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Sustainable energy for all?

Linking poor communities to modern energy services

WORKING PAPER NO 1

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2012

www.iied.org

IIED Sustainable Markets Linking Worlds Series

The Linking Worlds paper series looks at innovations in linkages between small scale/low income producers and service providers and modern formalised markets. The case studies highlight the importance of networks, intermediaries and/or facilitators in supporting market linkages that work for broader livelihood benefits and sustainable use of natural resources in textiles, energy and payment for environmental services. Case studies continue to be collected and will include a study looking at the small scale mining sector and the agricultural sector. Each paper highlights key characteristics or design features of these innovative linkages and advises on how the models might be replicated.

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ISBN 978-1-84369-865-4

Order no 16038IIED

Front cover: A girl studies under the light of a rechargeable solar lamp. Without the lamp she couldn't study at night as her home in Natore, Bangladesh has no access to electricity. Photo: G.M.B. Akash/PANOS

Sustainable energy for all? Linking poor communities to modern energy services

Emma Wilson, Rachel Godfrey Wood and Ben Garside

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Acknowledgements

We would like to thank our colleagues Abbi Buxton and Essam Yassin Mohammed for assistance in developing the ideas in this paper, and to Laura Jenks and Kate Lewis for managing the production process. We are very grateful to members of the DELiVER network of practitioners and researchers who have collaborated on thinking around energy delivery models, especially Ewan Bloomfield and Mattia Vianello of Practical Action Consulting, Raffaella Bellanca and Kavita Rai. Many thanks also to the experts that were interviewed for this paper, R.M. Amerasekera of Integrated Development Association, Sri Lanka; Namiz Musafer of Practical Action; Andrew Tanswell of Tough Stuff; Ned Tozun of d.light; and Annabel Yadoo, formerly of the Centre for Sustainable Development at the University of Cambridge. We would also like to thank Bill Vorley (IIED) and Andrew Scott (ODI) for very useful reviews of an earlier version of this paper.

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Executive summary

Linking small scale producers from developing countries into more formal markets to sell their goods can be difficult. The same is true of enabling low-income consumers to buy goods and services, such as efficient cookstoves, solar lamps or electricity, that are available in more developed markets. *Linking Worlds* is an IIED research paper series that looks across sectors – agriculture, mining, energy and textiles – at innovative organisational models that engage with small scale producers or low-income consumers to achieve greater fairness and equity.

The UN Sustainable Energy for All initiative, launched in 2012, places huge emphasis on the role of the private sector in delivering universal energy access. However, it is clear that achieving this ambitious goal will require a mix of actors – public and private sector and civil society – as well as new innovations in energy delivery models.

This paper, *Sustainable energy for all? Linking poor communities to modern energy services*, explores innovations in energy delivery models and multi-sectoral partnerships to deliver affordable and sustainable modern energy services to the poor. 'Energy delivery models' refer to the combination of technology, finance and management needed to supply energy to users. The delivery model can be designed as an enterprise, development project or a government programme, but innovations in the key elements of the model will help ensure positive sustainable development impacts.

The paper offers a tool for analysing the "pro-poor energy delivery system". This framework distinguishes between the ***delivery model*** itself and two key contextual elements that influence the design of the delivery model: the ***enabling environment*** of policy, regulations, incentives and established services such as financial services; and the ***socio-cultural context*** that encompasses local cultural preferences, awareness of technologies, local leadership and social organisation, and community cohesion or levels of conflict. These contextual factors determine not only the design of the delivery model, but also the need for ***additional support services*** to enable start up or scale up operations.

A business school tool, Osterwalder's ***Business Model Canvas***, is used to map the energy delivery model itself. Central to this is a "value proposition" which, in the case of models that benefit the poor, explicitly incorporates social and environmental value as well as more traditional economic value. Within the pro-poor delivery model conceptualised here, value is created not only for consumers but also for producers and distributors in the chain – many of whom may be part of the informal sector. Distribution channels for energy products and services are particularly important in reaching rural and outlying communities. The additional support services needed to get a model up and running might include micro-finance, awareness raising or skills training. These require targeted resources and explicit recognition in the design of the delivery model.

The four case studies explored in this paper look at a range of energy delivery models and show how they have been adapted to help deliver affordable and sustainable energy services to poor customers. The case studies were selected to illustrate a range of energy products and services, diverse socio-cultural contexts, various business models and partnerships, and varying degrees of formality in the markets under consideration. All of the case studies reveal the challenges of reaching the very poorest even with pro-poor innovations put in place.

The four case studies explored in the paper are:

- The Project for Renewable Energy in Rural Markets (PERMER), Argentina
- Portable solar product companies (Tough Stuff and d.light) in southern Asia and sub-Saharan Africa
- The Anagi stove in Sri Lanka
- Micro-hydro development in Nepal (the Rural Energy Development Programme)

The paper highlights a number of lessons:

1. **Private sector interventions alone often cannot reach the poorest of the poor**. 'Business as usual' is unlikely to reach the poor as profit margins and time frames are less attractive. Pro-poor models usually require 'non-traditional' business partners, such as government, non-government organisations, enterprise associations, social enterprises and communities themselves. A key challenge is targeting government and donor support to stimulate and enhance private sector involvement.
2. **Understanding the socio-cultural context is important in designing models that reach the poor**. This research highlights the importance of understanding the socio-cultural context. This understanding may help identify new entry points for the poor and ways of capturing their dynamism and innovation in designing products and services that meet local preferences. Designing a model that incorporates local preferences and expectations – such as women's views on health and the commercialisation of fuelwood – can be a short term investment that ensures the long term viability of the model.
3. **The success of energy access initiatives should be measured in terms of development benefits** not the number of households connected to the grid or efficient cookstoves distributed. The 'indicators of success' should be defined with the end-users and reflect the development benefits generated by access to energy, such as improved health, education and livelihoods.
4. **Lack of knowledge and understanding of delivery models is a key obstacle to investment.** There is a need for more systematic analysis of delivery models, in order to provide investors, governments and donors with evidence of their impact, financial sustainability and potential return on investment.
5. **Employing business analysis tools to in-depth case studies can be an effective way to highlight pro-poor innovations within a delivery model** in a way that doesn't compromise the key elements of a sustainable enterprise. Central to our model is the use of a value proposition that incorporates social and environmental as well as economic value. Applying such tools to in-depth case study analysis, along with development tools such as 'market mapping', allows us to analyse the appropriateness of a particular energy delivery model within a specific context. This approach also highlights the risks of replicating 'successful' delivery models when contextual factors are uncertain or inappropriate to a given model. The framework developed in this paper can be explored further to identify and categorise contextual factors to allow for more systematic analysis.

By exploring how 'energy delivery models' – involving public, private and civil society actors – can deliver fair and inclusive benefits to the poor, we can inform efforts to ensure that energy access interventions and enterprises are able to deliver lasting development impacts.

1. Delivering energy to the poor

Access to sustainable modern energy services is essential for the well-being and development of society. Electricity underpins health services, education and livelihoods in many ways, such as refrigerating vaccines, providing light and information technology, powering small-scale machinery and lighting trading kiosks. Irrigation and mechanisation can transform agricultural practices, while modern cooking methods and efficient stoves can improve health and reduce the time spent gathering fuel wood, allowing women and children more time for education, enterprise or greater social and cultural interaction.

Access to energy is highly unequal at both the global and local levels. In global supply chains high-value resources such as oil, gas, biofuels and rare earth metals are often sourced in less-developed countries for the benefit of wealthier populations; while national governments often prioritise support for grid electricity that does not reach poor or rural communities. One in five people around the world lack access to electricity, and around 40 per cent lack the technology to make cooking fuels clean, safe and efficient.

In 2012, the United Nations launched the Sustainable Energy for All initiative (SE4ALL) to promote universal access to modern energy services and support energy efficiency and renewable energy. The private sector is expected to fill gaps in the funding and skills needed to meet the SE4ALL goals, with scalable business models designed to tackle the challenges of delivering affordable and sustainable modern energy services. The International Energy Agency (IEA) maintains that a 3 per cent increase in global energy investment could make universal access to energy achievable by 2030. While the private sector can certainly make a significant contribution in this respect, delivering modern energy services to the poor also requires substantial involvement by governments, donor agencies, non-governmental organisations (NGOs) and social enterprises, using energy delivery models that link the poorest consumers to energy products and service markets.

Delivering sustainable modern energy services to the poorest sectors of the population requires innovative *design* and *support* for energy delivery models. This paper analyses certain aspects of delivery model design, such as the choice of technologies, payment systems and management and maintenance arrangements, and additional support services like start-up finance, micro-finance for end-users and skills training. We also consider the context in which energy is delivered – the enabling policy, regulatory environment and socio-cultural context of local norms and practices – and how it affects successful delivery of energy services.

Section 2 outlines the framework for this analysis, starting with the four 'building blocks' of a pro-poor energy delivery system: the socio-cultural context, the enabling environment, the delivery model itself, and the additional support services needed to make the delivery model work in a given context. We also employ a more detailed tool to analyse the delivery model and support services – Osterwalder's 'business model canvas'.

Section 3 presents four case studies of products and services that target poor communities in a range of socio-cultural contexts. In line with the *Linking Worlds* theme, we focus on those aspects that connect poor consumers to energy markets and allow the poor greater access to energy supply chains as producers and distributors. Finally, we consider whether these models are 'successful' (as defined by various stakeholders) and if so, how they have succeeded. Section 4 is a reflection on the extent to which our analytical tools helped us understand key elements of the models that contribute to their success or failure in achieving the desired goals. Our conclusions reflect the key findings from the case studies and offer some pointers for future research and action.

2. Analytical framework

The specific focus of this paper is a 'pro-poor' energy delivery system, considered through an analytical framework that concentrates on the **energy delivery system** and the **energy delivery model** that operates within it. This framework allows us to identify key elements of the system and delivery model that can facilitate the delivery of energy services to the poorest people, and determine the roles played by various actors in the system.

What is an energy delivery model?

There is still no agreed definition of the term 'energy delivery model', despite its increasing use in international development and public service delivery. The term has evolved out of research and practical work on access to energy, which has focused on market mapping and business model design, and explored models of public service delivery (see, for example, Albu and Griffith, 2006; Wilson *et al*., 2008; Practical Action Consulting, 2009; Yadoo, 2012; Bloomfield, 2012; Renewable World, 2012; Bellanca *et al*., forthcoming). The PISCES energy access programme[1] has also designed an analytical 'energy delivery model tool' to assist planners and designers of energy access projects.[2]

This paper defines an energy delivery model as the combination of technology, finance and management required to supply energy to users. This includes sourcing energy resources, conversion and processing, distribution (of products or power) and relations with end users. The design of this process needs to consider governance, management and ownership structures, and the chosen financing options and payment systems (product pricing or tariffs). The delivery model may be implemented by an enterprise, a development project or a government programme. There is usually a lead implementing organisation that has ownership of the model, which could be a business, social enterprise, co-operative or government agency, or an NGO or international development agency responsible for implementing a project.

The analytical framework is made up of two parts:

- **A map of the energy delivery system** showing its four key 'building blocks': the enabling environment, socio-cultural context, energy delivery model and support services (see below); and
- **A tool for analysis of the delivery model and additional support services**. In this instance, it is the Osterwalder business model canvas (see below).

Our map of the pro-poor energy delivery system is derived from the 'market map' developed by Practical Action and IIED's 'chain-wide learning' approaches, which are briefly outlined below. It also owes much to collaboration with Practical Action Consulting, GVEP International, HEDON Household Energy Network and Cambridge University, in a book entitled *Delivering Energy for Development* (Bellanca *et al*., forthcoming).

Market mapping was initially developed by Practical Action in the context of its work on agricultural market chains (Albu and Griffith, 2006). It is used to show the market actors (those involved in implementation, including supply chain partners and contractors), the enabling environment (which includes socio-cultural factors) and the supporting services involved, in order to develop a better understanding of the institutions, services and relationships needed to make market systems work, and identify those elements that help the value chain or delivery model serve the poor. Maps are often developed through a participatory process involving market actors, as a way of stimulating discussion and reflection on how to influence markets and increase opportunities for poor producers. Practical Action's market mapping approach proved effective in the analysis of bioenergy markets in the context of the PISCES energy access programme (Bloomfield 2012),[3] and has been adapted for broader analysis of energy delivery models in the book *Delivering Energy for Development* (Bellanca *et al*., forthcoming).

A similar approach, known as **'chain-wide learning'**, emerged from IIED's Regoverning Markets Programme (Vermeulen *et al*., 2008). This approach focuses on agricultural value chains, and aims to determine how they can be made more inclusive of small-scale agricultural producers. The core methodology involves mapping the value chain and

1 *Policy Innovation Systems for Clean Energy Security (PISCES) (http://www.pisces.or.ke/)*

2 *See: http://practicalaction.org/consulting/pisces/*

3 *See also: http://www.pisces.or.ke/*

identifying the main actors and flows of products, money and information. This exercise helps determine where value is created along the chain, and how different actors make a profit. Key policies and institutions (the enabling environment) are also mapped, as they influence the functioning of the value chain and the inclusion or exclusion of small-scale producers. Key drivers, trends and issues affecting the value chain are also identified, and future market development scenarios are explored. Options for greater inclusion of small-scale producers are considered, and strategies developed to support changes in policies and institutions in the public and private sectors and civil society.

Our 'energy delivery system' covers similar ground. It also separates the socio-cultural context from the enabling environment in order to highlight a set of factors that influence delivery (often at a more local level than regulatory/policy factors) but that are frequently overlooked. The delivery model is made up a set of functions (rather than actors), with additional support services presented as an extension of the core delivery model – and often representing the difference between 'business as usual' and pro-poor delivery. When combined with the 'business model canvas', the framework can be used in participatory processes similar to the market mapping and chain-wide learning approaches, to identify key elements of the delivery model that can be designed or re-designed to deliver energy to the poorest people.

2.1 Mapping the building blocks of an energy delivery system

Mapping the building blocks of the overall 'energy delivery system' enables us to identify contextual elements that are essential to the effective delivery of energy services. The **socio-cultural context** is often neglected in market analysis, but is central to our energy delivery system map as it is the key to the success or failure of any energy delivery model, especially those intended to deliver energy to the poorest sectors of the population. No less important is the **enabling environment** of regulations and incentives that support delivery through government, policy, market governance mechanisms[4] and financial services.

Another key building block is provided by **additional support services**, which appear as an extension of the **delivery model** itself in our model. This contrasts with a regular market context with more standard or traditional energy technologies, where it is assumed that additional support services are not required because the existing enabling environment is sufficiently supportive (with appropriate government subsidies and incentives or bank credit for start-up enterprises, for example). The socio-cultural context is also assumed to be supportive in a regular market context, with people willing and able to pay for services, and relatively high levels of awareness about relevant energy options and usage. It is worth noting that additional support services will not only be required for pro-poor delivery models, but also for any delivery model that seeks to address existing market failure (as in the early stages of promoting low-carbon energy technologies).

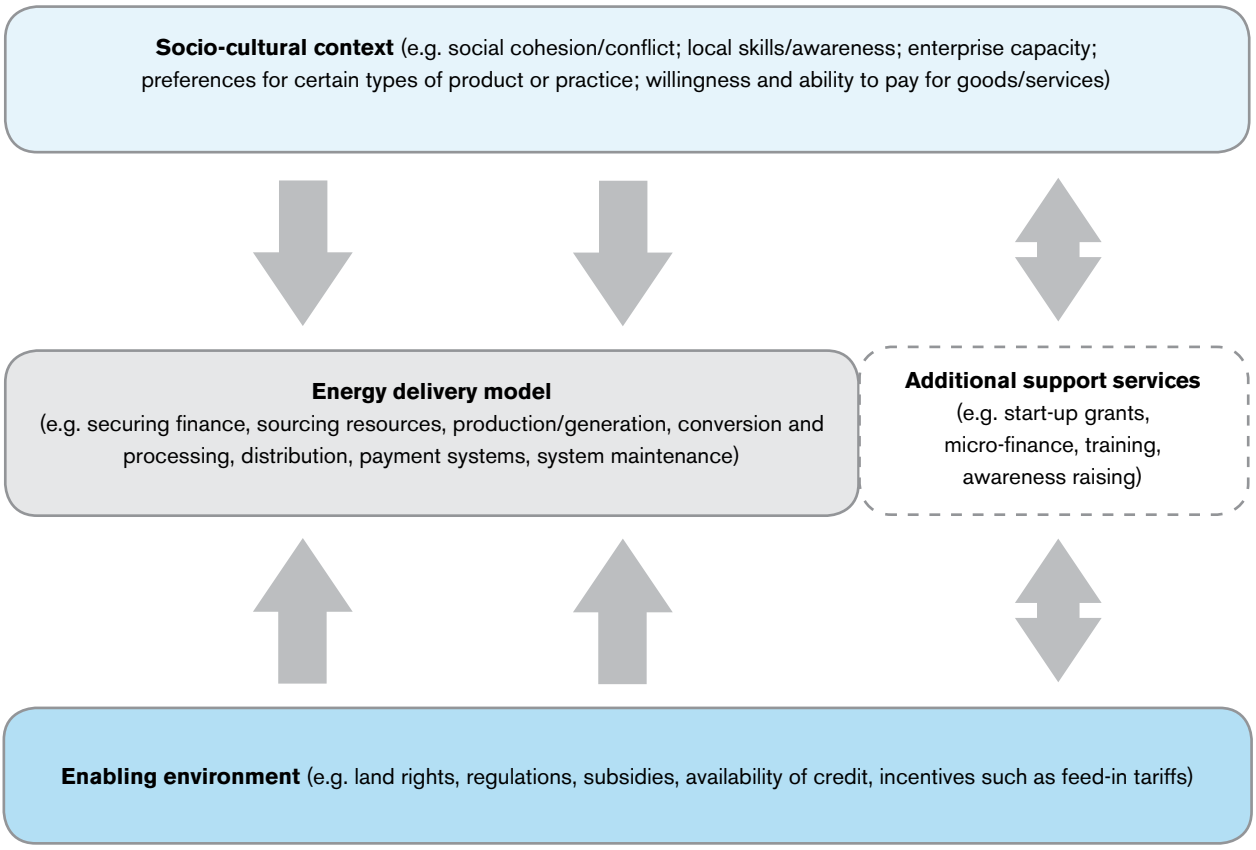
Proponents of pro-poor energy delivery models may need external partners to provide these support services. They are often development partners rather than regular market actors, ranging from governmental and international aid agencies to micro-credit facilities and non-governmental organisations. These partnerships and the additional services they provide often make the difference between 'business as usual' and a delivery model that can meet the needs of the poorest.

The four key building blocks of our energy delivery system shown in Figure 1 opposite are:

1. **Socio-cultural context:** The socio-cultural context of the host community and broader society are critical to successful energy service delivery and the feasibility of replicating or scaling up operations. People's willingness to pay for energy services, awareness of energy options, adoption and maintenance of new technologies and use of energy are influenced by factors such as levels of community cohesion, cultural preferences (cooking methods, etc.), expectations of public service delivery, local skillbases and leadership structures.
2. **Enabling environment:** The enabling environment is determined by government and policy regulations and incentives that support service delivery. This includes economic policies and laws, trading and quality standards and other regulations, rights of access to land and natural resources, the financial services provided by banks and financial service agencies (credit and guarantees, etc.) and policy incentives such as feed-in tariffs. It also includes any relevant voluntary private sector governance initiatives, such as certification and standards for environmental management systems.
3. **Delivery model:** The delivery model is designed and implemented by the proponent of the energy programme or project, who may be from the public or private sector, an NGO or a social enterprise. As defined above, the delivery model is the combination of technology, finance and management required to supply energy to users, from sourcing, converting and processing energy resources, to the distribution of products or power, and relations with end-users. The design of the model needs to consider governance, management and ownership structures, and possible financing options and payment systems (product pricing or tariffs). It will also be shaped by the enabling environment and socio-cultural context, which will determine whether additional support services are required, particularly when starting or scaling up operations.
4. **Additional support services:** Additional support services are needed to enhance the overall sustainability of pro-poor energy delivery models and overcome specific existing market barriers to starting and scaling up operations. They are often required for a discrete period until an enterprise or programme has become self-sustaining, as with financial support (grants or loans) for purchasing home solar systems, which have high up-front costs but much lower running costs than kerosene lamps or diesel generators. Support services may supplement

4 Market governance mechanisms are the formal or informal rules that change the behaviour of individuals, businesses or governments so that their decisions promote sustainable development (see: http://shapingsustainablemarkets.iied.org/)

Figure 1: Map of the pro-poor energy delivery system



the enabling environment by providing access to micro-credit or other financial support services that are not available in existing banks; or address aspects of the socio-cultural context, such as awareness-raising to increase acceptance of new technologies, training in maintenance skills or lobbying for policy reform. Although these services are often provided by non-government and/or non-profit actors like international development agencies or NGOs, government agencies also have a key role to play in stimulating pro-poor energy markets.

The delivery model and additional support services are seen as separate from, but dependent on and interacting with, the enabling environment and socio-cultural context. They can therefore be analysed together in the way that a standard 'business model' might be analysed, using Osterwalder's 'business model canvas'.

2.2 The business model canvas

Osterwalder's business model canvas sets out the key elements of a business model. As shown in Figure 2 overleaf, it describes the two key functions of the business model as **production** ('production activities', 'resources' and 'key partners') and **marketing** ('customer segments', 'customer relationships' and 'distribution channels'). It was designed to aid analysis of for-profit business models in any sector, to support business innovation and respond to the challenges of evolving markets, technologies and customer preferences.[5]

This canvas is also useful in identifying key elements of a business model where adjustments can result in better outcomes for poorer customers, producers and distributers. Vorley *et al.* (2009) use it to identify areas of an agricultural business model that can be adapted to promote the inclusion of smallholder farmers while not compromising key elements of a sustainable business, such as product integrity ('value proposition') and cost structure. This type of analysis highlights the importance of thinking about non-traditional 'key partners' within the business model framework, particularly partner networks, alliances and linkages, and the need for a good flow of information and knowledge among all participants in the chain. It also demonstrates the importance of understanding the needs of different consumer segments and targeting them with differentiated products.[6]

The key design features laid out in the canvas are discussed in more detail below. We highlight certain aspects of the delivery model design that can improve poor consumers' access to energy; opportunities for the poor to gain access to the supply chain (jobs and enterprise opportunities); and other ways of increasing the overall development impact (broadening the focus from energy access to productive uses and other benefits for livelihoods and well-being). This helps prepare the ground for the case studies presented in Section 4.

5 See: http://www.slideshare.net/Alex.Osterwalder/business-model-innovation-matter (accessed 6.09.12)

6 See: http://pubs.iied.org/G02340.html

Figure 2: Osterwalder's business model canvas

The Business Model Canvas

Designed for:

Designed by:

On Day Month Year

Iteration: No.

Key Partners

Who are our Key Partners?
Who are our key suppliers?
Which Key Resources are we acquiring from partners?
Which Key Activities do partners perform?

MOTIVATIONS FOR PARTNERSHIPS:
Optimization and economy
Reduction of risk and uncertainty
Acquisition of particular resources and activities

Key Activities

What Key Activities do our Value Propositions require?
Our Distribution Channels?
Customer Relationships?
Revenue streams?

CATEGORIES
Production
Problem Solving
Platform/Network

Key Resources

What Key Resources do our Value Propositions require?
Our Distribution Channels?
Customer Relationships?
Revenue Streams?

TYPES OF RESOURCES
Physical
Intellectual (brand patents, copyrights, data)
Human
Financial

Value Propositions

What value do we deliver to the customer?
Which one of our customer's problems are we helping to solve?
What bundles of products and services are we offering to each Customer Segment?
Which customer needs are we satisfying?

CHARACTERISTICS
Newness
Performance
Customization
"Getting the Job Done"
Design
Brand/Status
Price
Cost Reduction
Risk Reduction
Accessibility
Convenience/Usability

Customer Relationships

What type of relationship does each of our Customer Segments expect us to establish and maintain with them?
Which ones have we established?
How are they integrated with the rest of our business model?
How costly are they?

EXAMPLES
Personal assistance
Dedicated Personal Assistance
Self-Service
Automated Services
Communities
Co-creation

Channels

Through which Channels do our Customer Segments want to be reached?
How are we reaching them now?
How are our Channels integrated?
Which ones work best?
Which ones are most cost-efficient?
How are we integrating them with customer routines?

CHANNEL PHASES:
1. Awareness
How do we raise awareness about our company's products and services?
2. Evaluation
How do we help customers evaluate our organization's Value Proposition?
3. Purchase
How do we allow customers to purchase specific products and services?
4. Delivery
How do we deliver a Value Proposition to customers?
5. After sales
How do we provide post-purchase customer support?

Customer Segments

For whom are we creating value?
Who are our most important customers?
Mass Market
Niche Market
Segmented
Diversified
Multi-sided Platform

Cost Structure

What are the most important costs inherent in our business model?
Which Key Resources are most expensive?
Which Key Activities are most expensive?

IS YOUR BUSINESS MORE:
Cost Driven (leanest cost structure, low price value proposition, maximum automation, extensive outsourcing)
Value Driven (focused on value creation, premium value proposition)

SAMPLE CHARACTERISTICS:
Fixed Costs (salaries, rents, utilities)
Variable costs
Economies of scale
Economies of scope

Revenue Streams

For what value are our customers really willing to pay?
For what do they currently pay?
How are they currently paying?
How would they prefer to pay?
How much does each Revenue Stream contribute to overall revenues?

TYPES:	FIXED PRICING	DYNAMIC PRICING
Asset sale	*List Price*	*Negotiation(bargaining)*
Usage fee	*Product feature dependent*	*Yield Management*
Subscription Fees	*Customer segment dependent*	*Real-time-Market*
Lending/Renting/Leasing	*Volume dependent*	
Licensing		
Brokerage fees		
Advertising		

Source: http://www.businessmodelgeneration.com/downloads/business_model_canvas_poster.pdf

Customer segments: A pro-poor energy delivery model seeks to serve customers with little or no ability to pay for products and services. The challenge is understanding the target customer segment, assessing the ability and willingness to pay for the required services, and developing goods and services to meet those needs. Our research identified several approaches to this issue, some with product design based on robust participatory market research (Case Studies 2 and 3), and others using an overall cross-subsidy delivery model to serve poorer and less poor customer segments (Case Study 1).

Value proposition: The goods and/or services that an enterprise or programme offers its target customers or clients are known as the value proposition. In this case, it is the delivery of affordable and sustainable energy services to poor communities. Commercial ventures that target poorer users often fail to reach the very poorest among them (Case Study 3), so while it is important to address the needs of the 'slightly less poor', reaching the very poorest remains a key challenge for pro-poor energy delivery models. A pro-poor energy delivery model that is part of a development intervention may also offer broader social and environmental benefits (such as poverty reduction, forest protection, health improvements), in line with the goals of governments, donors, NGOs or social enterprises. The value proposition of a pro-poor energy delivery model often targets not only the end-users, but also the producers and distributors who may benefit from economic opportunities in the value chain. Government programmes may also target voters, while social enterprises may target social investors as key clients who provide investment and support.

Channels: The distribution channels for products and services are a key aspect of energy delivery models. In pro-poor energy delivery models, additional efforts are required to provide services to outlying communities, by extending the grid or through off-grid and mini-grid programmes. As the 'last mile' often presents the greatest challenge for distributers of energy-related products (Bellanca and Wilson, 2012), distribution can be a key area of opportunity for local entrepreneurs who can deliver products to outlying areas (Case Study 2).

Customer (or stakeholder) relationships: Customer relations tend to be more personal in delivery models that target the poorest groups. Research indicates that involving communities more closely in pro-poor energy delivery can enhance the outcomes of energy interventions, by creating a greater sense of ownership and improving the design of products and services (Amerasekera, 2004). Our analysis shows that participation is a key area. Although it can be costly, even limited participation can produce results (Case Study 1). This not only applies to customers, but also to other types of involvement in the value chain and to broader local communities, as they are affected by different aspects of energy delivery interventions.

Revenue streams (or 'benefits'): Every delivery model needs to be able to maintain a sustainable balance between costs and revenues. One of the key challenges for pro-poor models is assessing customers' willingness and ability to pay for goods and services. Therefore, tariff arrangements, product pricing and strategic application of subsidies are all critical in ensuring that a product or service is affordable while covering the costs of production and maintenance. Pro-poor delivery models may differ considerably from the 'business as usual' model in their rates of return, which require businesses and investors to accept lower profit margins and longer time frames. Non-financial benefits (such as job creation or improved health) may also be assessed alongside revenue streams, and constitute an additional 'accounting' stream for a pro-poor delivery model.

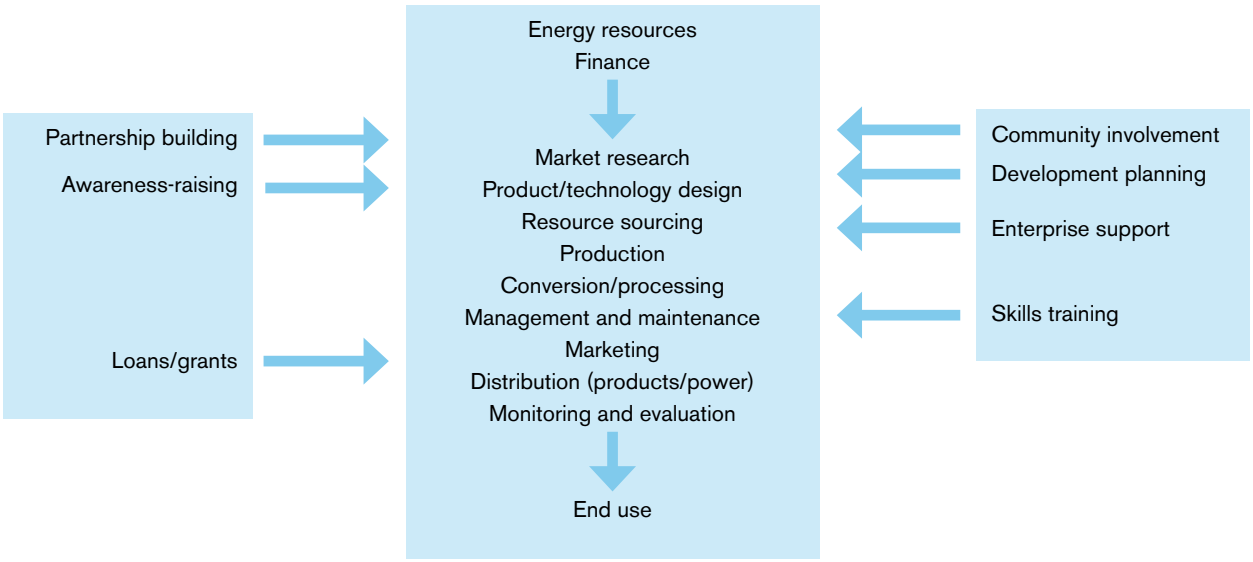
Key resources: These are the physical, intellectual, human and financial resources required to deliver the value proposition. Financial resources are perhaps at the forefront of most people's minds when designing an energy delivery model, and innovative finance and investment are critical in ensuring that pro-poor delivery models are supported and sustainable (Bellanca and Wilson, 2012). It is essential to consider the use of local energy resources (like biomass, water and sun) in extremely poor or isolated contexts where other options, such as constructing large-scale infrastructures, may not be viable. The availability and regulation of these resources are key aspects of the enabling environment and will influence the design of the delivery model. Another major consideration, which has considerable bearing on the development of inclusive local value chains, is sourcing the materials needed to manufacture products or construct infrastructures, and whether intellectual and human resources can be sourced locally. This has the dual benefit of incorporating local knowledge into the design of a product or service and enhancing local development impact (Case Study 3).

Key activities: Standard business model activities include product/technology design, production activities, market research, marketing and management, shown in Figure 3 overleaf. In a pro-poor energy delivery model, activities such as market research and product/technology design may differ from standard processes in that they require in-depth field research or participatory approaches, and additional activities such as skills training and awareness-raising. These additional support services, which are needed to compensate for a lack in the market, are often provided by entities other than the implementing agent.

Key partnerships: As already noted, the partners in a pro-poor energy delivery model may not be conventional business partners. The case studies presented below show that the most effective and long-term energy delivery models for the poorest are designed and implemented through collaboration and partnership with non-conventional business partners. These include government, international development agencies, enterprise associations, NGOs, social enterprises and communities themselves (Wilson *et al.*, 2009).

Cost structure: Affordability is a crucial factor in meeting the needs of the poorest. Therefore, costs need to be kept to a minimum without compromising quality, durability or safety in any way. Subsidies and up-front grants are often required for pro-poor delivery models, especially in the early stages of starting and scaling up operations. It is essential to ensure that ongoing (usually government) subsidies are sustainable (Case study 1).

Figure 3: Example of possible key activities



2.3 What makes a delivery model successful?

To use the language of the business model canvas, success can be defined by the extent to which the proponent of a programme or business initiative succeeds in delivering their 'value proposition' while ensuring that the revenue streams match or exceed costs. As indicated above, the nature of this 'value proposition' is likely to differ between 'business-as-usual' models and 'pro-poor' models. A pro-poor energy delivery model will aim to deliver development benefits over and above mere 'access to energy', at an affordable cost to the end-user. It is worth noting that different stakeholders may have conflicting views on the success of a delivery model; in other words, local communities may have very different priorities from businesses, donors or government. This point is explored in our analysis of the case studies.

One indicator of a successful project is when local people adopt and demonstrate long-term commitment to a product or programme. A case in point is the National Improved Stove Programme (NISP) in China, which installed 144 million cookstoves by 1994. Independent research conducted 10 years later reported that people had been using the improved stoves for so long that they were now considered 'normal' (Sinton *et al.,* 2004). Part of this programme's success was attributed to the fact that there was a public competition to design the improved stove, which meant that people felt a degree of involvement in the design and thus a sense of ownership over the programme (see also Case Study 3).

While it is generally agreed that a sense of ownership is an indicator of success (albeit one that can be hard to measure), there is less consensus over other considerations that might be interpreted as evidence of 'success', depending on one's perspective. These include the extent to which a delivery model should be financially self-sustaining (rather than subsidised); the extent to which energy services should contribute to 'development', 'productive activities', 'better health' or 'climate change mitigation'; the extent to which an intervention should benefit particular social groups such as women; and so on.

Development agencies and NGOs often tend to prioritise longer-term and globally relevant issues such as deforestation and carbon emissions, which may not be a concern for the poor, and can detract from the immediate issue of energy access (see Zerrifi and Wilson, 2010). This even applies to issues that directly affect the lives of the poor, such as the health impacts of indoor air pollution, which may be more important for donors than they are to the local people themselves (Chomcharn, 1991). It is also worth bearing in mind that the main benefits of electrification are often non-economic, such as making young people more aware of and connected to the wider world (Best, 2011). Proponents of pro-poor energy projects often keep potential donors and social investors better informed about their 'successes' than their end-users, especially on their websites. This is partly because demonstrating the positive impact of solar lighting products and gaining recognition for their work in this field is a key strategy for securing funding from investors and donors.

The 'value proposition' or 'vision of success' should be clarified from the outset, be appropriate to the context, and relevant to local stakeholders and beneficiaries. Our examination of 'pro-poor' energy delivery models suggests that the specific 'indicators of success' for such models will need to be determined on a case-by-case basis. It is generally assumed that this should be done in the early stages of the intervention, with the full participation of end-users and other relevant stakeholders, although our case studies show that this is not always possible. By using the business model canvas to break down the delivery model into discrete elements, we can highlight key aspects that could determine whether a pro-poor energy delivery model succeeds or fails – in other words, the extent to which it is able to deliver on its value proposition.

3. The case studies

The case studies presented below describe a range of energy delivery models, showing how they have been adjusted to help deliver affordable and sustainable energy services to poor customers. As the aim of the comparative analysis was to gain insights and learn general lessons that would be useful in a broader context, the case studies were selected in order to illustrate:

- A range of energy products and services (from cook stoves to solar products and electricity provision).
- Diverse socio-cultural contexts: ranging from a middle-income, highly electrified country seeking to extend electricity provision to its poorest, most outlying communities (Argentina) to countries in south-east Asia and sub-Saharan Africa with far lower electrification rates.
- Diverse business models to support the different technologies and local contexts, led by different types of proponent (including government and private business), with different levels of support from government and external agents.
- Varying degrees of formality in the markets under consideration.

Section 4 identifies certain key aspects of delivery model design and support services that can help distribute energy to the poorest and scale up or replicate successful elements and approaches. The diverse case studies show that, regardless of the technology or degree of market formalisation, the design of a delivery model and its support services must respond to the enabling environment and socio-cultural context. This is also a critical point to bear in mind when considering the replicability of any delivery model in different contexts.

Case study 1: Project for Renewable Energy in Rural Markets, Argentina

The Project for Renewable Energy in Rural Markets (PERMER)[7] is a government-driven, World Bank-supported programme launched in 1999 to bring basic electricity supplies to households, schools and other public service buildings in remote rural areas of Argentina. Because of the distance from the central grid and high potential for renewable energy, PERMER primarily uses solar home systems, along with renewable and hybrid mini-grids based on wind, hydropower, biomass and diesel. As the programme has developed it has added solar systems for heating water and space, cooking and pumping water. This analysis focuses on the north-eastern province of Jujuy, which is one of the poorest and most remote parts of Argentina and was one of the first regions to implement PERMER (Best, 2011).

The PERMER delivery model is a public–private partnership. The government has put a lot of money into installing generating equipment and subsidising user tariffs, and awarded exclusive delivery contracts to various public and private sector companies and co-operatives, which operate and maintain the service. Tariffs are set by local government, on the basis of negotiations with the concessionaires, public consultation (public hearings, etc.) and surveys on users' capacity/willingness to pay.

As a technically driven, top-down programme, PERMER's value proposition is the provision of affordable electricity for basic lighting, entertainment and connectivity (TV and radio) in areas that would not otherwise be reached by electrification. Despite long delays, funding constraints and design changes during its early years, PERMER is now considered broadly successful by the Argentinean government and donors. In the 10 years since it was launched, the programme has provided access to electricity to around 10,000 households and 1,800 schools, health centres and other public institutions in some of the most deprived areas of rural Argentina, enabling residents to pursue educational, economic and leisure activities in the evening. It is now in its second phase, working to reach another 18,000 households. The ability to use connective appliances has increased information flows, giving young people who migrate to urban areas greater awareness of the outside world.

However, the programme has been criticised for not providing sufficient power supply to meet all local needs and expectations (for domestic and productive activities and public services). This shortcoming is partly ascribed to lack of local consultation over project design and implementation. Progress on the programme has also been slower than expected and costs higher than anticipated, with some private sector concessionaires complaining that the tariffs set by local government are too low for them to make a profit.

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Socio-cultural context and enabling environment

When considering PERMER's success in reaching highly dispersed remote rural populations, it is worth noting the socio-cultural context for which it was designed. In certain aspects it differs from other countries with populations that lack access to modern energy services, and it is crucial to take this into account when considering the replicability of the innovations introduced by PERMER. One important factor is that Argentina is a middle-income country where over 95 per cent of the population are already connected to the grid. This makes it easy to target investment on geographical areas where people lack access to electricity – unlike many countries in sub-Saharan Africa, for example, which have lower per capita incomes and average electrification rates of 30.5 per cent (IEA, 2010). PERMER needed very substantial external loans and public finance to be viable, and it is not clear whether the same kind of programme would be economically feasible in poorer countries where a much larger proportion of the population lack access to electricity. Fee-for-service models in sub-Saharan African countries have shown some degree of success in establishing a viable business model, but remain unaffordable for the poor and tend to reach only a minority of rural populations (Lemaire, 2009).

With regard to the enabling environment, Argentina's federal system of government means that programmes such as PERMER cannot be implemented centrally; they have to be negotiated with provincial governments that operate in different contexts and have different electricity providers. PERMER has benefited from policies on subsidised electricity tariffs for remote rural communities, regulations governing tendering processes and the work of concessionaires, and effective provincial regulations that make service providers responsible for ongoing maintenance. Local people see this last point as a key factor in the project's success (Best, 2011).One of the main lessons learned from PERMER is the need for considerable institutional capacity building, particularly at the level of provincial government. Experience elsewhere has also shown that such programmes rarely endure if the institutional environment is not adequate and there is no reliable maintenance mechanism (Martinot *et al.*, 2000).

Another important factor was the political will to promote a decentralised model that involved the private sector. PERMER was designed when a major privatisation process was under way, hence the concessionaire-based approach. The model initially aimed to maximise the role of private sector concessionaires, making them responsible for procuring, installing and maintaining equipment, and providing capital investments that would be covered by user fees. Because the reform of the power sector had not been completed, private sector involvement had to be scaled down to allow PERMER to work in regions that had not yet privatised their distribution services (Best, 2011).

This project also shows the impact that dramatic changes in the enabling environment can have on a delivery model. The economic crisis and currency devaluation that hit Argentina in 2001 led to an increase in the cost of imported solar equipment and implementation costs for concessionaires, higher poverty rates and decreased ability to pay for energy services, and reduced the provinces' ability to support and subsidise the programme.

Delivery model innovations

PERMER is mainly funded by loans from the World Bank and the Global Environmental Facility (GEF), which the government has used to subsidise the installation of equipment. Ongoing tariff subsidies are supported by a national fund for electrical power derived from petrol tax and wholesale electricity sales. Other financial inputs include obligatory investments by concessionaires in the initial stages of the programme (subsequently reduced), and capital provided by end-users, provincial governments and the Ministry of Education. The total cost of Phase 1, which lasted from 1999 to 2008, was US$58.2 million (Best, 2011).

Setting tariffs has been a challenge, due to the nature of the value proposition and the specific requirement for electricity to be supplied at affordable prices for low-income consumers. A financially sustainable model needs to strike a balance between setting tariffs that are affordable for the poor and providing a revenue stream for cost recovery. In PERMER, the main criterion when setting tariffs is that users should not have to pay any more than they previously paid for energy sources such as kerosene. Price levels are established through surveys of users' 'capacity/willingness to pay', and negotiations between the provincial regulator and the concessionaire.

In accordance with policy that was already established prior to PERMER, tariffs are heavily subsidised by provincial governments to ensure that the service is affordable. At the end of 2010 these subsidies represented 76 per cent of the cost price, leaving users to pay an average of about US$4 per month, although rates vary significantly in different areas. Private sector concessionaires often complain that the tariffs are too low for their businesses to be profitable, and they are reportedly set lower than is strictly necessary in some areas (meaning that local people can afford to pay more), but cannot be increased due to policy restrictions. This indicates that even with extensive market research, it is not always possible to balance social, financial and political priorities. ITDG (now Practical Action) came to a similar conclusion with regard to its micro-hydro projects, noting that there is 'a clear trade-off between micro-hydro projects capable of meeting the needs of people and those that are profitable' (Khennas and Barnett, 2000).

One of the most striking innovations in the PERMER model is the collaboration between key partners and the way that this evolved and been maintained. This is a public–private partnership programme that involves national and local governments and receives substantial loan funding from international financial institutions. The concessionaire model itself was innovative, particularly in its initial focus on private sector involvement during the early stages of national privatisation. It was also one of the first times that the World Bank had used a concessionaire-based model to deliver off-grid electricity from a renewable energy source. Contract arrangements for the concessionaires varied according to each province and local market conditions. In Jujuy Province, urban and dispersed rural markets were bundled together,

and the award and retention of the urban contract was made conditional on successful delivery to this dispersed market.

The roles of the different actors have had to change over the course of the project as a result of factors in the enabling environment (power sector reforms, economic crisis). Indeed, it could be said that the most important factor in PERMER's survival and ability to reach the poorest has been participants' willingness to adapt to changing circumstances and move away from the rigidity of the original model. According to the initial project design, the only provinces that were eligible for World Bank funding were those that had initiated energy sector reform, thereby tying the project's progress to a broader package of privatisation. The other stumbling block was the companies' need to make a return on their capital investments. This was particularly challenging in the context of the economic crisis and currency devaluation in 2001, which increased concessionaires' costs, causing them to demand higher user tariffs that were unaffordable for rural populations with escalating rates of poverty, and unacceptable to the increasingly cash-strapped provinces that subsidised and set the tariffs.

These problems were addressed by removing the requirement for private sector companies to contribute to procurement and installation costs, so that more costs were covered by loans and public finance than initially anticipated. The strong private-sector focus of the original design was also modified, allowing entities from the non-profit sector (such as co-operatives and state-run companies) to install and maintain services. The private sector now provides and maintains the services but does not finance them, while public sector entities and co-operatives operate as concessionaires in certain regions.

PERMER's value proposition involves not only providing technology that is feasible in remote rural areas, but also maintaining the service that this technology provides. While other renewable energy programmes have failed because they were unable to do both, PERMER covers the maintenance aspect by awarding concessionaires service contracts that are enforced by regulators. This approach was partly prompted by a desire to limit the maintenance and repairs burden for users. It certainly seems to have been successful, as 90 per cent of problems in Jujuy Province were resolved without further complaints by residents, and the resulting confidence in the programme is a key factor in good customer relations (Best, 2011).

Limitations

Community consultation on PERMER has generally been minimal. Local involvement focused on individuals deciding whether or not they want the service, and in the case of higher-impact mini-grids, agreeing whether and where construction should take place. Certain indigenous communities had to be consulted separately due to World Bank requirements. PERMER also involves a number of projects led by NGOs and universities that work with local communities on testing alternative technologies like solar cookers and water heaters, and help local enterprises manufacture this equipment.

Relationships with stakeholders are mainly restricted to end-users (customer relations), and involve PERMER organisers informing people of the likely costs and benefits of getting connected. A survey on 'capacity/willingness to pay' was conducted, but the results did not necessarily feed into decisions on tariff setting. In this aspect, PERMER differs from the other delivery models considered here, which either aim to maximise local participation in establishing and maintaining energy services (as with the Renewable Energy Development Programme in Nepal discussed in Case Study 4), or actively seek out potential users when designing products and payment systems (the portable solar products and Anagi stoves in Case Studies 2 and 3).

Residents involved in PERMER had no role in choosing the technology or establishing and maintaining the service. While such an approach could doubtless be criticised as paternalistic, it should be considered in relation to the particular socio-cultural context. The local NGO Fundación EcoAndina suggested that potential users initially lacked the experience to make informed choices about the technology, certainly in the early years when local communities knew nothing about renewable energy technologies (cited in Best, 2011). Communities sometimes prefer experts to make such decisions on their behalf, as they are better able to judge which renewable technology is feasible for local conditions. Banerjee and Duflo (2011: 269) observe that the poor suffer from having to 'bear responsibility for too many aspects of their lives', while Yadoo and Cruikshank (2010a) note that Scottish islanders expressed a preference for being 'consulted' rather than playing a more active role in the decision-making and implementation of energy access projects. PERMER officials also highlighted the risk of participatory processes being captured by local political interests (Best, 2011).

So while PERMER could be criticised for the limited community involvement in decisions regarding energy services and rural development planning, it is important to note that a key consideration in the planning process was limiting the burden on local people. Our assessment would also be different if we focused on 'customer relations' (according to Osterwalder's terminology), as the service providers (concessionaires) have succeeded in promoting the service, winning customers and dealing with complaints.

One area where the programme could have benefited from more local consultation is in managing customer expectations. Residents are pleased with the impacts of the solar PV installations, but have reportedly expressed a desire for more electricity to power additional lights, TVs, computers, fridges and water pumps. Although it is far from clear whether an alternative model (or technology) capable of providing greater loads would have been viable, this illustrates the way that different actors view such initiatives: renewable energy advocates hope that such technologies will provide a comprehensive solution to people's energy needs, while project beneficiaries often see them as an interim step in progress towards a supply comparable with the central grid.[8]

8 This has also been observed in other countries, such as Indonesia (Madon and Oey-Gardiner, 2002), and Sri Lanka (Masse and Samaranayake, 2002), particularly when communities are close enough to the central grid to be able to compare it with their own alternatively generated supply.

Initial hopes that access to electricity would automatically lead to economic development have proved unfounded with PERMER. This was partly because the basic level of power provided by solar PV is not always sufficient to increase productivity significantly, but another, perhaps more important factor is that lack of access to modern energy is usually just one of many constraints to economic development. Off-grid areas are also likely to be deprived of the necessary infrastructure, capital and skills required for broader economic development.

This suggests that models which offer a value proposition based on the assumption that electricity access leads to higher incomes and willingness to pay could be vulnerable if they do not achieve these outcomes. It is therefore essential to establish a thorough understanding of the socio-cultural context before making such assumptions. Furthermore, if the objective is to encourage rural development in general, energy access projects need to be integrated with broader rural development policies, as advocated by Best (2011). Equipment for rural electrification (such as solar home system components) is rarely produced close to those who use it, meaning that value at the production level is not captured locally. In fact, the need to ensure that the equipment is of sufficient quality to be valuable to consumers makes it harder for small-scale local suppliers to win contracts.

PERMER´s success was not a foregone conclusion. Indeed, the various challenges that it had to overcome demonstrate the difficulties of reaching remote poor communities (with low population densities, customers unable to pay commercial tariffs and a highly volatile economic environment), even in a country not normally associated with a significant lack of access to modern energy.

Case study 2: Portable solar product companies[9]

Tough Stuff and d.light are social enterprises with a similar business model. Both companies design, produce and sell portable solar energy products that provide good quality light to low-income customers. Social enterprises are defined as businesses with 'primarily social objectives whose surpluses are principally reinvested for that purpose in the business or in the community, rather than being driven by the need to maximise profit for shareholders and owners' (DTI 2002). Tough Stuff prides itself on its 'triple bottom line' business model, which aims to 'achieve positive financial, social, and environmental outcomes'.[10]

Solar lamps enable people to remain active for longer each day and reduce the need to use kerosene, thereby decreasing indoor air pollution, reducing safety hazards and allowing users to make financial savings. The value proposition of these two enterprises goes beyond simply offering high-quality light, as the lamps have to be durable and, most importantly, affordable to the poor. Their products range from lamps that provide light for four hours (costing US$8–$10) to more expensive, longer-running devices that may offer additional services such as charging phones (costing approximately US$45). Because of the need to keep costs down, it is not effective to manufacture these products locally, and they are usually mass-produced in China. While this means that value from production is not captured locally, it is vital to keep costs low and quality high enough for the consumers to receive value.

By early 2012, d.light had sold 1.2 million lights, benefiting 6 million people. There are no data on which income groups were reached, although the channels through which the products are sold usually cater to the poor. The most affordable light, the S1, has only just gone on sale and is likely to reach even poorer groups. For its part, Tough Stuff has sold 140,000 products, benefiting 740,000 people (Ashden Awards, 2011). Once again, there are no clear data on exactly which poor groups have been reached, although the fact that items cost less than US$10 should be expected to make products more accessible to the poor.

Socio-cultural context and enabling environment

Tough Stuff and d.light generally target customers in Southern Asia and sub-Saharan Africa. These regions usually lack the large subsidies and administrative capacity that were needed to make PERMER work in Argentina, and solar home systems are simply unaffordable for the rural poor (see Karakezi and Kithyoma, 2002; Illskog and Kjellström, 2007; Jacobsen, 2007; Lemaire, 2009). A much higher proportion of the population of these regions lacks access to modern energy than in Argentina,[11] and there is much less prospect of government electrification programmes reaching rural areas. The business models adopted by d.light and Tough Stuff therefore target low-income groups living in areas unlikely to be reached by government programmes, and those who may have access to the grid but have a low-quality supply. [12]

While the lack of support for large-scale electricity programmes can facilitate sales of solar product by shaping local expectations, solar product manufacturers like Tough Stuff and d.light may be affected by several aspects of the policy environment. These include high import duties and taxes, 'perverse' subsidies for alternatives (such as kerosene), lack of support for entrepreneurship, lack of credit for businesses and consumers, and lack of investment in roads that hampers distribution. The role of donors and governments in facilitating investment is often a major issue, and aid programmes are frequently criticised for undermining markets with grants and free products, rather than stimulating them. Many actors in the private sector believe that governments and donors should work to reduce the risk to standard commercial business instead (Bellanca and Wilson, 2012).

9 Based on interviews with Ned Tozun of d.light and Andrew Tanswell of Tough Stuff in 2011.

10 See: http://www.toughstuffonline.com/pages/what-toughstuff-0

11 Standing at 69.5 per cent in sub-Saharan Africa and 38 per cent in South Asia (IEA, 2010).

12 Although lack of modern energy is predominantly a rural problem, 40 per cent of urban dwellers in sub-Saharan Africa do not have access to electricity, and many who do struggle with intermittent services. As they tend to have higher incomes, these groups can be easier to reach for companies and NGOs that sell solar lanterns and improved cookstoves.

Delivery model innovations

In this context, the product is perhaps the most important aspect of the value proposition, as solar lamps are specifically designed and produced with relatively low-income groups in mind. Significant research is undertaken with potential clients to develop a product that will function in their particular setting. In order to reach the poor, companies must continually find ways of keeping costs down while ensuring that their products are durable, long-lasting and provide high-quality light. Within the limits of affordability, they are also tailored to adapt to new customer demands, such as being able to use solar powered cells to charge mobile phones. It is crucial to ensure that all of these objectives are met simultaneously, as failure to reduce costs will mean that the lamps do not reach the poorest groups, while compromising on their reliability or durability could damage the credibility of both the brand and the technology, and they will not help improve people's lives.

It is worth noting that reaching low-income groups requires more than innovative products, as companies have to overcome two other constraints before they can make a sale. The first relates to distribution channels and the physical difficulty of reaching low-income populations, particularly those in remote rural areas. The second relates to customer relationships. The poor, and the rural poor in particular, are often averse to taking risks and likely to be suspicious of new products. People are unlikely to be swayed by the offer of a warranty if they have little or no experience of using them successfully; and it can be even harder to gain trust for solar products, which are still quite new in most places and require sellers both to promote the product and demonstrate how it works. Problems convincing potential customers of a product's reliability are often exacerbated by copycat producers selling cheaper, apparently identical copies, which soon break and undermine local people's faith in the genuine article. Therefore, existing attitudes to solar technology and the perceived value of product warranties need to be explored as aspects of the socio-cultural context that can affect the success of the delivery model.

These challenges call for new approaches to developing distribution channels and establishing positive customer relationships. One technique adopted by formal companies that sell products such as drinks, soap, snacks and cigarettes to the poor is to use distribution channels in the informal economy, as they already cater to low-income groups. Small-scale entrepreneurs who already sell products like frozen fish or corrugated iron could be enlisted to sell solar products if they are convinced there will be a demand for them. This could also help resolve the trust issue if vendors are well known to their clients, especially if they use the products themselves.

In other cases, urban customers with larger disposable incomes who are willing to try new products could act as a link between the company and rural communities, as they may buy a product to give their families when they visit their home village. Tough Stuff, d.light and local partners try to capitalise on these linkages and informal networks by training 'village entrepreneurs' to sell their products, thereby reaching more remote customers and ensuring that some value is captured locally at the distribution level.

In the long term, it is hoped that establishing a brand and a reputation for good quality, durable products will make it easier to reach low-income groups. It is also important that the delivery models are commercially self-sustaining and therefore not reliant on public funding. Although their products are sometimes subsidised by NGOs to ensure that they reach the poorest sectors, or bought by relief organisations to distribute after disasters, public money is not central to the Tough Stuff and d.light delivery models. This also means that they are not vulnerable to disruption caused by political changes.

Limitations

Even though Tough Stuff and d.light products are increasingly affordable for the poor and offer savings by reducing the need for expensive kerosene, their up-front costs can still be prohibitive for the poorest groups. These limitations could be addressed by providing additional support services. In some cases micro-credit institutions have been enlisted as partners;[13] elsewhere, very poor people in remote areas have been reached through co-investment by donors that subsidise the cost of such products and incorporate them into other development or relief projects.

The value proposition of an energy delivery model based on a portable lamp is essentially more limited than the solar home systems provided under a scheme like PERMER – especially given that beneficiaries in the PERMER project did not always see solar home systems as a comprehensive solution to their needs. Nevertheless, the very fact that the value proposition is more limited makes solar lamps less costly and therefore more accessible to the target market or customer segment.

This means that solar products are a viable option in poor countries with low levels of electrification; the very contexts where programmes such as PERMER would probably be unviable. They can provide a crucial interim solution in places that are unlikely to be served by the grid in the foreseeable future, and an alternative source of power in areas where grid supply is unreliable.

Case study 3: The Anagi stove in Sri Lanka

Electricity is by no means the only component of energy that matters to the poor. In fact, even when they do have access to electricity, it is often too expensive to use for the activity that requires most energy – cooking (Karakezi and Majoro, 2002). Governments, NGOs and multilateral agencies have spent over three decades promoting energy-efficient cookstoves as a means of tackling indoor air pollution and deforestation, and reducing the time and money spent on fuelwood. Yet selling cookstoves to the poor is notoriously problematic, largely because outsiders often simply assume that they are of value to local people, rather than demonstrating their potential to users and wider audiences.

Slaski and Thurber (2009) argue that there are three main reasons why many cookstove projects fail: they can be expensive, the perceived value of cookstoves is frequently quite low, and they often require users to change their cooking

13 See: http://www.ashden.org/files/ToughStuff%20winner.pdf

habits. Moreover, distribution projects have repeatedly failed to include users in the design of the stoves and overlooked local preferences and other socio-cultural factors (see Cecelski, 2004 and Agbaje, 2009). For example, Agbaje (2009) ascribes the failure of the Maendeleo stove in rural Kenya to the designers disregarding the fact that rural people were not used to paying for fuelwood, unlike their counterparts in urban areas (where the Jiko stove was quite successful). Although they could still have gained from the non-economic benefits of the project, such as health and forest protection, Agbaje suggests that these were more important for the project proponents than for local people. Anneke (2010) highlights the fact that stakeholders can have very different views on the outcomes of stove interventions and that this should be understood at the outset in order to monitor their effectiveness in meeting local expectations.

In addition to the Chinese programme mentioned in Section 2.3, one cookstove programme that is broadly considered to be successful is the Anagi initiative in Sri Lanka, where the combined actions of key partners (national and international NGOs, local entrepreneurs, donors and government agencies) ultimately succeeded in facilitating a commercially viable local market for energy-efficient Anagi stoves. Interventions were carried out in successive projects that differed from one another but built on the successes of previous schemes. Around 300,000 Anagi stoves are now produced each year and sold for as little as US$1.40, reaching approximately 15 per cent of the population of Sri Lanka.[14]

Unlike the more high-tech solar products, cookstoves lend themselves well to local production and provide greater opportunities to create value at the production stages (in addition to distribution, where solar product delivery models generate much of the value for local entrepreneurs). Local artisans in five Sri Lankan villages took advantage of donor support and successfully expanded production of the Anagi stoves, generating a viable livelihood strategy for themselves and significantly improving their living conditions.

Socio-cultural context and enabling environment

Local context can be a major factor in the success or failure of improved cookstove projects. Drawing on experiences around the world, Cecelski (2004) identifies several key issues in cookstove projects: incomes, the status of women (who are expected to benefit the most from reduced indoor air pollution), and the extent to which fuelwood is commercialised (allowing families to make immediate financial savings by using less fuelwood).

In the Sri Lankan case, the Anagi stove has proved popular in rural areas where fuelwood is not commercialised, suggesting that the time saved by not having to collect so much fuelwood and reduced cooking time is also important to stove users.[15] The Anagi stove programme shows the importance of taking time to understand the socio-cultural context, local cooking practices and preferences for cookstove functions. This was done through in-depth participatory market research, which fed directly into the product design (see below).

With regard to the enabling environment, support for sustainable resource management is critical in enabling efficient cookstove projects to go ahead. Macqueen and Korhaliller (2011) note that there may be little government support for potentially sustainable resource use (for example, the charcoal industry is illegal in some African countries). One important factor in the success of the Anagi stove was the government's willingness to use subsidies strategically to stimulate its early adoption (see below).

Delivery model innovations

As with the other energy delivery case studies presented in this paper, the Anagi stove programme owes much of its success to the promoters' readiness to be flexible in their approaches and to learn from previous experience. The programme strategy shifted a number of times in response to the lessons learned over three decades of interventions.

One of the programme's most significant innovations was the development of the product, which was a key element of its value proposition. Instead of simply designing a technically efficient stove and attempting to distribute it, extensive market research was undertaken with potential users in order to develop a product that would be adopted, valued and used locally on an ongoing basis. Different NGOs and governmental agencies came up with their own designs, whose efficiency, cost effectiveness, durability and usability were compared through laboratory and field tests carried out under the auspices of the Ceylon Electricity Board.

The Anagi stove emerged as the eventual winner of this market research process, not because it was the most fuel efficient stove, but because it was most acceptable to users. The first, three-part Anagi model was considered too cumbersome for both producers and sellers, and the more user-friendly Anagi 2 model was finally adopted. This shows the importance of balancing external priorities (in this case fuel efficiency promoted by the government, NGOs and donors) with local preferences, and allowing potential users a say in product development. Subsidies and a one-month warranty were used to encourage early adoption after the design stage, although the users' subsidies were later withdrawn (Amerasekera, 2004).

Another important factor was the flexible approach taken to stove production. Initial efforts focused on having the stoves made in large formal tile factories, in order to take advantage of economies of scale and ensure high-quality production. This proved unviable, as the tile-making companies already had profitable businesses and little reason to carry on producing the cookstoves once the additional programme support was withdrawn; while the artisanal potters brought into the factories did not like the highly formal and rigid working environment, preferring the independence of the informal economy.

By contrast, efforts to support producers in five villages with a long tradition of pottery were far more successful. These producers were granted loans to meet their capital costs, given technical and business training, and provided with free

14 Personal communication, Namiz Musafer, Practical Action Country Manager, Sri Lanka.

15 Personal communication, Amerasekera, former Executive Director of Integrated Development Association, Kandy, Sri Lanka (now retired).

moulds and templates to ensure quality control. Some 83 per cent of the Anagi stoves produced in Sri Lanka are now made in these five villages (Amerasekera, 2004). Giving users and producers a say in developing the product was central to the success of the Anagi stove. This highlights the importance of maintaining good relationships with customers and other stakeholders, and seeking key local partners for the delivery model in order to enhance the local development impact. As production and demand for the stoves increased, distribution channels were established through linkages with wholesale buyers and retailers that already serviced the market for ceramic products.

Limitations

Like the Tough Stuff and d.light business models, commercial cookstove projects are more likely to be financially successful if they target the non-poor and middling poor, especially in the early stages when markets are just being created. It is easier to reach poorer groups once a market is already established, costs have been reduced and the product is trusted. Even so, the poorest are unlikely to form a major customer segment for Anagi stoves (Amerasekera, personal communication). The main beneficiaries of the early Urban Stoves Project (USP) were wealthier groups living in urban areas (Pisces, 2009), and other relatively successful stove projects, such as the Jiko stove in Nairobi, had similar outcomes (Karakezi and Majoro, 2002). It was only after a market for Anagi stoves had been created that efforts were made to bring the stove to the rural poor in Sri Lanka. This was done through the Rural Stoves Marketing Project (RSMP), which worked with small NGOs that used the stoves as part of broader development goals (as with Tough Stuff and d.light products).

This demonstrates the difficulty of reaching the poorest sectors of society, and the need to design specifically targeted delivery models to address this challenge. Lower purchasing power is not the only socio-cultural factor that affects uptake; research has shown that the poorest people also tend to be less willing to pay for reduced smoke in the home (Tsephel *et al*., 2009) as they may use it to deter insects and preserve meat (Chomcharn, 1991). These kinds of local preferences are important aspects of the socio-cultural context that need to be taken into account when designing an energy delivery model for the poorest.

The Anagi stove faced similar quality control challenges to the solar lamps. Once its reputation was established, certain entrepreneurs started producing stoves that looked like the Anagi stove but were less durable and had longer cooking times. In this case, programme implementers did make some effort to incorporate the 'look-alike' producers into the programme and train them to produce better stoves – with limited success. This shows that even when 'look-alike' producers are local, it can be hard to maintain absolute levels of quality control in a programme with numerous producers and dealers spread across an entire country.

Another issue is the difficulty of increasing production beyond 300,000 stoves per year, because potters incur added costs if they have to hire extra workers. There have also been various problems associated with mechanisation, and increasing concerns about the sustainability of clay supplies (Amerasekera, 2004). Attempts to support small-scale production in areas outside the five original villages have been less successful due to difficulties in keeping production costs down, lack of interest in producing the stoves, and risk-averse entrepreneurs.

This case study shows that even when a good quality product, attractive value proposition and viable distribution channels have been established, scaling up and reaching the poorest remains a challenge. This is partly due to issues of finance and affordability, and partly to socio-cultural factors such as user preferences and entrepreneurs' perceptions of risk. There is much to be learned from the Anagi stove programme and the way that it has addressed these challenges.

Case study 4: Micro-hydro in Nepal

Only 30 per cent of the rural population in Nepal have access to electricity. The country has huge potential to produce renewable energy, particularly through hydropower, which has the capacity to generate 83,000MW through large- and small-scale plants (Banerjee *et al*., 2011). Micro-hydro plants can harness small flows of water to generate a reliable electricity supply, and have been promoted by the government's Alternative Energy Promotion Centre (AEPC), particularly under its flagship Rural Energy Development Programme (REDP) (Yadoo and Cruikshank, 2010a; Banerjee *et al*., 2011). REDP is an award-winning programme that uses a community-run self-governance approach to enable local people to design and manage their own energy systems. A key feature of the model is the use of 'community mobilisers' to guide local people through the various steps and decisions in the electrification process.

To date, REDP has established 272 micro-hydro plants and 10,527 community organisations, each with an average of 25 members (Banerjee *et al*., 2011). Like the solar home systems provided under PERMER, the value proposition of the REDP micro-hydro programme centres around the provision of reliable electricity services to local populations. Access to power has had substantial positive impacts for local people in terms of better quality light, less indoor air pollution and the opportunity to save money (Yadoo, 2012; Banerjee *et al*., 2011). When the results were averaged out across the REDP programme, micro-hydro was found to increase non-farm household incomes by 11 per cent and average school grades among girls by 6.5 per cent. As with the PERMER programme and portable solar products, the most commonly cited benefit of electricity is light for education (Banerjee *et al*., 2011).

Socio-cultural context and enabling environment

REDP has benefited from specific support from the government's Alternative Energy Promotion Centre (AEPC) and a general collective ethic in resource management. Nepal has seen a growing cultural shift towards community-based management of business, social issues and a range of natural resources. Active local organisations range from local forestry committees to water supply, irrigation and sanitation working groups, mothers' associations, micro-hydro interest groups and dairy co-operatives (Yadoo and Cruikshank, 2010b).

Another key enabling factor is the small number of more educated individuals (particularly teachers) who understand the potential benefits of renewable energy and can generate awareness and enthusiasm in their communities (Yadoo, personal communication). This enables the programme to draw on local natural and human resources and social capital.

The very nature of decentralised energy provision and the challenges of maintaining micro-hydro plants mean that a certain degree of local participation and buy-in is likely to be a pre-requisite for successful projects (Yadoo, personal communication). However, communities differ greatly in terms of their cohesion and organisational experience, and these factors are likely to have a bearing on the replicability of the REDP community-based delivery model in other socio-cultural contexts.

Delivery model innovations

The main difference between PERMER and REDP is not in the final output – a reliable electricity service – but the way that it is achieved. Unlike PERMER, which is a relatively top-down programme that keeps user input to the minimum, REDP deploys community mobilisers to raise awareness and facilitate local decision-making throughout the electrification process, starting with educational visits to functioning micro-hydro plants in other areas.

In REDP it is seen as important to discuss potential risks from the outset in order to reduce the likelihood of excessive expectations. The programme places much greater emphasis than PERMER on establishing strong customer relations, involving users as key partners in the model and in developing and maintaining the service. Its value proposition is also broader in the sense that mobilisers work on a range of community issues, including organisational development, capital mobilisation, skills enhancement, women's empowerment, technology promotion, environmental management, and establishing community energy funds (Yadoo and Cruikshank, 2010a). There is a belief that electricity provision needs to be integrated into productive and development activities to increase its impact and sustain the electrification process by raising incomes (and capacity to pay) and increasing the demand for electricity. This contrasts strongly with PERMER, which focuses solely on electricity provision.

The development impact of REDP has been enhanced by additional support services, such as seed capital for productive activities, training for agricultural processing mills and other small and medium enterprises, and saving funds to finance productive activities that will benefit from electricity (Yadoo, personal communication). This enables people to capitalise on one of the main strengths of micro-hydro power: the fact that it can provide enough power to support a range of productive end uses, unlike solar PV, which simply provides light and enables people to work later into the night (Khennas and Barnett, 2000).

Limitations

Despite the inclusive design of the delivery model and the local capacity-building initiatives associated with REDP, its systems are still limited by technical problems. Banerjee *et al.* (2011) report that 62 per cent of users experience voltage fluctuations and that all rural households endure average power outages of up to 9 hours a day, despite having a technician permanently on hand within the community. They suggest that the technicians need better training; while Yadoo and Cruikshank (2010b) emphasise the importance of striking a balance between training individuals who are most likely to make effective technicians (relatively well-educated young adults) and those who are least likely to move away from the community (who are often older and less skilled).

Enterprises that were set up to take advantage of micro-hydro plants have not proved any more profitable than those that use diesel generators – partly because such problems with supply can be highly disruptive, but also because they are newer and smaller than more established businesses (Banerjee *et al.*, 2011). This is just one of the challenges for models that aim to link access to electricity with new micro-enterprises and productive activities. For the time being, REDP will require subsidies to remain sustainable.

Back in 2000, ITDG (now Practical Action) noted that although most consumer demand is for electric lighting, the most financially viable micro-hydro plants are those that deliver power to businesses that use machinery. In other words, there is greater demand for household and educational purposes than for productive uses associated with enterprise development (Khennas and Barnett, 2000). This suggests that even when the most cost-effective technologies are used, the reality is that full electrification in the poorest rural areas is unlikely to be financially self-sustaining and will generally require some kind of subsidy where there is significant community involvement and additional support for productive activities.

4. Energy for the poor: analysis of the delivery model

Innovation in energy access models for poorer markets has blossomed in recent years (Aron *et al.*, 2009; Gradl and Knobloch, 2011), with the UN initiative *Sustainable Energy for All*[16] providing a further incentive for businesses and governments to tackle universal energy access with greater urgency (WBCSD, 2011; UN Global Compact, 2011). Reaching the poorest with decentralised and/or low-carbon technologies has long been identified as a particular challenge (Geoghegan *et al.*, 2008), and business models that attempt to target the poor (such as the so-called 'base-of-the-pyramid' models)[17] often end up delivering energy services to the relatively poor, who can still afford to pay a reasonable price for such services (Wilson *et al.*, 2008; Bellanca and Wilson, 2012). As development agencies and international initiatives such as SE4ALL place increasing emphasis on the private sector's role in delivering aid objectives, there is a risk that opportunities to provide energy services to the poorest may be overlooked (Renewable World, 2012).

So what can we learn from these case studies? We will start by considering how successful the different initiatives have been from various perspectives, and then discuss how our analytical framework helped us understand some of the key elements required to make a 'pro-poor energy system' work.

4.1 Success from different perspectives: the case studies

Tough Stuff and d.light have been recognised repeatedly for their work delivering sustainable energy services to poor markets. Tough Stuff won an Ashden Award for sustainable energy in 2011 and a World Business and Development Award in Rio in 2012; while d.light won a Golden Ashden Award in 2010, and their solar-powered lantern and mobile phone charger featured as the iconic 100th object in the BBC series 'A History of the World in 100 Objects'. Between them, they have reached millions of people with their products, as noted in Case Study 2. While there are no specific data on how many of these people fall into the 'poorest' category, the two companies' products do appear to be affordable to the very poor, and local users acknowledge that they are cheaper than the alternative kerosene.[18] Both companies have also managed to train local distributers to take part in their supply chains, thus providing opportunities to improve local livelihoods.

The Anagi stove programme has succeeded in establishing a viable local market for a product that is seen to be safer and more efficient than previous models, while appealing to users' preferences for traditional stoves. It seems to have created a sense of ownership and increased the level of adoption by designing the stove in collaboration with local stakeholders, producing a product that was not the most efficient model possible, but was the most desirable to potential users. Although the poorest may not be a key customer segment, there is some evidence that the programme delivers important development benefits, and it has enhanced livelihood opportunities for local entrepreneurs by bringing local artisans into supply chains and (like the solar products producers) developing local distribution networks.

Donors and government view PERMER and REDP as successful because of their ability to deliver electricity to relatively large numbers of outlying rural communities that would otherwise be unable to benefit from grid extension. Nevertheless, some of the beneficiaries of PERMER would like more power to satisfy their domestic needs and better support productive activities and public services. The fact that their expectations have not been fulfilled is partly due to lack of consultation ('expectation management'), especially given that the vast majority of Argentineans have access to the grid. The country's changing economic situation and policy on tariff setting also left a number of PERMER concessionaires feeling that their businesses could have benefited more from the programme.

Studies show that REDP has increased household and non-farm income by 11 per cent, girls' school grades by 6.5 per cent, and that beneficiaries have been able to create additional income using the electricity generated by the programme. Yet Case Study 4 suggests that promises to invest in 'productive energy use' are not always realised,

16 See: http://sustainableenergyforall.org/

17 See Prahalad and Hart, 2002; Aron et al., 2009; Wilson and Garside, 2011.

18 See: http://www.youtube.com/watch?v=0pi1zUfPvs0

and that local people often prefer to use the electricity for domestic lighting and education. Similarly, the access to electricity provided by PERMER did not automatically lead to economic development. This was partly because of the low levels of power generated, but also due to the other constraints to economic development inherent in outlying rural areas, such as lack of infrastructure, capital and skills.

4.2 Socio-cultural context and enabling environment

All these case studies show that the success or failure of the delivery model is highly dependent on the context in which it is implemented. It is essential to have a good understanding of this context when using the Osterwalder business models canvas. Awareness of the socio-cultural factors that determine willingness to pay will be helpful in targeting the appropriate customer segments; understanding local preferences for certain products and services is essential when developing the value proposition; and knowledge of the enabling environment helps identify what support services (key activities) may be required to make up for lack of access to finance or other gaps.

The context of a delivery model can be analysed in different ways, as demonstrated by the 'market mapping' and 'chain-wide learning' approaches discussed in Section 2, and the framework developed by the authors of *Delivering Energy for Development* (Bellanca *et al*., forthcoming). While it is not essential to divide the analysis of this context into the distinct categories used here ('socio-cultural context' and 'enabling environment'), we found it useful to emphasise the socio-cultural factors, particularly from the communities' perspective, and to separate them from the more formal regulatory and policy aspects commonly associated with the enabling environment.

Local preferences and expectations

The current literature offers limited insights into the socio-cultural factors that affect energy delivery, although the literature on cook stoves does take increasing account of local preferences and expectations (see for example, Boiling Point, *Household Dynamics* Issue 57). More attention is also being paid to other factors, such as women's status and views on health, the commercialisation of local fuelwood (which affects the perceived value of alternative options), and the sense of ownership created when the community plays a role in the design and local production of a stove.

Community expectations are critical when considering access to electricity or the provision of lighting products. While some PERMER customers have been disappointed with the level of power the programme has delivered, REDP ensures that potential risks and challenges are discussed with communities from the outset in order to reduce the likelihood of unrealistic expectations. If people have high expectations of access to the grid, they are less likely to adopt or pay for options that are perceived as inferior. The solar product companies serve markets with much lower expectations, or which have such unreliable access to the grid that the products provide a convenient supplement. Where kerosene lamps are the only alternative, anything that provides a stronger, safer and cheaper light is more likely to be welcomed.

Community cohesion and capacities

Community organisation and levels of cohesion are also important factors that can determine the success or failure of a project. The case study on hydro-power in Nepal shows that a culture of community management and collaboration is crucial for co-operative delivery models. It also demonstrates the importance of local capacities, such as the presence of educated elites to drive new technologies and approaches. It is much more difficult to implement co-operative models of energy service delivery where there is a lack of community cohesion or universally low levels of education and no exposure to external ideas. The authors' experience with the SUNGAS project in Nigeria illustrates the challenge of finding a suitable community for an energy access demonstration project in the Niger Delta, where there is heightened potential for conflict, less inclination to collaborate and a strong sense of entitlement to external support from government and oil companies (which reduces peoples' willingness to pay for utility services).[19]

The Anagi programme's initial failure to establish sustainable production units for the stove could have been avoided by early analysis of the socio-cultural context in which local entrepreneurs operated. This would have shown that existing tile-makers already had profitable alternative business activities, and artisan potters preferred informal trade arrangements. In the end, the programme had much more success in five villages with a long tradition of pottery making. Nevertheless, it is worth noting that while earlier analysis could have saved some time, developing a successful model is often a matter of trial and error and – most importantly –willingness to listen to local people, respond to their desires and needs, and alter the delivery model accordingly.

Policy, regulation and strategic government support

With regard to the more formal enabling environment of regulation and policy, the case studies show the importance of supportive policy, sensible regulation and institutional capacity to implement policies and regulations effectively. The difference between centralised and regional decision-making can also be significant. Existing subsidies for rural electrification were beneficial in the case of PERMER, although the unfinished privatisation process limited its ability to involve private sector concessionaires, and the impact of the 2001 economic crisis was an unexpected and quite devastating event.

PERMER, REDP and the Anagi stove programme all benefited from being government programmes with significant donor funding, and from the strategic application of government subsidies. This type of strategic government and donor support to stimulate commercial investment would

19 The SUNGAS project (Sustainable Utilisation of Nigeria's Gas and Renewable Energy Resources) is an EU-funded project, launched in 2009. For more information, see www.sungas-nigeria.org

certainly be helpful for more individual, private sector initiatives like those of the solar product manufacturers (Bellanca and Wilson, 2012).

Regulation repeatedly emerges as a key issue in many areas, from natural resource management (fuelwood, etc.) to product quality control, import tariffs and concessionaires' operating and maintenance activities. The PERMER case study highlights the importance of capacity building for both regulators and implementers.

4.3 Innovations and challenges associated with the delivery model

These case studies also drive home the importance of flexibility in the design and implementation of pro-poor energy delivery models. This includes the ability to adapt to changing circumstances, such as the major economic crisis that hit PERMER. The success of the Anagi stove programme owes much to its promoters' willingness to take a flexible approach and learn from previous experience, adapting their strategies to reflect the experience gained over three decades of implementation.

Delivering development impacts

Elements of the value proposition in each case study were intended to enhance the development impact and/or increase accessibility for poorer users. The Anagi stove programme and solar product manufacturers largely attribute the high uptake of their products to the effort invested in involving local customers and other stakeholders in the product design. These case studies illustrate the importance of building trust and a sense of ownership around a product or programme. PERMER's value proposition entails not only providing technology that is feasible in remote rural areas, but also maintaining the service provided by that technology. Much of its success is due to its ability to do both, unlike other renewable energy programmes that failed because they did not deliver on the second count.

The development impact of REDP was enhanced by additional support services such as seed capital, training and enterprise support. The programme also demonstrates the benefits of close local consultation and involving the community in decision-making, which creates a sense of ownership and responsibility for the success of the initiative.

Partnerships and stakeholder relations

Another lesson that emerges from these case studies is the importance of organising relations between key partners in the delivery model, and finding workable combinations of traditional market and non-market players. PERMER is a public–private partnership that involves national and local government and public and private sector concessionaires, and is funded by loans from international financial institutions. The Anagi programme would not have succeeded without the flexible approach taken to stove production, which entailed exploring different options and arrangements between local partners; while Tough Stuff and d.light have built local distribution channels and created local enterprise opportunities by training 'village entrepreneurs' to sell their products in more isolated communities. However, local training does not always guarantee success. Despite the inclusive design of the delivery model and local capacity-building initiatives, REDP was beset by technical problems that are partly attributed to a lack of training, and partly to the difficulty of retaining skilled technicians in the local community.

Engaging with customers and other stakeholders has emerged as a key challenge and area for innovation. PERMER mainly focused on its customers, and spent little time engaging in development discussions with beneficiary communities. REDP, on the other hand, followed a much more participatory process, deploying community mobilisers to raise awareness and facilitate local decision-making, organising educational visits to other micro-hydro plants, and treating local people as key partners in operating and maintaining the plant (although there have been issues with training and retaining local technicians, as noted above).

Finance for starting up, scaling up and sustainability

Finance remains a key challenge, and there is an ongoing debate about the relative roles of government, donors, and private social and mainstream investors in pro-poor energy delivery models. PERMER has been funded through a combination of loans from the World Bank and Global Environmental Facility, government subsidies and capital investment, private capital, and government support for tariffs. Tough Stuff, d.light and similar enterprises now face the challenge of scaling up their operations and increasing opportunities to provide this kind of access to energy in poorer markets, especially in sub-Saharan Africa. Their websites reflect their success in reaching their target audience, showing the high number of products sold and pictures of poor children reading by the light of solar lanterns. Donors and social investors have supported both companies' efforts to stimulate market development and scale up and replicate operations.

Tough Stuff and d.light have benefited from grants to support market and product development, and partnered local micro-credit institutions to help customers cover the up-front cost of their products. One of their major goals now is to demonstrate the effectiveness of the delivery model – in terms of development impact, financial sustainability and return on investment – in order to attract more mainstream investment to scale up their activities (Bellanca and Wilson, 2012).

5. Conclusions and Recommendations

The research carried out for this paper has yielded a number of findings that can direct further research, development support and targeted investment. Our key conclusions and recommendations are summarised here:

1. **Private sector interventions alone often cannot reach the poorest of the poor.** Energy delivery models led by the private sector are unlikely to reach the poorest on a large scale without support from the government or other external agencies, and considerable amounts of thinking outside the 'business-as-usual' box. The private sector may be able to reach those poor energy users who have certain capabilities and assets, but even this generally requires 'non-traditional' business partners, such as government, non-governmental organisations, enterprise associations, social enterprises, actors in the informal sector and active members of the communities themselves.

   In many cases, given the context and the target customers, a delivery model requires additional support services to make it work, either in the short term or in the long-term. In the short term these support services are often provided by entities other than the implementing agent. They may include awareness-raising, skills training, micro-finance, or support for research and development or feasibility studies. Longer-term subsidies tend to be institutionalised within government agencies and depend on a sustainable source of finance from budget revenues, as in the PERMER example in Argentina. There is also a role for government social protection programmes in reaching the poorest (MRFCJ 2012). These programmes might be integrated into a broader government programme of energy service delivery, ranging from full subsidy to market-based service delivery.

   A key challenge is to understand the best way of targeting government and donor support in order to stimulate and optimise private sector activities. The PERMER model is a public-private partnership and has used loans from the World Bank and Global Environment Facility as well as tariff subsidies and capital inputs by regional and federal government to cover the cost of instrastructure. Its main innovation is perhaps the use of concessionaires to implement the model, which was a new direction for World Bank assistance. In Nepal, the (subsidized) government programme REDP has provided training in agricultural processing, offered seed capital and set up savings funds to support productive activities to make use of the hydropower for development benefits and to increase payment capacity.

   The Anagi stove programme in Sri Lanka demonstrates that commercial initiatives are more likely to be successful if they target the 'less poor' and emerging middle classes, at least in the early stages of building the market. The Rural Stoves Market Project subsequently targeted poorer customers in partnership with small NGOs that deployed the stoves as part of development initiatives. Tough Stuff and d.light products have also been distributed as part of development programmes in sub-Saharan Africa. These solar product companies also use donor grants for market development and scaling up their business activities.

2. **Understanding the socio-cultural context is important in designing models for reaching the poor.** In addition to the 'enabling environment' of policy, regulation and services, this research highlights the importance of understanding the socio-cultural context of local preferences, community cohesion and social organisation. This may help identify new entry points for capturing local dynamism and innovation in designing products and services to meet local preferences. The socio-cultural context is also a key factor in determining whether a model that works well in one place may or may not be replicated in another.

   The REDP programme was possible due to a cultural shift within Nepalese society towards more community-based management of enterprises and resources. Levels of education also meant that champions within the community could understand the model and support its implementation. Targeted investment in the PERMER programme was possible because of the political will within government to promote decentralised electricity provision involving the private sector. However, a key challenge was the need for institutional capacity building in provincial government to manage the programme.

   In the communities targeted by Tough Stuff and d.light, the lack of electrification shapes local expectations (i.e. people are not expecting the grid to reach them anytime soon so

are more willing to try out solar power). On the other hand, poorer communities may be risk averse and suspicious of new products. To overcome this, the companies have worked with local communities on product design. The Anagi stove programme chose a final design for their stove, which was not the most efficient, but was more efficient than previous stoves, while being the most acceptable design to the users.

The additional resources allocated to a model that incorporates local preferences and expectations or that is organised around local social institutions, can be a short term investment that ensures the long term viability of the model.

3. **The success of energy access interventions should be measured in terms of development benefits.** Practitioners are becoming increasingly aware that the success of energy interventions should not be measured solely in terms of the number of households connected to the grid or efficient cookstoves distributed. The 'indicators of success' should reflect the development benefits generated by access to energy, such as improved health, education and livelihoods (IIED Energy Forum, 2012). For example, the PISCES project employed the livelihoods framework to assess the impacts of decentralised energy access programmes.[20] Indicators need to be agreed in advance, not only with development experts and government, but also with local stakeholders who may prioritise light, connectivity and education rather than climate mitigation or even health. There is a need to better understand the links between energy access and development outcomes in particular contexts, and better integrate energy access projects into broader rural development planning, which may include education on the links between clean energy access and health and livelihoods benefits.

   Monitoring and evaluation remains a key challenge. The case studies in this paper offer evidence of how local stakeholders have perceived the success of the initiatives. In the case of both PERMER and REDP, local communities valued the educational benefits of light. In the PERMER example it was noted that young people have benefited from the increased connectivity and a greater awareness of the outside world. Some expressed disappointment that the solar PV installations could not provide sufficient power for all the household appliances they required, and wanted additional lights, TVs, computers, fridges and water pumps. This suggests that agreeing indicators of success in advance with communities would have the added benefit of managing expectations.

   Debates around efficient cookstove programmes often highlight the disparity between local perceptions of benefits and the goals of those promoting the programmes (governments, aid agencies, NGOs). Anneke (2010) rightly highlights the need to understand these different viewpoints from the outset in order to effectively monitor whether and how local expectations have been met.

4. **Lack of knowledge and understanding of delivery models is a key obstacle to investment.** A key observation of smaller enterprises such as Tough Stuff and d.light is that potential investors and donors have insufficient understanding of how these models work. This is a barrier in particular for investors, which may be "socially responsible", but still require a return on their investment. There is therefore a need for more systematic analysis of delivery models, in order to provide investors, governments and donors with evidence of their impact, financial sustainability and potential rates of return (Bellanca and Wilson 2012).

   A better understanding of the nature and functioning of pro-poor energy delivery models can help investors understand the risks, generate more interest in these models, and allow donors and governments to target their grants and subsidies in a way that facilitates private investor support. It can also help governments incorporate energy service delivery for the poorest into other aspects of development planning.

   In particular there is much evidence around the success or failure of stove projects (e.g. Cecelski, 2004, Agbage, 2009 and Anneke 2010) but more case-study evidence is needed for other types of energy intervention. While NGOs, donor agencies and businesses are generally reluctant to share their failures, it is important to do so as these stories are just as enlightening as those of success.

   Finally, this evidence should be available not only in the form of academic research papers but in formats that are able to inform the decisions of investors and donors on whether or not to provide financial support.

5. **Applying business analysis tools to in-depth case studies can be an effective way to identify opportunities for pro-poor innovations within a delivery model.** This approach can help to see where adjustments can be made to a model (whether for profit or not) to make it pro-poor in a way that doesn't compromise the key elements of a sustainable enterprise. Case studies allow us to analyse the context of a given delivery model in some detail, and to understand the technical and technological challenges and solutions within that context.

   Using the Osterwalder canvas to analyse the nuts and bolts of a delivery model and the additional support services has enabled us to highlight design features that need particular attention when delivering energy services to the poor. These include targeting relevant customer segments with the value proposition; ensuring that finance and cost/revenue structures are sustainable; sourcing energy resources locally where feasible; and considering collaboration with non-traditional businesses partners, customers and other stakeholders as an integral part of the model.

   Close involvement of communities as key partners, as in the case of REDP, can help to create a sense of ownership and therefore longer-term sustainability of a delivery model. Such relations can help to overcome key

20 PISCES standards for Policy Innovation Systems for Clean Energy Security. See: http://www.pisces.or.ke/

issues such as ability and willingness to pay for goods and services, which may depend on awareness, trust and confidence, as well as on the affordability and quality of the goods and services provided. Distribution is a key area of challenge for solar product and stove producers, but also offers opportunities for local/informal entrepreneurs who can help to deliver products and services to outlying areas. Models that can respond flexibly to change enjoy more success. For example, the Anagi stove programme tried different options for local manufacturing, while the PERMER programme had to respond to the aftermath of a financial crisis.

The framework developed in this paper can be explored further to identify and categorise contextual factors to facilitate a more systematic analysis of the various key elements of a delivery model and its context. Efforts have been made to do this based on the 'market mapping' tool in the Practical Action publication *Delivering Energy for Development* (Bellanca *et al*., forthcoming), while Bellanca and Garside (forthcoming) are following up on this analysis in collaboration with CAFOD with the aim of applying the analytical framework in field situations.

The innovations, successes and challenges described in the case studies in this paper are only a fraction of the rich experience that is already out there. Only by systematically sharing and learning from such experiences can we ensure that energy delivery models employed in the future deliver fair and inclusive benefits to the poor. This is critical if countries are to meet the ambitious universal access targets set by the UN Sustainable Energy for All initiative.

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Sustainable energy for all? Linking poor communities to modern energy services

This paper explores the emerging concept of 'energy delivery models', looking at the nuts and bolts of how energy is delivered from resource to user, focusing on how to reach the poor in terms of energy access and opportunities in the supply chain. The paper introduces an analytical framework for the 'pro-poor energy delivery system' (including enabling environment and socio-cultural context, and the Osterwalder 'business model canvas' to analyse the delivery model itself). The paper contributes to current efforts by researchers and practitioners (notably Practical Action) to clarify the concept of 'energy delivery models' and to explore in depth how to deliver sustainable energy services to the poor that maximise development benefits.

This paper was produced by IIED's Sustainable Markets Group. The Sustainable Markets Group drives IIED's efforts to ensure that markets contribute to positive social, environmental and economic outcomes. The group brings together IIED's work on market governance, business models, market failure, consumption, investment and the economics of climate change.

ISBN 978-1-84369-865-4

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