

Sakhi Retail, Frontier Markets, Jaipur Rugs, and Dharma Life

availability of customer services remain. A robust last-mile service and distribution network is also essential to develop relationships of trust with customers, and to ensure the provision of ongoing feedback regarding the products and services.

Additionally, it is equally important to establish trust within remote communities in order to foster strong partnerships and develop a service-based model, as such communities depend highly on word-of-mouth marketing. If service providers and distributors that are physically distant from these villages do not understand local market characteristics, this may result in a loss of customers, adding to these firms' operational costs.

About the innovation

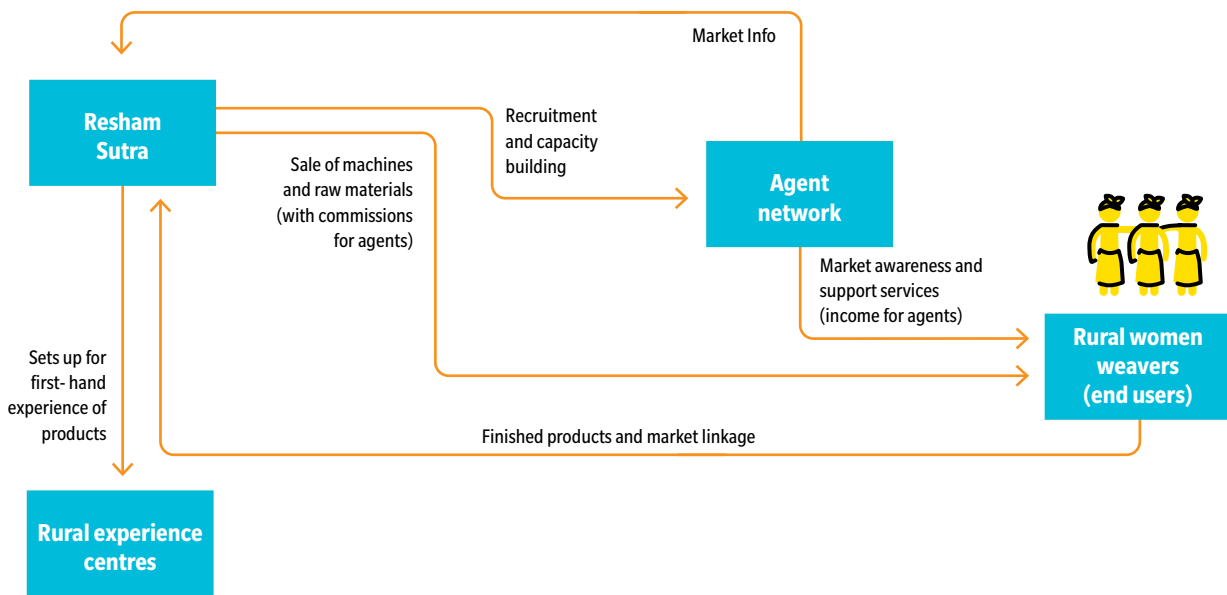
Research into successful companies shows that business models focusing on low-income consumers in remote areas need to consider innovative, cost-effective, culturally sensitive after-sales customer-engagement solutions. Last-mile agent networks and last-mile experience centres, both of which are pillars of Resham Sutra's business model, are relevant innovations here.

The company's model involves identifying individuals within the target neighbourhood who can serve their communities directly as distribution and customer-service agents. These agents are trained to be the company's eyes and ears on

the ground and serve multiple functions. For example, an agent's role ranges from providing after-sales support and maintenance to engaging in marketing and collecting field feedback. For the community, this results in a swift, affordable service that is culturally acceptable. Community members see the company representative as an insider whom they can trust, and who speaks their language. The company benefits in terms of lower operating costs and greater market penetration, thus increasing resilience.

Providers of renewable energy products such as solar lamps, cookstoves, and solar home systems in rural areas of Africa and Asia have successfully implemented such agent models for the purposes of distribution and servicing. Resham Sutra's experience shows that a similar model can produce a win-win situation in the context of productive appliances if the manufacturer provides the right engagement and support structure for its agent network.

Illustration of business model innovation



Beyond conventional business factors such as access to finance and technology enablers (support services), success factors for agent networks in India include cultural sensitivity and geographical proximity to the communities. Organisations such as Sakhi Retail, Frontier Markets, Jaipur Rugs, and Dharma Life use a last-mile agent-network model to connect remote low-income consumers with their products and services. However, most organisations face challenges in the form of high agent attrition rates and management difficulties.

To make the partnership financially viable, Resham Sutra provides its agents with multiple income-generating activities, such as operating the machines and training other agents. Moreover, it provides them with growth opportunities within the organisation, allowing them to increase their incomes over time, which in turn helps to lower the attrition rate. It has been helpful for Resham Sutra to work in partnership with trusted local organisations such as Astitva Mahila Samiti in Chattisgarh and women self-help groups (SHGs) in Madhya Pradesh to identify agent candidates and manage its agent network. A strong and committed agent network that ensures last-mile reach and community engagement is one key to the resiliency of the company and its business model.

Background

The handloom industry is the second-largest employment generator in India, just after agriculture. There are an estimated 2.67 million weavers in India,³¹ 440 thousand of whom are involved in silk production (tassar, muga, and mulberry). 78% of these weavers live in remote rural areas, and about 70% of the workers engaged are women (Handloom Census 2019-20³²). A woman silk weaver earns as low as \$40 a month, often lack market linkages, which isolates them from support services, financing mechanisms, and technology that could improve their productivity and enable growth.

The Indian government has several initiatives that aim at improving the condition of weavers, focusing on technology enhancements, credit access and subsidies, and marketing support. However, despite the implementation of measures such as the National Handloom Development Programme and the Handloom Weavers Comprehensive Welfare Scheme (HWCWS), a large percentage of weaver households continue to earn less than INR 5,000 (USD 90) per month, and thus live below or close to the poverty line.

These low-income levels fail to motivate the youth to join the industry. The average number of weavers per household in Indian weaver communities decreased from 1.28 to 1.05 between 2010 and 2020.³³

31 According to the 2019-20 Handloom Census.

32 Fourth All India Handloom Census - <http://handlooms.nic.in/writereaddata/3736.pdf>.

33 Fourth All India Handloom Census - <http://handlooms.nic.in/writereaddata/3736.pdf>.

CASE STUDY

RESHAM SUTRA

Empowering women by generating income and raising productivity through the use of an agent network



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Resham Sutra at a glance

Resham Sutra has introduced innovative equipment and practices for rural textile producers. The company manufactures innovative solar-driven weaving machines and has set up community-level agent networks and market linkages, thus providing a comprehensive ‘farm to fabric’ ecosystem for women silk weavers. The agent networks produce an end-to-end support system that provides women weavers access to finance and technology, as well as business and technical support services. The business model innovation thus improves these silk weavers’ productivity and efficiency, which has a positive impact on their lives.

Comprehensive customer support through Resham Sutra’s grassroots agent network

Resham Sutra has supported silk weavers in rural India since 2015 by providing an integrated solution that includes highly efficient solar-powered machines, a custom field-based training programme, and an agent-based distribution and after-sales service (and feedback) model. The company has developed a suite of solar-powered spinning (Unnati), reeling (Buniyaad and Sonalika), and weaving machines for silk yarn production in collaboration with India’s Central Silk Board, providing a comprehensive approach and end-to-end ecosystem for silk weavers. These weaving machines typically run on three-horsepower motors (as per the required speed), and cost between USD 2,000 and USD 3,000 based on the

Key figures

- Key geographies: Northeastern states of India (eg Sikkim, Jharkhand, Bihar, Orissa, and Chhattisgarh)
- Team: 22 staff members
- Turnover (2019): USD 606,000
- Installed silk reeling machines (2019): 12,000 units
- No. of beneficiaries (2019)³⁴: 12,000 silk workers
- Year founded: 2015

Business model innovation

- Products: Five product lines for spinning, twisting, and reeling, as well as a loom supported by an agent network of service providers.
- BMI: Last-mile agent network
- SDGs addressed:



Contact details

- Website: www.reshamsutra.com
- Kunal Vaid, CEO

level of customisation required. The 2.5-kilowatt solar plant costs an additional USD 1,200 to USD 1,500 and ensures a steady supply of power or serves as an adequate backup supply (if required).

³⁴ <https://ashden.org/winners/resham-sutra/>

“The technical requirements of products like ours and the remote locations of customers necessitate innovations in last-mile service-delivery models. This model is now a pillar of strength for our company.”

Kunal Vaid, CEO, Resham Sutra

Early in their business journey, Resham Sutra’s founders realised that to be successful while creating sustainable impact and building community resiliency, their product needed to be a part of a more extensive suite of services. They observed that many end users often undervalued their products in the absence of proper demonstrations and last-mile engagement. Additionally, they noted that most servicing needs and equipment repairs could be handled at the local village level with some basic training and the provision of standardised tools and protocols, thus saving significant money by eliminating unnecessary travel by technicians. The company’s managers further realised that the weavers would need regular on-the-ground education and capacity-building programmes in order to use the equipment effectively. It was also deemed essential to cultivate relationships of trust at the local level so as to prevent gender issues from interfering with the provision of accurate and consistent feedback.

The company saw this as an opportunity to create a grassroots-level agent network in which trained local representatives would provide servicing, regular maintenance, and other after-sales support. A secondary benefit of the model was that it also provided income-earning opportunities for community members, thus further improving their quality of life, and increasing their willingness to engage with the company. Over time, the community agents have become Resham Sutra’s eyes and ears on the ground, helping the company manage last-mile quality control while reducing defects and issues further downstream in the value chain. Information flow has become more effective, with vital communication taking place from and within the community; this allows the company to iterate its products continuously and develop innovations based on bottom-up needs. The strong connection with the local communities thus enhances Resham Sutra’s resiliency, enabling last-mile product distribution and maintenance as well as constant product innovation based on regular feedback, making the products more relevant for community use.

The agent-network process starts with the identification of groups of people from the community who want to participate in the initiative. Resham Sutra does this in two ways:

1. advertising among their customers, who help spread the word and provide recommendations;
2. soliciting suggestions from existing agents and partner NGOs that have connections in the target community.



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The typical agent profile includes young men or women who have graduated from high school and have prior experience working with yarn or fabric (to date, the majority have come from weaver families, with mothers or sisters working as producers). Following identification, the potential agents receive a stipend to train for three weeks at a Resham Sutra branch location. The training modules are divided into topics including technical troubleshooting, customer service, sales and marketing, and soft skills, with Resham Sutra tailoring the program to fit the participants’ background and cultural sensitivities. Following graduation, the agents return to their communities. They regularly engage with the women weavers, visiting them at their homes to provide them with support services while also updating them on company data, available government schemes, and other relevant information. The agents earn commission on the sales of machines from the company, and charge fees for the technical services they provide. The agents are also always accessible to the women producers via a phone call. To date, the company has deployed 42 agents/technicians spread across more than 15 villages in Jharkhand and Chhattisgarh, collectively supporting more than 1,000 weavers.

Leveraging the success of these agent networks, Resham Sutra has also started experimenting with rural experience centres. These centres are typically located in large villages of 5,000 households or more, acting as hubs where users can gain first-hand experience using the different machines, while additionally accessing services and training. Resham Sutra is also using the experience centres to expand its agent network, drawing on existing agents to train newly identified agents. The organisation is additionally bringing more women into the agent network by partnering with NGOs that work with women.



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Impact

Community: Resham Sutra has impacted more than 12,000 silk workers to date. Thanks to the network's support, the women have increased their productivity levels, as they are better equipped to use the solar-powered machines. Weavers' incomes have on average doubled from USD 40 per month to USD 80 per month, and this increased income has allowed the women to invest more time and money in their children's education, healthcare services, and home improvements, therefore improving their overall quality of life and social status. In addition, as the women are making economic contributions, they are gaining greater decision-making powers in their households and communities and have developed leadership and organisational skills. Resham Sutra has also helped create additional livelihood opportunities for agents and trainers from the communities it serves. This service-model approach builds strong partnerships with local organisations, thus increasing resiliency for the organisation while building self-reliant communities.

Organisation: The organisation currently employs 22 people in its headquarters and maintains about 42 agents at the local level. This network has enabled Resham Sutra to penetrate hard-to-reach areas and scale its operations. In addition, the network allows the company to save on the costs associated with regular field visits.

Environment: Resham Sutra's solar-powered machines each offset nearly 850kg of greenhouse gas emissions per year, produced by diesel-based machines, in total leading to an estimated GHG offset of 7,000 tonnes annually. The company has also been able to use its renewable energy technology to run power looms that would typically use diesel generators.

Spotlight on beneficiaries

Resham Sutra is empowering rural women by enhancing self-employed reeling, spinning, and weaving opportunities in India's north-eastern states, mainly Sikkim, Jharkhand, Bihar, Odisha, and Chhattisgarh.

"Previously, I had a lot of back pain from sitting on the floor thigh reeling. I had cuts to my hands and the skin on my thigh, my right leg was sore from the wooden spindle resting on it, and my arm hurt from turning it. I feel so much better now I can use the Buniyaad [reeling machine]." - Gitanjali Das, silk weaver, Fakirpur, Odisha.

Tuni Das is a weaver from Odisha. She and her two daughters reel silk for a living, and for several years used thigh reeling techniques that hurt her hands and thighs. Today Tuni uses solar-powered reeling machines from Resham Sutra and can continue spinning even if there is no electricity from the grid. After purchasing one machine, she found that it produced more silk thread than she could generate by hand, in fewer hours. She now buys cocoons,

reels thread, and sells it to nearby shops for more money. With her increased income, she is able to pay school fees for her daughters' education, buy more raw material, and even manages to save money. She currently owns two machines, and soon aims to buy five more so as to increase her income and fund a grand wedding for her daughters.

"Around 300 women reel silk in my village. We all reel at home, and youngsters are also joining us in this traditional art. The community lives happily, as we all make more money now, and are contributors to our families' income." - Tuni Das, weaver, Odisha.

"I joined the Resham Sutra network through Astitva Mahila Samiti in 2016. I was involved in household chores at that time for most of my day and had little or no say in major family decisions. Today, I am an approved master trainer for the Central Silk Board, Bangalore, and draw a monthly salary of INR 21,000. I feel independent and empowered, I am a contributor, and am no longer a dependent." - Shail Kashyap, trainer, Chhattisgarh.



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Spotlight on partnerships

Resham Sutra sees partnerships as the key to reaching consumers within its target market, who typically belong to the base of the income pyramid. The company has worked with NGOs and social enterprises such as Astitva Mahila Samiti to reach out to weavers and help develop its pool of trainers. These organisations have developed high levels of trust within the communities they serve; this factor has been crucial for Resham Sutra in helping to raise awareness of the advantages of the company's products, and in the assistance, they provide at training events.

Bastar, a district in Chattisgarh, is fertile and known for silk production from silk forms, a practice known as sericulture.³⁵ However, most of the local population had little knowledge of thread reeling and processing, which significantly undermined the community's ability to generate income. Resham Sutra recognised this market gap, and identified silk thread reeling as a potential source of steady, growing income for members of this rural population, especially woman. In 2016, the company joined forces with Astitva Mahila Samiti, a local NGO, to provide training, technical repair, and support for solar-powered reeling machines, sold on the basis of easy-to-manage instalments. It also helped the community extend its market linkages. Since then, the association with the NGO has grown stronger. One remarkable achievement has been the installation of 100 reeling machines in Bilaspur's central jail in 2017, after which the two organisations worked together to train women prisoners in their use, giving them skills that would help them earn a livelihood after completing their sentences. The convener of the NGO, Ms Pooja Verma, was afterwards given special recognition by India's government for her work in building institutions.

Again, in partnership with Astitva Mahila Samiti, Resham Sutra is now opening an experience centre called Resham Sewa Kendra in Jagdalpur (district headquarters of Bastar), with the aim of producing textiles under a new brand.

³⁵ Sericulture is the production of raw silk by means of raising caterpillars (larvae), particularly those of the domesticated silkworm.



Success factors for replication and scalability

Agent network: Resham Sutra sees the agent network as playing a role beyond simply providing local communities with service agents. The company plans to expand the agents' functions, giving them responsibilities in the areas of raw-material procurement, end-product marketing, sales, and holistic capacity-building, and in some cases working with the rural experience centres. The company sees the agents as critical actors helping to increase the organisation's resilience and enhance sustainability at the local community level. Resham Sutra is also exploring other ways of scaling its current model, in part by helping its agents become trainers, adopting a 'train a trainer' approach. The agents are thus given an incentive to find potential new agents for the network, and to train them in the skills needed to play this role. This growing network of agents is helping Resham Sutra expand its customer base in new areas.

Government schemes and access to finance: Government subsidy programmes and financial-support measures such as the Pradhan Mantri Mudra Yojana, the National Handloom Development Programme, and the Handloom Weavers Comprehensive Welfare Scheme have helped to sustain the company's growth and have made replication of the business model possible. The subsidies play a significant role, as they encourage entrepreneurs and agents to join the sector.

Partnerships: The company is a strong advocate of scaling through partnerships. It has collaborated with other actors in the sector in a variety of ways, ranging from procuring the machines for the women and sourcing the raw materials for their work to creating a market for the finished products. Resham Sutra partners with farmer cooperatives to procure raw materials, works with NGOs for functions such as agent management and community engagement, and cooperates with government agencies such as Jharcraft (Jharkhand), Serifed (Odisha), and the Ministry of Textiles (government of India) to ensure sale of the finished products and establish stronger market linkages.

Interview list

Organisation	Interviewee(s)
Ajummery Bikas Foundation	Subarna Kapali Ashma Vaidya
Boond	Kunal Amitabh
Claro Energy	Kartik Wahi Gaurav Kumar
DESI Power	Aklavya Sharan

Organisation	Interviewee(s)
Practical Action	Pooja Sharma
Promethean Power Systems	Jofi Joseph Sachin Sharma
Resham Sutra	Kunal Vaid
Sakhi Retail	Upmanyu Patil

Bibliography

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