Opportunities to achieve poverty reduction and climate change benefits through low carbon energy access programmes

A review of the portfolio of the Ashden Awards for Sustainable Energy, for the Department for International Development

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Executive summary

Headline issues

Small and medium enterprises[1] (SMEs) are contributing to low carbon economic development strategies by enabling wider access to low carbon energy by poorer households and small businesses. They complement initiatives, such as the multi-donor Clean Technology Fund, that focus on the transformation of high-emitting energy technologies for centralised power generation or industrial use.

Some SMEs have achieved impressive scale in low carbon energy access (LCEA) technology promotion, and in doing so, deliver well-being, poverty reduction and wider environmental benefits.

Socially-oriented SMEs seek to employ a mix of market and non-market tools to overcome affordability constraints to LCEA technology acquisition by poorer households. Affordability limits the wider uptake of some technologies capable of enhanced emissions reduction.

Prioritising benefits for the poor imposes high transaction costs and reduces the SME's opportunities to accrue profits.

National and international policies, market signals and finance instruments, including soft loans from international financial institutions and different sources of carbon finance, can influence the ways that LCEA SMEs operate, the types of services that they deliver and thus the trade-offs that they face between reaching the poor and delivering wider benefits.

Accelerating the expansion of LCEA SMEs so that they can play a more significant role in low carbon growth strategies will require policies, market and finance instruments, and technologies that support the achievement of an equitable and balanced mix of development objectives. There is a role for donors and international agencies in supporting research and innovation in these areas.

Background to the study

This report presents the findings of a survey of international winners of Ashden Awards for Sustainable Energy. Its aim is to inform the UK Department for International Development (DFID) and key international development partners of opportunities to scale up LCEA programmes in order to contribute to climate change mitigation, poverty reduction and progress towards the Millennium Development Goals.

The review surveyed the Ashden Awards' portfolio of 51 low carbon energy access projects. Based on preliminary evidence of achievement of scale and poverty reduction benefits, ten projects were selected for more in-depth assessment through the examination of secondary information and semi-structured interviews with project leaders.

The findings need to be treated as preliminary as some of the evidence needs triangulation across other sources and further research to substantiate it.

The study uncovered intriguing directions and trends that have implications for achieving poverty reduction, well-being improvements and climate change mitigation through increasing low carbon energy access. It has revealed the existence of vibrant and innovative

[1]For the purpose of this review, the term SMEs refers to the range of organisations, including for profit private sector companies, not for profit non-government organisations and government supported institutes that initiate and coordinate small and medium scale local-level projects to provide low carbon energy access goods and services.

low carbon energy small and medium enterprises operating at impressive scale in a number of developing countries.

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Summary of main findings

Direct benefits to the poor from low carbon energy access can be substantial. Direct benefits include: (1) better well-being through reduced health risks, increased opportunities for educational and social activities, and better communications and information access; (2) savings and income through lower recurrent energy expenditure and revenue generation opportunities. Both types can improve livelihoods and reduce vulnerability and so contribute directly or indirectly to poverty reduction.

Scale and impact are achievable by small and medium enterprises. SMEs promoting local LCEA technologies are serving a substantial number of people in developing countries and in many cases numbers served are growing rapidly. The ten LCEA SMEs surveyed in this review are estimated to have served 9 million beneficiaries.

Scale brings wider environmental benefits. SMEs can contribute to the reduction of greenhouse gas emissions and avoidance of deforestation through the promotion of low carbon energy access. The scale of the contribution is dependent on the technology, the technologies it is replacing, and the reach and sustainability of the LCEA promotion.

LCEA SMEs can contribute to growth in local economies through the development of technology and service supply chains and promotion of income-creating activities based on the technology. The greatest beneficial effects on local economies are from technologies that increase demand for local materials and create local jobs. Reduced imported fossil fuel use is another important economic benefit of some LCEA technologies.

LCEA SMEs face trade-offs in delivering direct and wider benefits. Decisions that SMEs make regarding the technologies they promote and business models they employ influence the mix of benefits that they are able to deliver. These decisions can be further influenced by policies, market signals, and finance instruments used by the SMEs. For the poor, the greatest benefits are from the technologies that are specifically designed for their use especially in the context of lack of access to alternatives. Achieving a desired balance of benefits requires understanding and taking account of these influences.

'Hybrid' business models combine commercial and non-profit attributes to reach poor and low-income users and achieve benefits. Some of the SMEs surveyed were formally classed as non-profit organisations and some as for-profit businesses. However, nearly all employ business models that combine both market and non-market approaches and financial instruments to reach poor and low-income users and achieve other desired co-benefits. Grants, subsidies, and soft loans are among the non-commercial instruments that have helped the SMEs achieve this.

LCEA SMEs are drawing on the carbon finance market, with potentially significant effects on direct and wider benefit trade-offs. Seven of the SMEs surveyed have entered into voluntary carbon deals or are arranging for carbon financing support. The opportunity exists for socially oriented organisations to use this support to reduce end-user prices and thereby to improve affordability for poorer households. However, the use of finance from carbon markets by SMEs providing energy access to the poor requires further inquiry, as evidence suggests that, as currently structured, such financing provides incentives for SMEs to emphasise emissions savings rather than direct benefits to the poor.

Affordability and the opportunity cost of using LCEA technologies are key determinants in reaching the poor. Technology design and use, affordability and delivery

model are the main determining factors in reaching poor users. Access to end user credit, at affordable rates and terms, is essential for bringing LCEA technologies to the poor. Microfinance institutions backed by soft loans and government subsidies are common mechanisms for making LCEA technologies affordable to the poor; however even with these the opportunity cost of technologies that do not offer income generating opportunities is very high for poorer households.

LCEA SMEs face high costs of innovation in design or adaptation of technologies, and in designing delivery mechanisms for these technologies. Current innovation by companies in the North or South does not often prioritise technologies or delivery mechanisms appropriate for the poor (with the exception of work on improved stove technology). This throws the innovation burden on the SMEs themselves, whose capacity to develop technology that requires scientific resources and investment capital is very limited. Supply channels for existing technologies need to function better and there are opportunities for South-South transfer of technologies, applications and delivery mechanisms.

Preliminary policy implications

Accelerating the growth of LCEA SMEs so that they can play a more substantive role in low carbon energy strategies across a range of developing countries will be dependent on:

- Policies - to create an enabling environment for LCEA SMEs to flourish – through coherent energy policies that specify the desired contribution of LCEA in achieving equitable energy access; the use of economic instruments such as taxes, import tariffs and subsidies in ways that support SME growth; and support for the availability of credit to end-users.
- Finance and investment – new and additional financial instruments and approaches are required to meet the objectives of LCEA SMEs to achieve direct benefits for the poor and wider environmental benefits. Both the regulatory and voluntary carbon finance markets may be important growth drivers if they can become aligned to the special requirements of ‘hybrid’ SMEs targeting energy access for poverty reduction.
- Global markets - that both support the growth of LCEA SMEs through higher fossil fuel costs and constrain them through component cost increases and the slow pace of relevant technological change. SMEs have little control over these factors.

Both direct benefits to the poor and wider environmental benefits have public good attributes. There is therefore an important role for development agencies and other external actors to perform in overcoming market failures by supporting innovation in:

- End-user financing - since one of the main barriers to bringing LCEA technologies to the poor is cost;
- Enterprise finance - including carbon finance, to minimise transaction costs and meet the specific needs of socially-oriented LCEA SMEs;
- LCEA technologies - that are affordable to the poor, can reduce poverty and provide other benefits including reduced vulnerability to climate change effects;
- Technology delivery mechanisms – for example supply chains, organisational structures, distribution, marketing and maintenance networks, training of technicians, education of end-users, web-enabled supply chains and distribution channels.

Section 1: Summary of what was done and why

1. Objective

1.1 This review is to inform DFID and other key international development partners about some critically assessed opportunities to achieve climate change and poverty reduction benefits through scaling up low carbon energy access projects delivered at local level by small and medium enterprises (SMEs). The review provides evidence for policy making in the context of the World Bank's Clean Energy Investment Framework, the proposed multi-donor Climate Investment Funds, the UK's Environmental Transformation Fund and other global and local initiatives to support energy access and the transition to a low carbon economy in developing countries.

2. Importance of the review

2.1 Low carbon energy access (LCEA) SMEs are already serving a substantial number of people in developing countries (~9 million direct beneficiaries of the ten projects reviewed in this study), and in many cases their market share is increasing rapidly.

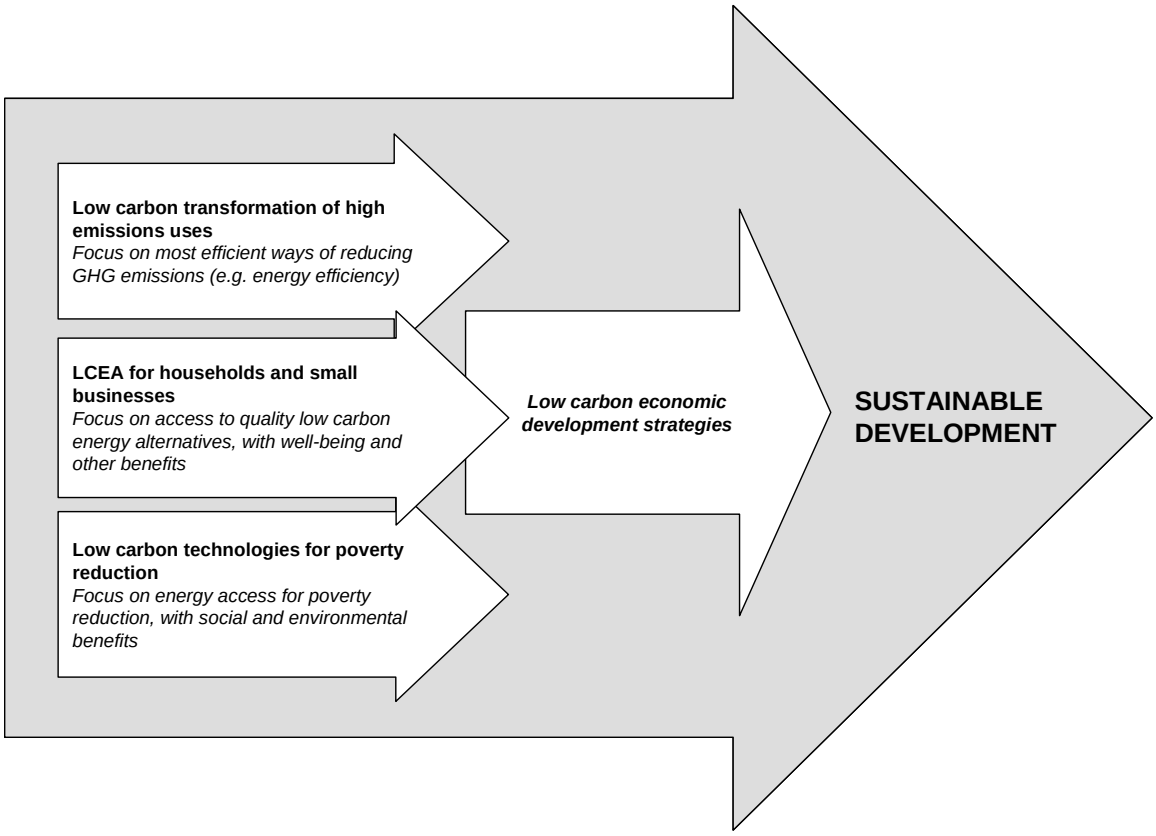
2.2 The success of LCEA SMEs is important because of the role of energy access in meeting many of the Millennium Development Goals[2]. It is from this perspective that the ability of SMEs to achieve scale becomes a development issue.

2.3 To the extent that LCEA SMEs can achieve scale, they can also contribute significantly to integrated strategies for low carbon economic development in developing countries. While much attention is now being given to reducing emissions in rapidly growing countries through large-scale transitions to clean energy technologies for centralised power generation and industrial use, it will be equally important over the long term to move society as a whole into sustainable, low carbon pathways. Low carbon energy alternatives for domestic and small business use contribute to improved well-being and climate change mitigation through both reduction and avoidance. Low carbon technologies can also potentially contribute to poverty reduction while increasing energy access for the poor. LCEAs SMEs have potential roles in these two areas (Figure 1).

2.4 The various types of low carbon technologies, the different delivery mechanisms and the economic and social contexts in which they are offered pose different opportunities and challenges from a development perspective. The LCEA SMEs reviewed in this survey covered the most important technologies used at a local level (improved stoves and brick-kilns which reduce wood demand; biogas systems; photovoltaic solar-home-systems and lanterns; water pumping systems). Projects using hydro or wind energy were not reviewed: the examples of hydro energy in the Ashden portfolio had not achieved large scale, and the portfolio has no examples of wind energy used at a local level. (Wind and hydro are widely used globally, but most often delivered on a large rather than local scale). The cases reviewed came from two very different and diverse regions – east Africa and south Asia. While this report does not include a detailed comparison of the technologies surveyed and their advantages and disadvantages in different contexts, the examples used provide an indication of where the major differences between technologies and delivery mechanisms lie in terms of achieving direct benefits to the poor and wider environmental benefits to society.

[2] As discussed in the DFID Report "Energy for the Poor: Underpinning the Millennium Development Goals" (online at http://www.dfid.gov.uk/pubs/files/energyforthepoor.pdf)

Figure 1: Low carbon economic development strategies in developing countries.



3. Acknowledgements

3.1 The review was conducted by the International Institute for Environment and Development (IIED), working closely with the Ashden Awards for Sustainable Energy. GVEP International provided extensive advice and support throughout the process. The review was wholly funded by DFID.

3.2 We are grateful to all the project leaders - Saroj Rai, Debesai Ghebrehiwet, Iwan Baskoro, Dipal Barua, Amitabha Sadangi, Ashililya Nyanda, Dharmappa Barki, Indrani Hettiarachchy, Harish Hande and Vidya Sagar for supplying information and giving their time for interviews, and to the following individuals for their input and comments on this review:

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- Andrew Pendleton, Christian Aid
- Alexis Rwabizambuga, London School of Economics
- Teodoro Sanchez and Maria Arce, Practical Action

4. Summary of methodology and research framework

4.1 The review was based on a survey of the 51 low carbon energy access projects across Africa, Asia and Latin America that received an Ashden Award for Sustainable Energy between 2001 and 2007[3].

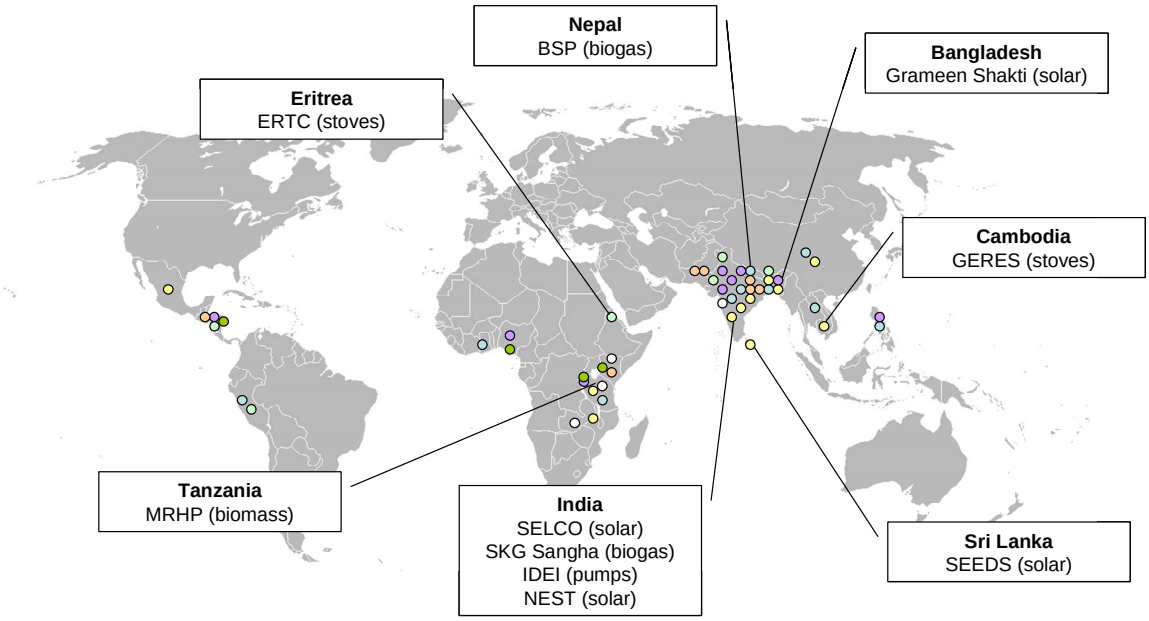
4.2 The research framework developed for the review is presented in Annex 2. The review consisted of:

a) Retrospective analysis of existing case study material on the 51 winners from the Ashden Awards files.

b) Detailed analysis of a sub-set of 10 projects whose selection was based on evidence of their success in achieving appreciable growth in scale while also delivering poverty and climate co-benefits. These projects are shown on the map in Figure 2 below. (The dots on the map show all Ashden Award winners since 2001).

Figure 2

Projects selected for in-depth assessment

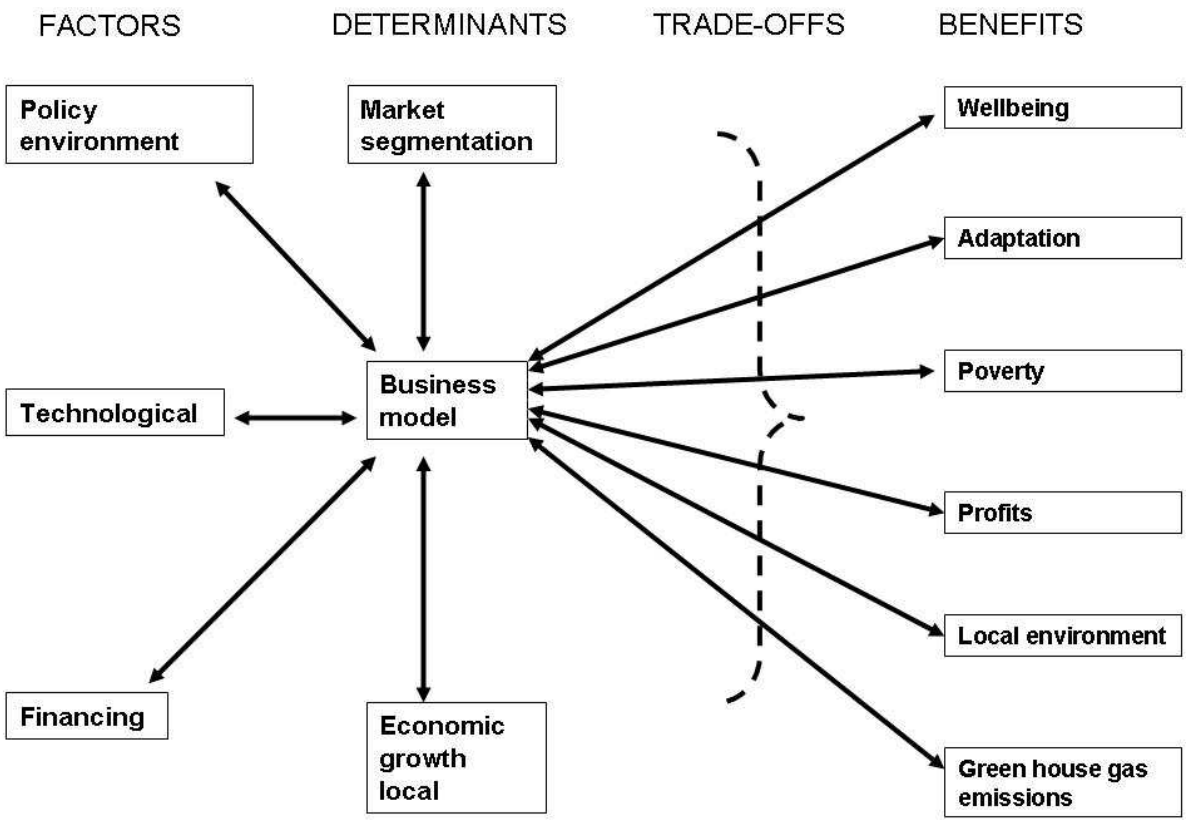


4.3 The sub-set of projects was examined using semi-structured interviews with project leaders conducted either by telephone (eight cases) or face to face (two cases). The questions posed during the semi-structured interviews are presented in Annex 3.

4.4 Project level information was then assessed using an analytical model that combines pathway analysis with a pressure-state-response approach. Information was gathered during the interviews to understand the factors important to the implementation of the business model (or expansion strategy). This was added to the evidence from the secondary sources and then plotted onto the analytical model. The analysis looked at how factors and determinants affected the scale of the enterprises and the delivery of direct and wider benefits. It also identified trade-offs between potential and realised benefits. The case analysis framework is shown in Box 1 below.

[3] Background on the Ashden Awards is provided in Annex 1.

Box 1. Case analysis framework



4.5 The analysed evidence from the ten projects was used to answer the key review questions. These were:

I. How can low carbon energy access projects and technologies have poverty and climate change co-benefits?
II. What factors contribute to, and what factors constrain, the sustained growth of low carbon technology SMEs that have poverty and/or climate co-benefit potential?
III. What conditions enable and encourage users, particularly the poor, to access low carbon technologies?
IV. What opportunities exist for low carbon technologies to be mainstreamed into development to achieve climate and poverty co-benefits?

4.6 In assessing poverty reduction benefits (through income generation, savings on expenditure and employment creation), the survey employed a broadly accepted income poverty threshold of USD2 per day. In assessing climate change benefits, the survey focused particularly on mitigation – reduction of greenhouse gas emissions, although it also compiled evidence of adaptation benefits where this was readily available. The review also identified other direct benefits from the projects including improved health, increased opportunity for study and socio-cultural activities, which are discussed briefly in the Findings section below.

Section 2: Findings

1. Overview

1.1 This section looks first at the ways that the ten Ashden Award winning projects reviewed have achieved poverty reduction, climate and other benefits, and the challenges and constraints they have faced in doing so. It then assesses the factors that appear to have been important for these projects to achieve scale while delivering co-benefits.

1.2 Table 1 below provides a brief overview of the ten projects. Additional information on these projects is included in Annex 4.

2. Direct and wider environmental benefits

2.1 In addition to increasing access to energy services, low carbon energy offers users and society a range of important benefits. This survey looked specifically at poverty reduction and climate mitigation benefits, which are discussed in detail below. It also found evidence of a range of other benefits including:

Household well-being:

- Health improvements from switching from open fires to improved stoves[4] or biogas stoves[5] are well recognised and in some cases quantified.
- Children's ability to study for longer hours with bright, reliable lighting from solar home systems (SHS) and lamps is widely accepted, although we found no studies quantifying these benefits.
- Safety benefits from fewer burns and reduced incidence of fires caused by open cooking fires, candles or kerosene lamps.
- Well-being benefits from reduced time spent on collecting wood, purchasing fuel or charging batteries – often reported as particularly significant for women and children.
- Solar-home-systems also power radios, mobile phones and (in some cases) television and entertainment systems. They enable users to keep in better contact with the wider world.

Local environmental impact:

- Reduced deforestation can be a major co-benefit of widespread use of improved stoves, biogas plants and crop waste brick kilns. A recent report on the GERES improved stoves programme estimates that biomass savings currently exceed the equivalent of 90 ha of forest per month, with that figure rising steadily as the improved design gains an ever larger share of the total cooking stove market[6].

Climate resilience:

- None of the SMEs surveyed are currently concerned with delivering benefits that increase resilience to climate change. However, some evidence of the link between certain technologies and improved adaptation were identified. For example:

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[4] See for example Von Schirnding, Y., N. Bruce, K. Smith, G. Ballard-Tremeer, M. Ezzati, and K. Lvovsky. 2000. Addressing the impact of household energy and indoor air pollution on the health of the ooor: Implications for policy action and intervention measures. Paper prepared for the Commission on Macroeconomics and Health. Geneva: World Health Organisation.

[5] For health data on biogas plants in Nepal, see Acharya, J., M.S. Bajgain, and P.S. Subedi. 2005. Scaling up biogas in Nepal: what else is needed? *Boiling Point* 50: 2-4.

[6] Bryan, S. 2008. Monitoring report: fuel savings with improved cook-stoves in Cambodia. Draft version 2, January 8, 2008. Phnom Penh, Cambodia: GERES Cambodia

- SHS sold by Grameen Shakti kept many rural households electrified and connected to communications links when cyclone SIDR wiped out grid power throughout the country[7] and solar systems were also installed in relief centres after the cyclone. Such alternatives will be increasingly valuable if frequency of storms and flooding increase in Bangladesh as projected. More generally, the potential for low carbon energy technologies in disaster relief is substantial and has been little explored.
- Northwest Tanzania is projected to experience an increase in extreme weather event frequency, with potentially serious effects on traditional mud-brick housing. Households that have built homes with fired bricks made from the Mwanza Rural Housing Project's kilns report many fewer occasions of storm damage to houses, indicating that this form of construction will be increasingly valuable in the future.

The main benefits reported in addition to poverty reduction and climate change mitigation benefits are indicated in Table 2 below.

[7] We do not have information on the level of damage to solar home systems from the cyclone.

Table 1. Overview of cases surveyed

SME	Country	Technology	Type of enterprise	Year started[8]	Sales to date	Estimated direct beneficiaries[9]	Current rate of sales[10]	Medium-term target
BSP-Nepal	Nepal	Domestic biogas plants	Government supported NGO	1992	170,000+	1+million	16,000 plants/year	25,000 plants per year by 2010, 50,000 plants/ yr by 2015
Energy Research and Training Centre (ERTC)	Eritrea	Improved wood stoves	Government institution	1998	60,000+	300,000	10,000/year	Provide every Eritrean household with a stove within eight years (Government policy statement)
GERES	Cambodia	Improved charcoal stoves	NGO	2002	380,000+	1.4 million	15,000/month	2 million sold by 2012
Grameen Shakti	Bangladesh	Solar home systems	Non-profit supplier and microfinance institution	1996	150,000+	1.2 million	5,000/month	By 2015: One million SHS, ten million improved stoves, 0.5m biogas plants
IDEI	India	Treadle pumps	NGO	1991	600,000+	3.17 million	40,000/year	Increase income of 250,000 small farmers by USD400/yr with treadle pumps and drip irrigation
Mwanza Rural Housing Project (MRHP)	Tanzania	Crop-residue fired-brick making	NGO	1998	Bricks to build ~100,000 homes	400,000	10 new groups/ year	To continue at current rate

[8] Indicates year that full-scale or commercial production or supply began.

[9] Figures provided by enterprises on beneficiaries are extrapolated from sales based on average customer household size and number of products per household (generally one, but more for GERES improved stoves).

[10] Where very recent monthly figures are available (and sales are not affected by seasonality), these are shown; otherwise figures are for most recent year that data are available.

SME	Country	Technology	Type of enterprise	Year started[8]	Sales to date	Estimated direct beneficiaries[9]	Current rate of sales[10]	Medium-term target
NEST	India	Solar lanterns	Commercial company	2001	100,000+	400,000-500,000	25,000/year	300,000 sold and sales of 100,000/yr in next 3-5 years
SEEDS	Sri Lanka	Solar home systems	Microfinance institution	2001	80,000+	350,000	1,300/month	Increase sales, expansion into other renewable energy technologies, e.g biogas and irrigation
SELCO	India	Solar home systems	Commercial company	1995	90,000+	500,000	450-500/month	200,000 customers (for all technologies offered) by 2011
SKG Sangha	India	Domestic biogas plants	NGO	1993	50,000+	250,000	7,000/year	100,000 installed by 2013

Table 2. Benefits reported from cases surveyed in addition to poverty reduction and climate change mitigation[11]

SME	Health and safety	Study	Environment	Climate adaptation
BSP-Nepal	Reduced indoor air pollution	Improved lighting for studying	Reduced deforestation from fuelwood collection	
ERTC	Reduced indoor air pollution		Reduced deforestation from fuelwood collection	
GERES			Reduced deforestation from fuelwood collection	
Grameen Shakti	Reduced indoor air pollution and fire danger	Improved lighting for studying		Resilience to loss of grid in major storms
IDEI	Improved family nutrition from more diverse crops and ability to purchase livestock		Less damaging to soils and controlled drawing of groundwater than diesel pumps	Resilience to drought conditions (unless water table falls below reach of pumps)
MRHP	More robust structures and amenable spaces for homes and other buildings		Reduced deforestation from fuelwood collection	Homes and other buildings more resistant to extreme climate events
NEST	Reduced indoor air pollution and fire danger	Improved lighting for studying		
SEEDS	Reduced indoor air pollution and fire danger	Improved lighting for studying		
SELCO	Reduced indoor air pollution and fire danger	Improved lighting for studying		
SKG Sangha	Reduced indoor air pollution	More time for studying due to reduced time spent collecting firewood	Reduced deforestation from fuelwood collection	

[11] Table summarises benefits reported by project leaders; not all information independently substantiated.

2.2 Providing direct benefits to the poor.

2.2.1 Energy is a crucial requirement for human development and an important element of poverty reduction, as access to affordable, reliable energy can provide income generation alternatives and employment creation.

2.2.2 Energy needs of the poor vary between genders and age groups and among households, communities and geographic regions. A clear understanding of these differing needs is crucial to any targeted intervention to provide energy services through LCEA. LCEA may be particularly well suited to poor communities because it can provide electricity in the absence of grid access and because it can replace costly energy options that the poor are often forced to resort to. Benefits to the poor from LCEA technologies, which in many cases remain poorly quantified, are generally of three types:

- increasing energy access for the poor and improving their resilience and livelihood opportunities;
- improving household well-being through contributions to reducing health risks, and better opportunities for home study, communications and information access, and socio-cultural activities. While these benefits can accrue to all users, they may be particularly important to the poor;
- contributing to poverty reduction, through the creation of new income generation opportunities and savings on recurrent energy expenses, which can comprise a substantial portion of the income of poor households[12].

2.2.3 A number of cases in the survey show how households can benefit from reduced reliance on costly fossil fuels and from additional income opportunities through increased energy availability (particularly for small businesses employing solar systems which were able to extend their working hours or add services such as mobile phone charging). Many LCEA technologies, particularly those that replace or reduce wood fuel, result in time savings, especially for women and girls. BSP-Nepal estimates that these savings average three hours per day for households switching to biogas digesters.

2.2.4 Most of the LCEA SMEs surveyed have contributed to increased energy access by the poor, although to varying degrees. The greatest impact has been from the technologies that are specifically designed for use by poor households without access to comparable alternatives; these include solar lanterns, improved stoves and treadle pumps. The SMEs disseminating these technologies report that the large majority of customers fall below the USD2/day poverty line (though rising costs of components are making solar lanterns less accessible to the poorest customers).

2.2.5 The SMEs surveyed that provide solar home systems are not collecting sufficient data on customer income levels to allow accurate segmentation of their markets against household or per capita income thresholds. In interviews SHS project leaders stated that their SMEs provide energy services to poor people, but they expressed concerns about the affordability of SHS technologies for the poorest people in their regions. Other reviews concur that affordability of certain LCEA technologies constrains the SMEs' ability to serve the poorest households[13].

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[12] For example, research by SEEDS indicates that their average customer household spends 19% of its monthly budget on energy (SEEDS. 2007. Funding for alternative energy sources. http://www.seeds.lk/Divisions/Funding%20for%20Alternative%20Energy%20Source%20-%2030.09.2007.pdf).

[13] See for example the International Finance Corporation report available on-line at http://www.ifc.org/ifcext/enviro.nsf/AttachmentsByTitle/p_CatalyzingPrivateInvestment_SellingSolar/$FILE/SellingSolar.pdf), also "Who benefits from solar home systems in India?" Kunal Mehta, Boiling Point No 51 (2005); and the GEF evaluation - "The GEF solar PV portfolio: emerging experience and lessons." Martinot, Rmankutty and Rittner (2000).

2.2.6 Assessing the total income of poor households that often live at least partially in non-monetised economies is very difficult. In the case of SEEDS it was possible to corroborate to some extent the information on SHS customer household income. SEEDS and other SHS SMEs in Sri Lanka have been able to service a client base of which approximately 40 per cent are in the lowest income category of around USD 1 per capita per day[14]. According to the Grameen Shakti project leader "using Grameen Bank criteria as a poverty indicator … the majority of the clients reached by Grameen Shakti come from a slightly higher income group than Grameen Bank members … So Grameen Shakti is reaching a slightly richer strata of rural people than Grameen Bank members who fall under the low income category." [15]

2.2.7 While both the biogas SMEs surveyed indicated that they serve quite poor communities, they also acknowledged that their customers were largely among the more prosperous households in those communities. Cost of the units is one factor in reducing accessibility by the poor, but poor households also generally lack the requisite number of livestock to feed the systems[16]. For this reason, SKG Sangha is now providing livestock with its biogas plants, which customers can repay either in livestock or in processed fertiliser.

2.2.8 The well-being of poor households is improved by LCEA in a range of ways. Health benefits from improved low carbon cooking technologies and the range of benefits from solar electricity have been discussed above. A study that assessed the impacts of the IDEI treadle pumps on child welfare concluded that increased household income from the pumps translated into improved health and nutrition, more resources for education, and a more stable home environment due to the reduced need for work-related seasonal migration by fathers.[17].

2.2.9 Poor families can spend a substantial portion of household income on energy, and LCEA can reduce this burden by replacing fossil fuels with renewable sources of energy such as sunlight and cattle dung, or by reducing the amount of firewood or charcoal purchased for cooking. These technologies eventually more than pay for themselves in fuel cost savings; see Table 3 below. As fossil fuel costs increase, fuel savings from LCEA will become increasingly significant to poor households, assuming they are able to afford the cost of the technology.

[14] Corroborative evidence can be found in the AC Neilson (2005) Sri Lanka solar industry market survey (2005) ACNielsen Lanka (Pvt) Ltd/RERED AU, May 2005

[15] Personal communication from Dipal Barua 08/05/2008

[16] BSP-Nepal estimate that households need to have the equivalent of dung from two large ruminants daily to adequately feed the small size digester they promote. This means that at least one third of rural Nepali families cannot use the technology.

[17] Couton, A. 2007. A fairy tale for all? A rapid assessment of IDEI's treadle pump program in Uttar Pradesh, and its impact on children's welfare. Acumen Fund.
http://www.climatecare.org/media/documents/pdf/acumen_tp_impact_on_children_report_070817.pdf.

Table 3. Financial payback period from fuel savings in some projects

SME	Product	Average unit cost	Financial payback period	Source of information
GERES	Improved charcoal cooking stoves	USD4	60 days (22% fuel savings)	Interview with project leader
Grameen Shakti	Solar home systems	USD450 (50W system)	At least 15% deposit then 2-4 years depending on cost of system and loan repayment terms.	Interview with project leader
IDEI	Treadle pumps	USD20-30 installed	More than paid back in one additional crop season	TERI 2007[18]

2.2.10 The third way that LCEA can benefit the poor is through opportunities for increased income. Of the cases surveyed, the most striking examples are the IDEI treadle pumps and MRHP's crop waste brick kilns. The treadle pumps are specifically designed for productive use by poor farmers. A recent study estimated that income of farmers (most of whom are farming 1 ha or less) increases by an average of USD410 per year with the ability to harvest up to three crops per year rather than only one[19]. MRHP has established over 70 brick making groups – many in rural areas – that generate income by making and selling bricks.

2.2.11 Other SMEs surveyed, particularly those dealing in SHS, reported cases of income generation through the use of the technology; although they do not formally collect data on the numbers of beneficiaries and levels of benefits.

2.2.12 Several of the SMEs have attempted to support income generation activities by poor users. While the potential for income generation by the poor through LCEA is substantial, achieving it is a long-term process that requires the development of skills and the availability of finance capital and markets for the goods and services being offered. In the case of treadle pumps, IDEI has been able to assist farmers to select, grow and market new crops. In another case, described in Box 2 below, a potentially profitable income opportunity has been constrained by the absence of established markets for the product.

Box 2. Increasing household income through biogas stoves with fertiliser production

In order to increase the benefits to customers from its biogas plants, SKG Sangha offers the option of a vermicomposting unit to turn the residue from the plants into high quality fertiliser. There seems to be widespread agreement that the fertiliser produced is of excellent quality and can improve crop yields substantially. But the units increase the cost of the biogas plants and no market institutions yet exist through which to sell the product. To date, only 6% SKG Sangha's biogas plant customers have opted for the vermicomposting unit, and the extent of income generation from them has not been assessed.

2.3 LCEA SMEs and climate change

2.3.1 The types of technologies surveyed either provide previously unavailable energy access or replace high emissions technologies using fossil fuels or unsustainably sourced wood which produce greenhouse gas emissions (see Table 4).

[18] The Energy and Research Institute (TERI). 2007. Socio-economic-techno-environmental assessment of IDEI products (Treadle pump). Report prepared for IDEI, March 2007.

[19] Ibid.

Table 4. Unsustainable energy sources replaced by products surveyed

SME	Technology	Technology replaced	Savings
GERES, ERTC	Improved stoves	Less efficient stoves	Wood
Grameen Shakti, SEEDS, SELCO	Solar home systems	Kerosene lanterns, candles, and kerosene and diesel generators	Fossil fuels
NEST	Solar lanterns	Kerosene lanterns or candles	Fossil fuels
BSP Nepal, SKG Sangha	Domestic biogas plants	Wood stoves and kerosene lanterns	Wood and fossil fuels
IDEI	Treadle pumps	Diesel pumps	Fossil fuels
Mwanza Rural Housing Programme	Crop waste burning brick kilns	Wood burning brick kilns	Wood

2.3.2 At scale, these SMEs can achieve greenhouse gas emissions savings – see Table 5. However, even universal domestic use of these technologies could only provide very modest contributions to lowering global carbon emissions as compared, for example, to transforming centralised power generation from fossil fuels in developed countries. If there is to be a significant global climate change impact from LCEA programmes, it will be in establishing long-term low carbon growth trajectories across the developing world.

Table 5. Estimated emissions savings of greenhouse gas emissions from projects reviewed.

Award winner	Country	Product	Number in use	Estimated emissions savings per product (tonnes/year)	Estimated emissions savings in 2008 (tonnes/yr)[20]	Source for extrapolation of 2008 figures
BSP-Nepal	Nepal	Biogas plants	170,000+	4.7	813,000	Ashden Awards case study 2005, based on CDM assessment.
ERTC	Eritrea	Improved wood stoves	60,000+	3.95	237,000	VER verification (personal communication from ERTC)
GERES	Cambodia	Improved charcoal cooking stoves	380,000+	0.43	165,000	VCU verification report for 10 May 2003 - 9 Jan 2007
Grameen Shakti	Bangladesh	Solar home systems	150,000	0.50 per 50Wp	68,000	CDM assessment 2008 (personal communication from Grameen Shakti)
IDEI	India	Treadle pumps	600,000+	0.48	290,000	2008 in use figure; emissions savings based on TERI 2006
MRHP	Tanzania	Residue-fired bricks	Bricks to build ~100,000 homes			Insufficient information on type of bricks avoided
NEST	India	Solar lanterns	100,000+	0.16	16,000	Estimate as reported from NEST
SEEDS	Sri Lanka	Solar home systems	80,000+	0.76	62,000	Total 2008 kerosene savings provided by SEEDS
SELCO-India	India	Solar home systems	90,000+	0.29	26,000	2008 in use figure; emissions savings from Ashden case study 2007, based on survey of kerosene use.
SKG Sangha	India	Biogas plants	50,000+	4.0	200,000	2008 in use figure; emissions savings from Ashden Awards case study 2007, based on measurement of wood saving, assumed unsustainable.

[20] Emission savings are estimated from the most recent Ashden Awards data, extrapolated for 2008 using the updated data on usage provided in interviews.

2.3.3 The assessment and interpretation of emissions savings is inherently more complex for small-scale LCEA systems than for large-scale energy supply. The following sections review the key issues by technology.

2.3.4 In the case of solar-home-systems, the amount of light provided by a small electric light is far greater than the kerosene lamp which it replaces (for example, a 5W fluorescent light has about 20 times the light output of a kerosene wick lamp). This additional service is not reflected if the emission savings are simply based on the previous kerosene use (as in Table 5). The wider services which the LCEA technology gives access to (such as radio, phone charging, television) are also not reflected.

2.3.5 In the case of improved stoves and biogas systems, the emission savings depend on the amount of wood or charcoal saved, and the sustainability of the supply. Detailed surveys of savings and sustainability have been undertaken for both BSP and GERES as part of carbon finance assessments. ERTC and SKG-Sangha have surveyed wood savings, and assumed from local knowledge that the wood supply is largely unsustainable.

2.3.6 About three quarters of the treadle pumps provided by IDEI replace existing diesel pumps, and therefore directly reduce emissions from diesel. The remainder provide pumping services which were not available before: some of these would have been provided by future increase in the uptake of diesel pumps (avoided emissions) and some provide service where it was not available before.

2.3.7 Some of the project leaders interviewed identified the need to investigate properly what households would have done without access to the new LCEA technology so that accurate and realistic estimates of emissions savings can be carried out[21].

2.3.8 Until very recently, the SMEs surveyed were little motivated by a desire to optimise emissions benefits. However, the possibility of accessing carbon finance is likely to change this. Seven of the SMEs surveyed either have entered or are negotiating carbon trades (BSP-Nepal, ERTC, GERES, Grameen Shakti, IDEI, SELCO and SKG Sangha). None of the cases provided evidence of the emergence of government incentives to LCEA SMEs for increasing their emissions savings.

2.4 LCEA SMEs and local economic development

2.4.1 The main contributions of these cases to local economic growth have occurred through supply chains that employ local materials and create jobs for local labour, for example:

- The stimulation of the SHS sector in Sri Lanka through the microfinance provided by SEEDS has spurred an increase in the number of solar companies, from three when the programme began to 11 today, resulting in “thousands” of new jobs.
- BSP-Nepal has helped in the establishment of 70 biogas companies, creating between 2,500 and 3,000 jobs. Added to this are 16 registered biogas digester workshops, employing between five and 10 people each, to service the companies.
- MRHP in Tanzania has started up 70 brick making groups which employ full-time and temporary labour.
- IDEI estimates that total wealth created through the treadle pump supply chain and on the farms of users up to March 2007 totalled nearly £390 million. Additional

[21] From a clean development perspective it would be rational to compare at some aggregated geographic level – a district, a country - the emissions from the use of the electricity-generating LCEA technologies with the emissions expected from a grid serving centralised energy generation technology, as well as with the emissions produced by decentralised alternatives such as kerosene lanterns or battery charging systems. Such a comparison of emissions would give a clear indication of the relative merits of decentralised as compared to grid-based energy access strategies.

growth is likely to have occurred through increased farm productivity and increased local marketing of crops.

- Grameen Shakti employs over two thousand people.

2.4.2 Developing supply chains employing local material and labour is a long process, requiring considerable investment by project initiators. Several of the SMEs have put substantial effort into building and nurturing their supply chains, offering technology transfer, training, start-up financing, and quality control. BSP-Nepal, is plays an 'umbrella' function in supporting other SMEs. IDEI, MRHP and GERES do similarly. While some maintain arm's length relations with manufacturers or retailers, close relations are common: *"my dealers are almost like my employees"* (President of NEST). IDEI licenses and monitors every enterprise in the treadle pump supply chain, from its 34 manufactures to its 132 distributors, 1,043 retailers and 1,500+ installers.

2.4.3 The LCEA technologies encountered in this review have different effects on the local economies they are introduced into. To understand better these effects a simple local economy model was applied to selected cases. The model relates growth drivers, supporters (linkages) and leakages to production, consumption and investment. Box 3 shows the generic model. Annex 5 provides three illustrative examples of what can happen when a LCEA technology is introduced to a local economy. Although, as shown in the individual applications of the models, the information on linkages is incomplete, application of the local economy models is informative in terms of possible and likely effects of the three different LCEA technologies. These effects are summarised in Table 6 below. The virtuous cycle through growth linkages depends to a large extent on what demand patterns the increases in local wages precipitate – increases in wages for the poorer households are likely to lead to increased demand for local non-tradeables and fewer leakages from local economies.

Box 3. Effects of LCEA technology introduction on growth of local economies

Simple conceptual model of growth in local economies

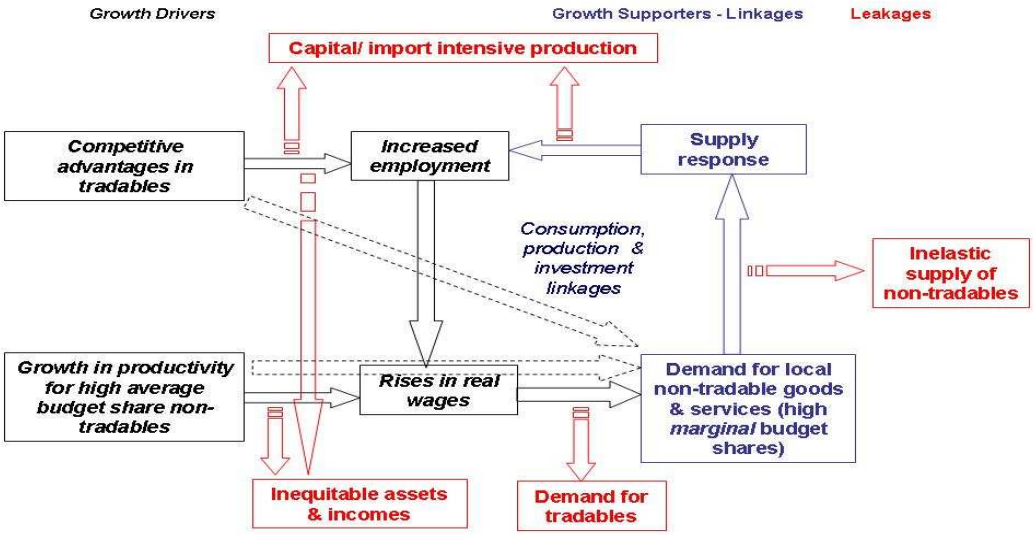


Table 6. Effects of LCEA technologies on growth of local economies

Projects, technologies	Growth drivers	Growth supporters	Leakages
SEEDS, Sri Lanka Solar Home Systems	Supply of SHS leads to increased local employment of installation technicians and micro-credit staff.	Some evidence of linkages to other productive activities by households e.g. mobile phone charging service. Also small businesses are important customers.	SHS are imported and are capital intensive leading to leakage of capital from local economy, but also reducing fossil fuel imports, reducing or nullifying net leakage effect.
MRHP, Tanzania Crop waste brick kilns	New market created for crop waste and for fired bricks leading to increases in local employment and wage rises.	Availability of bricks leads to demand for labour for house and other building	Crop waste often imported. Inelastic supply means that prices rise.
IDEI, India Treadle water pumps	Treadle pumps made locally from mainly local materials – increasing demand for labour and raw materials. Pumps increase agricultural productivity and in turn demand for agricultural labour.	Demand increase for local non-tradeables including knowledge on crop combinations, local market information, innovations in land use, use of bio fertilizers etc.	None identified from information available.

2.5 Trade-offs in benefit delivery

2.5.1 The main objective of the LCEA SMEs surveyed is to promote technologies that increase clean energy services to households (and small businesses) that previously did not have access to such services. Benefits flow from low carbon energy access. This report is concerned with two broad sets of benefits that LCEA technologies can deliver, namely direct benefits to poorer households including well-being improvements and poverty reduction, and wider environmental benefits including reduced greenhouse gas emissions and avoidance of deforestation. The technologies promoted by the SMEs have different potentials in terms of greenhouse gas savings, because of the different sources which they replace. They also have different potentials in terms of direct benefits to the poor, due to differences in affordability, savings on recurrent energy expenditure, income generation potential and contributions to growth in local economies through employment creation.

2.5.2 The technologies also have different associated costs – costs of access and use to end-users, and costs of delivery to the SMEs. Transaction costs of delivering LCEA technologies to poorer households can be significantly higher than to better off households, particularly where micro-finance has to be organised. Transaction costs have to be covered by the SMEs and this reduces any profit from the LCEA enterprise for re-investment. The SMEs are therefore faced with choices as regards technologies to promote and customers to target. These choices involve trade offs[22] in the delivery of benefits that the SMEs make - implicitly or explicitly.

[22] A trade-off involves a sacrifice that must be made to obtain a certain outcome, rather than other outcomes that can be made using the same required resources.

2.5.3 The survey results show that in reality delivering the two sets of benefits (direct benefits to the poor and wider environmental benefits) requires different and sometimes incompatible business models. Wider environmental benefits are greatest when the switch to low carbon technologies is made by high emitters of carbon. At the household level the use of wood fuel causes high carbon emissions – though the absolute level of emissions depends on the way trees and forests are managed. Improved wood stoves and charcoal stoves can reduce emissions and these technologies are being offered in accessible ways to the poorest households. Biogas digesters are less affordable both in terms of initial purchase price and the livestock manure required to supply adequate feedstock. SHS which provides lowest per unit carbon savings is also one of the most expensive. Reaching poorer households is expensive and means the SMEs have less opportunity to invest in non-recoverable costs such as technology development.

2.5.4 The analysis of the different project cases used the framework illustrated in Box 1 (see para 3.5 in section 1 above). The completed analytical models for each of the project cases are shown in Annex 6. Table 7 below lists some of the benefit trade-offs found in the projects reviewed. The trade-offs that were identified most often were:

- Environment, emissions and user well-being versus poverty reduction - whereby in order to achieve the primary objectives the project accepts market segmentation effects and addresses mainly better-off households (in biogas and solar home systems).
- Poverty reduction versus dividends to SMEs – whereby the SME foregoes the possibility of accruing profits in favour of reinvesting in the transaction costs of reaching the poorer end-users.

Table 7. The benefit delivery trade-offs identified from project cases

Project case	**Trade-offs** (first against second)	**Explanatory comments**[23]
BSP, Nepal, biogas digesters	Environment and Well-being vs Poverty reduction	Seeks to maximise the expansion of end-users in order to achieve largest reductions in wood burning and to reduce indoor air pollution. Poorer households are unable to use the technology because they cannot acquire sufficient animal dung and cannot afford the loan to be able to purchase the digester.
	Profits vs Poverty reduction	Digester companies implement business plans that target better off households to maximise profits that are seldom reinvested in companies
ERTC, improved stoves, Eritrea	None identified (government agency that provides 100% subsidy to clients)	The SME is supported by the Government and able to provide stoves and training in stove construction free of charge to clients. Thus costs to end-users and SME vastly reduced hence no trade offs
GERES improved stoves, Cambodia	Poverty reduction vs Profits	No dividends accrue to GERES. Income to supply chain supports local economic growth
Grameen Shakti solar home systems, Bangladesh	Profits vs Poverty reduction	Profits reinvested in business not channelled through local economy. However, job created and businesses supported
	Well-being vs Poverty reduction	Limitations in reaching targeted poorer households. However, adjustments being made to technologies and new financial products being offered
IDEI treadle pumps, India	Poverty reduction vs Dividends	No dividends for IDEI. Dividends through supply chain contribute to local economic growth
MRHP crop waste brick firing, Tanzania	Profits vs poverty	Brick making groups in the urban areas are targeting better off and institutional purchasers
NEST solar lanterns, India	Poverty reduction vs Profits	Little profit to SME from lanterns. Profits from silica ventures reinvested in core business
SEEDS finance for solar homes systems, Sri Lanka	Emissions vs Poverty reduction	Limited ability to reach targeted poor households. However, adjustment of technologies being tried and more accessible financial products being offered
SELCO solar home systems, India	Well-being vs Poverty reduction	Reaching poorer households has required adjustment of technologies being sold and new financial arrangements offered in partnership with SEWA Bank .
SKG Sangha biogas plants, India	Environment and Well-being vs Poverty reduction	Main objective of improving indoor air pollution overrides problems of technology inaccessibility for poorer households

[23] All information in the explanatory comments is taken from interviews with project protagonists or secondary data provided by Ashden Awards

3. Achieving scale

3.1 The review confirms that LCEA SMEs can contribute to low carbon growth strategies that address domestic and small business use and that increase energy access and benefits to the poor. However, for that contribution to be meaningful, achieving scale is essential. This section looks at how the SMEs have managed to achieve impressive growth through the development of business models that give particular attention to the achievement of co-benefits, particularly for poor and low-income households.

3.2 Delivering benefits requires a special kind of business model. The SMEs surveyed, be they commercial companies, non-governmental organisations or microfinance institutions, all have a strong social orientation and a mission to bring energy to poor households. The main elements of these business models, summarised in Table 8, include institutional arrangements, enterprise financing, end user financing, technological innovation, and production and delivery.

Table 8. Summarised business models of programmes surveyed

Award winners	Summary of business model
BSP-Nepal	Provides technical supports to SMEs which provide technology and services to qualifying households. Households also get grant subsidies of around 30% of the total biogas digester cost
ERTC	Government agency investing in public good research and training. National and sub-regional government support for expansion strategy. Negotiating GEF support based on emissions reductions.
GERES	Umbrella NGO involved in product and market development, mainstreaming of technology in existing commercial stove market and ongoing quality control and support. Funded through donors and negotiating voluntary carbon trades.
Grameen Shakti	Non-profit entity providing SHS. Vertically integrated from production to sales and financing. Some components manufactured outside. Offers credit to buyers through microfinance facility and subsidy. Funded through national World Bank-supported initiative, negotiating CDM carbon finance.
IDEI	Umbrella NGO involved in product and market development, support to supply chain for commercial production, and promotion, quality control and monitoring. Funded through donors and negotiating voluntary carbon trades.
MRHP	Umbrella NGO promoting and providing training to SMEs in technology; also arranges loans and provides some follow up and advice. Funded through donors.
NEST	Commercial in-house production of lamps; sales through network of licensed dealers. New lamp rental enterprise. Side ventures to mine and process silica.
SEEDS	Non-profit entity. Provides micro-finance to stimulate sector development and offer access to lower income households. Funded through World Bank-supported initiative.
SELCO	Commercial SHS production and sales. Some components manufactured elsewhere. Tailors systems to customers' needs and budget and offers local service. Assists customers to obtain credit from commercial finance institutions. Employs grants, soft loans and voluntary carbon finance for innovation.
SKG Sangha	Non-profit domestic biogas company. Vertically integrated production, sales, financing and service. Costs kept down through on-site construction employing customers' labour. Funded through government subsidies and voluntary carbon finance.

3.3 Institutional arrangements. The SMEs were striking in their use of a creative mix of market and non-market tools and structures to achieve scale while delivering co-benefits,

especially for the poor. Neither entirely commercial nor wholly non-profit[24], these hybrid institutions can best be described as social enterprises evolved expressly to deliver co-benefits sustainably and at scale. It is notable that the majority of these SMEs have been led by the same individuals since their early days, and that the SMEs and their leadership were motivated by a strong mission that guides organisational objectives. It may be that such clear and sustained leadership is necessary for scaling out clean energy technologies while generating co-benefits, given the range of challenges discussed in this report.

3.4 Enterprise finance. Because of their emphasis on achievement of co-benefits, these SMEs face different opportunities and constraints regarding access to finance than more purely commercial enterprises do.

3.4.1 On the opportunity side, bilateral and multilateral donor agencies and private foundations have played a major role in promoting LCEA technologies in developing countries, and in some cases national donor-funded programmes have been key factors in accelerating expansion of the projects surveyed.

3.4.2 Over the past ten years, the International Financial Institutions (IFIs) have worked through governments in many countries to increase access to renewable energy technologies and grow the alternative energy sector. The World Bank-funded Renewable Energy for Rural Economic Development (RERED) programme in Sri Lanka and Rural Electrification and Rural Energy Development Project (REREDP) in Bangladesh are largely responsible for the rapid expansion of the SHS programmes of SEEDS and Grameen Shakti by providing capital through soft loans for them to create and service microfinance loan facilities offering favourable credit terms (in the case of SEEDS) or subsidies (in the case of Grameen Shakti) to customers.

3.4.3 BSP-Nepal has been supported since its inception through grants from German and Dutch development assistance agencies to the umbrella organisation that supports BSP. In addition, the World Bank provides the umbrella organisation with grant finance in recognition of successful LCEA SME scaling up – in effect a pull mechanism. This has allowed BSP-Nepal to support the slow but steady evolution of the commercial biogas sector through training, quality control, and technical and marketing assistance. Given the still small-scale nature of most of the biogas plant production and installation enterprises, it is unlikely that the sector would have expanded at the rate it has done without this support.

3.4.4 The emergence and rapid growth of the treadle pump industry in India and the improved stove industry in Cambodia are due to the efforts of grant-funded NGOs, which have been able to devote more resources than would be available to a commercial enterprise for technology development, market research, supply chain creation, quality control and promotion. In the inception the treadle pump programme support was provided by the Swiss Agency for Development and Cooperation (from 1992 to 2000) and IDE India has also received support from several private foundations. It has recently received a large grant from the Bill and Melinda Gates Foundation, which will be used for another major phase of scaling out. The European Union has been the major supporter of the improved stove programme, which is now also receiving funding from GEF and Dutch and Danish development agencies and is in negotiations with the World Bank for support to a national improved stove programme.

3.4.5 Commercial SMEs have very limited access to grants and therefore are more likely to rely on commercial or IFI loans and social investment funds such as the Acumen Fund. Some commercial SMEs feel that the grant funding available to NGOs causes market

[24] Many of the civil society enterprises that were initiated as non-profit are now using co-owned non-dividend formats whereby employees co-own shares of the enterprise but do not receive dividends. Non-employee share holders do receive dividends but can not own sufficient shares to force managerial changes.

distortions and hurts their ability to compete: *"my greatest competition has been the non-profits because they can subsidise their products and attract the best employees with high salaries"* (SELCO CEO). The actual situation is more complex, with non-profits able to expand into unprofitable areas of work through grants, and with commercial SMEs accessing funding from some sources on terms that are equivalent to grants; see Box 4.

Box 4. Financing strategies of LCEA SMEs for achieving co-benefits

SELCO, a commercial SHS company, has sourced grants and soft loans to increase its ability to meet the need of its customers, particularly the poor.

NEST, another commercial company, has entered into a profitable joint venture whereby NEST mines silica in India and sells it to a Japanese solar company. In exchange the Japanese company assures NEST a guaranteed supply of silicon components for its PV production. The venture has proven to be highly profitable, and NEST is reinvesting the earnings into a new venture to provide daily lamp rental services to the poorest customers at the same cost as a day's supply of kerosene.

The microfinance institution SEEDS and the national sector programme BSP-Nepal function as 'apex institutions' supporting the development of the sector without themselves profiting from it. Their own costs are covered by income from its loans in the case of SEEDS and by government and bi-lateral grant funding and CDM financing in the case of BSP-Nepal.

3.4.6 Carbon finance has recently been added to the finance mix. In order to secure more sustainable funding sources than grants and government support, several SMEs are entering the carbon finance market, which offers both opportunities and challenges. Four SMEs (ERTC, GERES, SELCO and SKG Sangha) have signed contracts for voluntary carbon trades, one (IDEI) is in the process of validation for voluntary trading, and three (BSP-Nepal, ETRC and Grameen Shakti) have or are working towards Clean Development Mechanism (CDM) regulatory carbon trading. As currently structured, both voluntary and CDM carbon finance carries substantial administrative and financial costs – some of these costs are independent of scale and so fall disproportionately on SMEs. Their willingness to enter these processes therefore indicates their strong desire for sustainable funding to expand and improve those aspects of their operations that deliver co-benefits but are not fully financially viable, including reducing the costs for poor end-users. However, if carbon trading becomes an important source of finance for LCEA SMEs, the desire to maximise emissions savings may have two consequences:

- Pushing some less socially oriented SMEs upmarket – away from poorer households and into segments of the market where sales volumes can be achieved more easily and emission savings can be more easily verified
- Discouraging the roll-out of technologies that are more accessible to poorer households, but deliver lower greenhouse gas emissions per unit of investment (or where emission savings are less easily verified).

3.4.7 Profile is important. International visibility seems to greatly increase an SME's ability to access enterprise finance, including carbon finance. Several SMEs noted that receipt of an Ashden Award and other awards brought donors, investors and potential partners to their doors: *"[after receiving the Ashden Award], my company became instantly global"* (President of NEST); *"we used to think publicity wasn't important. Now [since receiving the Ashden Award] we realise it's essential"* (President of SKG Sangha). Award winners feel that the award gives them a 'quality branding' that attracts support.

3.5 End user financing. To benefit the poor, LCEA technology products need to be affordable to them. The most common ways that products are made affordable to lower

income customers are through (i) a rapid payback period (see Table 3 above); (ii) flexible, low-interest credit, principally through specialist microfinance institutions; or (iii) local or national government subsidies.

3.5.1 The ability to offer flexible, affordable credit has been crucial to achieving scale and reaching poor and low-income market segments. In Bangladesh and India, the microfinance sector is well developed and has been willing to offer loans for some LCEA technologies, most notably SHS. On the other hand, SELCO in India found that commercial banks needed to be sensitised and convinced before they were willing to enter the sector.

3.5.2 Mainstream finance options are generally not available for inexpensive products. NEST and IDEI have both struggled to find ways to help their customers obtain finance. NEST offers credit to its dealers to allow them to sell to customers on instalment, an option that 60 - 70% of all customers for its USD36 lamps take. IDEI requires its licensed dealers to provide up to 120 days of credit to customers to allow them to bring in a harvest before paying. IDEI is also collaborating with a major Indian bank to establish a 'nano-credit' facility for its customers because microfinance institutions, although widespread in the areas IDEI works in, will not service loans for the relatively small cost (USD20-30) of a treadle pump, nor do they provide loans for agricultural uses.

3.5.3 Solar-home-systems and biogas units are more expensive than the other technologies. Poor people's ability to access these facilities can be constrained by need for collateral for loans and complicated administrative requirements of subsidies, and the opportunity cost of investing in a loan to acquire a LCEA technology that does not contribute directly to household income may be too high for the poorer households – despite recognised well-being co-benefits. As discussed above, some SMEs have sought to overcome this problem through encouragement of income generating activities based on the technology; however the challenges they face can be substantial. The difficulties of reaching poorer customers with these technologies have been compounded by component price rises (especially photovoltaic modules and batteries) and withdrawal of government subsidies for both SHS and biogas in India.

3.6 Technology and the need for innovation. LCEA is in some ways inherently pro-poor in that it provides alternatives for poor communities without grid access. However, simple and reliable technologies that meet current needs and offer tangible benefits, particularly financial ones, are especially suited to the needs of poor households. The financial benefits from IDEI's treadle pumps have been discussed earlier. NEST's solar lamps offer a brighter and cleaner alternative to kerosene lanterns. GERES improved stoves are nearly identical to the traditional Cambodian charcoal stoves; so require no training or changes in cooking practices.

3.6.1 Several of the SMEs have adjusted and are adjusting their product mix and credit options to better meet the needs and budgets of poor customers; some of these innovations are listed in Table 9 below.

3.7 Promotion and delivery. The SMEs addressed the issues of product promotion and delivery from the perspective of the benefits they aimed to deliver, particularly in terms of benefits for the poor. Reaching poor households means bringing products and services to their doorsteps. SMEs stressed the importance of local service, including the employment of local staff known to customers. SKG Sangha selects its service technicians from among the youth of customer families because they will be familiar both with the technology and the community. SELCO has established 25 regional service centres and aims to increase the number to 50 over the next few years. SEEDS and Grameen Shakti representatives visit customers on a monthly to collect payments and check on their SHS systems. Grameen Shakti has 387 local offices that collect repayments. IDEI and GERES work through local supply chain agents.

Table 9. Pro-poor LCEA SME strategies

Mechanism for reaching poor customers	SME employing mechanism
Expansion into pro-poor technologies	
Improved stoves	Grameen Shakti, SELCO and SKG Sangha
Drip irrigation	SEEDS and IDEI
Small SHS using LED	Grameen Shakti
Finance instruments for the poor	
Daily rental of lanterns	NEST
Nano-credit facility with commercial bank	IDEI
'Micro-utility' SHS sharing	Grameen Shakti
Subsidies through advances on carbon finance	SKG Sangha
Other mechanisms for reaching the poor	
Biogas plants with loan of livestock	Grameen Shakti and SKG Sangha

3.7.1 Familiarity with and accessibility of the technology facilitate end-user interest. Availability of information on the technology and its benefits (often a role for NGOs or international agencies) is important. Often there is a lack of awareness, especially in poor communities, about the benefits of clean energy, such as health and cost savings, compared to alternatives.

3.7.2 Well-targeted promotion is also critical to reaching poor communities. Product promotion often begins well before commercialisation, to sensitise prospective customers and to promote the product to potential manufacturers and dealers. Much promotion done by these SMEs is at village level, with an emphasis on demonstrations, but broader campaigns are also effective: sales of GERES stoves increased by 105% in the year following a major television, radio and newspaper national campaign. Effective promotion generally requires significant up-front financing.

3.7.3 Capacity to monitor and evaluate (M&E) may also support SMEs' ability to expand their services and provide co-benefits. Most commercial SMEs have only a limited ability to monitor trends affecting their product or evaluate its uptake and benefits. This limits to some extent their ability to forward plan or respond to opportunities. Well-resourced NGOs often do have M&E capacity, and can use it to better understand market issues and trends. Both IDEI and GERES have implemented comprehensive M&E systems that provide ongoing information they can use to better support enterprise development.

4. Accelerating expansion: triggers and constraints

4.1 While the SMEs have been able to develop business models that have allowed them to increase their scale of operation while delivering a range of co-benefits, particularly to poor and low-income households, their future success also depends on a range of factors largely outside of their control. This section looks at the policy, development assistance, financial, and trade environments in which these SMEs operate, to identify the factors that can accelerate or impede continued expansion.

4.2 Policy environment. The extent to which national and state policies have supported LCEA SMEs varies among the cases, but where it has been supportive it has contributed importantly to the SMEs' ability to grow.

4.2.1 In two cases (BSP-Nepal and ERTC in Eritrea), the Government has played a lead role in the development of the project and dissemination of the technology. The Government of Nepal through BSP[25] provides subsidies to end-users, and supports BSP to provide a quality control function for biogas digester promotion; this has been crucial to the rapid scaling out of the sector over the past fifteen years.

4.2.2 While government subsidies aimed at increasing access have been essential to making some SME businesses viable in their early stages, they have sometimes proven unreliable as they depend upon the often changing priorities of the political directorate. For example, subsidies for biogas in India, once abundant and generous, have been largely phased out over the past few years. Subsidies can also constrain growth of the sector if not available to all SMEs: *"Subsidies in one way is good and in one way is bad"* (President of SKG Sangha). While some SMEs, including SKG Sangha, have scaled out significantly through the availability of subsidies, other SMEs, such as NEST and IDEI, have intentionally developed business models which do not depend on government subsidies. Subsidies are thought by some to distort the market by undervaluing products and reducing overall willingness-to-pay. However, subsidies can play an important role in introducing new technologies by providing an incentive for people to try them, and they can also bring more technologies within the reach of poorer households.

4.2.3 While climate change concerns are creating incentives for LCEA in many countries in the North, they remain a secondary concern for the governments of the countries surveyed, and there are no incentives in place to specifically encourage climate mitigation through the use of LCEA technologies[26]. This is understandable considering the many other development challenges these countries face and the very small contribution of domestic users in these countries to overall global emissions. Incentives are more likely to support increasing energy access, particularly for those communities beyond the reach of grid electricity.

4.2.4 The main policy impediment to the expansion of LCEA from PV solar home systems is government preference for grid electricity, which is often shared by end users. The SMEs in some countries believe that renewable energy is not a high government priority, and that policy-driven incentives favour non-renewable energy options. They report that most subsidies and incentives are aimed at bringing people on-grid, and consumers generally pay well below full cost, making alternatives such as solar comparatively expensive. If the government has plans to expand grid access to an area, most poorer consumers will wait for it rather than invest in another option. To overcome this reluctance to invest in alternatives, SEEDS's finance contracts with buyers include a guaranteed refund of equity if the grid becomes available to a customer before the solar system is paid off. Another constraint that solar SMEs face is that government plans for expansion are sometimes short-term and

[25] In addition to Government support, BSP-Nepal receives substantial bilateral donor funding.

[26] While governments are involved with the approval of Clean Development Mechanism projects, the finance for these comes from overseas.

uncertain; so solar companies cannot invest in an area with a high level of confidence that grid power will not arrive soon. Problems with reliability of grid electricity and their susceptibility to increasingly frequent extreme weather events in some countries may offer an opportunity for solar home systems as a back-up or alternative source of electricity.

4.2.5 In some countries, SMEs can influence national policy in ways that support their technology's development. GERES has been influential in the development of a national Wood Energy Working Group, which is developing a new wood energy policy for Cambodia. It has also been able to influence the Industrial Standards Office to make the improved stove the national standard and to set targets aimed at converting the entire sector to the improved stove by 2018. Such policy influencing may be easier in a smaller country like Cambodia than in a large one such as India, where the policy landscape is complex and determined by a diverse range of factors (see Box 5).

Box 5. Evolution and impact of India's policies on renewable energy

Indian SMEs surveyed feel that national policies do not favour LCEA. This is borne out to some extent by a 2006 Government of India Planning Commission report laying out a 25 year energy security strategy based on coal, oil and hydropower, and stating: "even if India somehow succeeds in raising the contribution of renewable energy by over 40 times by 2031-32 , … the contribution of renewables to our energy mix will not go beyond 5.6% of total energy. This is consistent with various projections worldwide that shows [sic] that the fossil fuel dependence of the world as a whole will continue to rise till 2031-32" (Government of India. 2006. *Integrated energy policy: report of the Expert Committee*. New Delhi: Government of India Planning Commission).

Despite the lower priority placed on renewable energy today, Indian government interest in the sector dates to the early 1970s, when it was seen as a solution to the challenge of bringing energy to remote rural areas. Through the 1980s, a number of government projects brought renewable technologies to different parts of the country. A macroeconomic policy shift in the early 1990s towards a more open, market-based economy marked the end of this period, although the government has continued to support the development of a commercial renewable energy sector, particularly through the Ministry of New and Renewable Energy (the first ministry in the world to focus on renewable energy).

An energy policy aimed at providing energy access to all by 2012 has resulted in recent years in an emphasis on grid expansion and reduced interest in other more dispersed options. Subsidies for renewable energy technologies, including solar and biogas, have eroded while grid-based electricity remains heavily subsidised especially for residential users, making it affordable even to quite poor households.

While at a broad level policy remains generally supportive of the renewable energy sector (and while different states have their own, often widely differing, policies on energy), the emphasis on grid electrification means that there are few incentives to support clean energy SMEs. As an example, public technical schools training electrical technicians do not include training in renewable technologies, leaving solar SMEs to provide and cover the costs of training for their technicians, while the public utilities benefit from a public good.

4.3 Finance and investment. As discussed above, many SMEs have benefited from various forms of external support, particularly IFI and donor-funded programmes. In some cases, these have led to rapid scaling out; for example:

- The GEF/World Bank funded support programmes in Sri Lanka and Bangladesh have enabled growth of the solar PV sector. SEEDS's SHS loan portfolio expanded rapidly in 2001 when it became a 'Participating Credit Institution' in the World Bank-funded RERED programme. However, the finance for rapid scaling out may exceed

the rate of market growth, particularly if other economic factors come in to play. SEEDS's sales are now stagnating as a result of SHS cost increases and it therefore cannot take full advantage of a new phase of World Bank financing.

- In the case of biogas in Nepal, long-term support from Dutch and German development agencies has allowed BSP to function as an independent umbrella organisation to provide training and certification. This has given confidence in the technology, whilst allowing the installation and microfinance organisation to operate independently.
- The technical development and commercialisation of improved stoves in Cambodia was undertaken with support from the EU. In a similar way to biogas in Nepal, the donor involvement has provided umbrella support which has enabled private businesses to grow.

4.3.1 Loans and equity stakes are other ways that LCEA SMEs may seek to accelerate expansion, but there are challenges related to both. Loans can be difficult or impossible to arrange in certain national contexts (e.g. in India loans from foreign entities must be approved) and for early stages of LCEA SME establishment as these are seen as high risk and potentially volatile enterprises. Equity stakes are not a possibility for SMEs that are non-profit organisations unless they establish a for-profit subsidiary, which can involve high transaction costs. These challenges underline the difficulties faced by 'hybrid' institutions in matching their needs to the existing finance architecture.

4.3.2 Global markets are other factors outside the control of LCEA SMEs that can either accelerate or constrain their development. Three factors are of particular importance to the SMEs surveyed at this time: the rising cost of fossil fuels and of imported solar components, and the pace and emphasis of technological innovation at the global industry level.

4.3.3 The cost of fossil fuel alternatives, including kerosene, LPG, and diesel is growing worldwide and this trend is likely to continue and perhaps accelerate. None of the SMEs had quantified evidence that rising fossil fuel costs were enabling increased sales of alternatives, but anecdotal evidence is increasing. GERES has some evidence that rising LPG costs are causing middle-class urban households to revert to charcoal and is soon to undertake a study to determine the extent to which this is occurring. The cost of cement in Tanzania is making concrete blocks more expensive relative to MRHP's fired bricks and the cost of petrol is increasing transport costs favouring locally produced alternatives. Kerosene prices in all countries surveyed are rising faster than the recurrent costs of solar lighting alternatives.

4.3.4 On the other hand, increased costs of solar panels (because of increased global demand) and batteries are making solar photovoltaic products less affordable to poor and low-income customers despite good credit terms. The SHS SMEs are beginning to market mini-systems, some using cheaper LED technology, to bring both system size and cost in line with the needs of poor customers.

4.3.5 SMEs employing 'off-the-shelf' technologies including solar photovoltaics should be able to benefit from the global industry's ongoing technological innovation. However, the manager of SEEDS's SHS programme stated that SHS technology has not changed since her programme took off in 2001. Indeed, few innovations have improved the technology's utility for developing country contexts or reduced the costs of systems aimed at poor and low-income customers[27]. Because the kind of innovation that would be useful to LCEA SMEs aiming for development co-benefits is not happening elsewhere, SELCO has accessed grant funding to establish an in-house innovation department focusing on new products and financial services, particularly to serve the poor[28]. This work shows that innovation at the

[27] The introduction of LED light has improved the quality of light only and not any other features.

[28] See http://www.lemelson.org/news/spotlight_detail.php?id=795.

local level is also an important factor in tailoring products and services to the needs of end-users- For instance, SELCO provides SHS with additional light sockets, so that a single light can be moved from room to room.

Section 3: Conclusions

1. Summary

1.1 The challenge of making economic development and achievement of the Millennium Development Goals sustainable in the face of climate change will require more than transforming large scale carbon emitters to low carbon energy pathways: the forms of energy that households, communities and smaller businesses have access to and use will need to be transformed as well.

1.2 The Ashden Award-winning SMEs that this survey has looked at show that it is possible to scale out low carbon energy access in ways that provide development benefits, including direct benefits to the poor and wider environmental benefits. More than 9 milllion people benefit from the services provided by the 10 SMEs that were studied.

1.3 In many of the cases surveyed, social enterprise business models have played a greater role in achieving success than either policy directions or market signals. However, both policies and markets will be important in accelerating further expansion of LCEA SMEs in support of low carbon development pathways. In the development of enabling policies, market instruments, and programmes of technical and financial assistance for expanded LCEA, particular attention will need to be paid to the trade-offs that can exist between delivering poverty benefits, reducing emissions, and generating enterprise profits.

2. Implications for national governments

2.1 The potential for LCEA SMEs to greatly increase energy access, particularly for poor households and remote communities, is well demonstrated by the cases examined in this review. The services provided by LCEA SMEs are those most directly relevant to the poor, including cleaner, safer cooking; electricity for better quality lighting and communications; and energy for water supply.

2.2 National governments would benefit from seeing such increased energy access as a sustainable contributor to national energy policies rather than as a stop-gap measure until grid electricity can be made universal, particularly given the challenges of grid capacity and expansion in many countries.

2.3 There would be benefits to national governments in working in partnership with LCEA SMEs on strategies to bring energy to the poor. This would entail identifying where local LCEA provided by SMEs is the most cost-effective, reliable and immediate solution and offering incentives to make it work in those places.

2.4 In moving towards low carbon energy growth strategies, national governments would do well to consider the options for domestic and small business users in addition to larger industrial users, and to take energy access and LCEA's poverty reduction potential into greater account in developing and implementing national poverty reduction strategies.

2.5 While government subsidies for LCEA technologies can undermine commercial enterprise if poorly designed, this review points to the usefulness of well-designed 'smart subsidies' that improve end-user affordability without creating dependence or having significant market-distorting effects, especially to help poor customers access technologies that work for them.

3. Implications for bi- and multi-lateral development agencies

3.1 This study demonstrates that efforts by development agencies to help countries move towards integrated low carbon energy pathways that address the unmet energy needs of poor communities and households can have positive results, and that LCEA SMEs can be an effective vehicle for such programmes. Donors have supported programmes in Nepal, Cambodia, Bangladesh and Sri Lanka. However, if energy access by the poor is an objective of donor-assisted programmes, it is important that they promote technologies that are affordable and appropriate for poor households. Important areas for development agency support include innovation and development of instruments for enterprise financing.

3.2 Development agencies can overcome a market failure by supporting innovation and transfer of LCEA technologies and delivery mechanisms. Current LCEA innovation does not prioritise technologies and delivery mechanisms appropriate for and accessible to the poor. This market failure has thrown the burden onto the LCEA SMEs. There may be an important role for development agencies in supporting innovation and South-South transfer of technologies and delivery mechanisms.

3.3 Development agencies can also support innovation for cost reduction, since one of the main barriers to bringing LCEA technologies such as SHS and biogas to the poorest is cost. The SHS SMEs SELCO and SEEDS were the only ones in the survey whose sales were stagnant or declining, and this downward trend was attributed to increased unit costs and supply constraints (which should reverse in the near future). For these technologies to make a larger contribution to low carbon development, these cost barriers need to be overcome urgently. If cost barriers remain, there is a risk that some SMEs in this sector will orient themselves exclusively towards middle and high income segments.

3.4 End user financing is another area where innovation is required. SMEs are exploring a range of options, including loans, subsides through carbon finance and daily rentals of products. More systematic examination of these, as well as the development and testing of new options, for example fee-for-service models, is needed.

3.5 Profit/non-profit hybrid institutions seem to have real potential for development of pro-poor markets that provide social and environmental co-benefits, thus institutional innovation is another area where development agency research support would be useful. Needs include the development of legal frameworks and finance instruments tailored to these hybrid institutions and their particular needs.

3.5.1 Most existing instruments are designed for either commercial (e.g. loans and equity) or non-profit (e.g. grants) enterprises. The review identified the need for an innovative kind of enterprise finance that would make transaction costs to some extent recoverable whilst embodying the risk/reward sharing aspect of equity financing. This issue is not unique to LCEA SMEs and is relevant to other sectors where achieving development objectives requires the involvement of both private sector and civil society players.

3.6 Carbon finance instruments including the Clean Development Mechanism and voluntary carbon markets are challenging for LCEA SMEs because of high transaction costs and the absence of clear incentives for delivery of benefits other than greenhouse gas emission reductions. Development agencies need to invest resources to identify and implement ways through which such finance channels can be made more accessible and useful to LCEA SMEs, either individually or in associations.

4. Implications for financial institutions and investors

4.1 The brokerage of voluntary carbon trades is facing a proliferation of standards and certification schemes. In addition, the market is being driven by developed country buyers, sellers and brokers. If this potential finance stream is to enhance LCEA SMEs in developing countries, there is a need for instruments that enable rather than constrain trade.

4.2 For institutions offering microfinance for LCEA: microfinance institutions can help to address the cost gap for some technologies and the potential of LCEA for poverty reduction by working with customers to explore options for generating revenue from LCEA and developing loan facilities for poor families without collateral (e.g. through loans to self-help groups, which is being attempted in a few cases).

Section 4: Further research requirements

This survey only offers a snapshot only of the LCEA SME landscape, and further research is required to fully assess opportunities for investment and support. Research gaps that have been revealed during the survey (some of which were raised in the previous section) include:

- More detailed quantification (or monetisation) of benefit streams for the purpose of designing effective policy support of LCEA SMEs.
- Analysis of the ways in which trade and investment policies constrain SME development; for instance SMEs may benefit from reduced tariffs on imports of technology and inputs and increased tariffs on competing products and services.
- Identification of revenue generation options from LCEA technologies.
- Means of providing incentives for innovation by companies in the North or South to prioritise technologies and delivery mechanisms appropriate for and accessible to the poor.
- The design of innovative kinds of enterprise finance that would minimise transaction costs whilst embodying the risk/reward sharing aspect of equity financing.
- Deeper analysis of experiences with subsidies for LCEA and their effectiveness for achieving scale and benefiting the poor.
- Carbon financing support design to minimise trade-offs between climate emissions and achieving well-being and poverty reduction co-benefits for the poorest.

One issue that has not been discussed in this report is the interplay between centralised and partially/wholly decentralised energy options, and the role of “mini-grids” or grid-tied electricity technologies (e.g. solar PV or small hydro). This is because it was not a focus for any of the programmes that were reviewed. This is a further area for research, for example looking at the comparative advantage of different technologies in this context, and the pathways that might lead to progressive upgrading of energy services to promote economic development.

Finally, although it was not an explicit objective of any of the cases surveyed, it was found that some low carbon technologies can help reduce climate vulnerability and contribute to adaptive capacity (see Section 2.1 above). Research on the role that LCEA technologies can play in climate change adaptation is an obvious next step in understanding and supporting their potential contribution to low carbon energy development pathways.

Annexes

Annex 1. Background to the Ashden Awards for Sustainable Energy.

Since 2001, the Ashden Awards have given awards to 51 local sustainable energy programmes that are successfully delivering low carbon energy services across the developing world. The 'local' element refers to the fact that they are all generating energy close to the point of use and there is some form of local ownership (individual, community or business). The portfolio of winners is delivering services across the sustainable energy sector, and often in more than one segment of the supply chain, including:

- Direct supply of energy services to households or businesses.
- Training programmes in manufacture, installation and/or repair.
- Installation programmes with the provision of maintenance and repair.
- Design and manufacture of technology.
- Providing or facilitating provision of finance for energy services.
- Awareness-raising and education programmes.

Some of the winning programmes have been successfully operating for ten years or more, so their activities extend beyond typical donor or NGO funding cycles and offer insights into long-term programme development.

In 2008, the Ashden Awards will be giving up to seven international awards, with winners receiving grant funding, publicity and support for their business development and communication activities. The Ashden Awards will also recognise the continued growth of a previous Award winner with the Outstanding Achievement Award. All winners will be invited to London for the awards ceremony and associated events in June 2008, including a seminar hosted by DFID for the third year in a row.

The Ashden Awards were started by the Ashden Trust, a private grant-making trust. By investing in a public awards process with an annual ceremony and significant international publicity, the Ashden Awards believe that they can have a greater impact than by making private grants or investments. By publicly recognising successful organisations, the Ashden Awards believe that they will contribute to their future success, demonstrate the exciting potential for local sustainable energy programmes to achieve social, environmental and economic objectives, and give winners a platform to engage with key stakeholders in their home countries and internationally.

Annex 2. Research Framework.

Overall objective of research

The research aims to better understand how small and medium-sized enterprises providing low carbon energy related technologies can have a sustainable and substantial impact on development in poor countries, particularly in terms of addressing poverty and climate change. More specifically, the research seeks answers to the following questions:

- What information can the Ashden Awards portfolio provide on the potential for sustainable energy technologies to provide the energy required for poverty reduction and sustainable development, whilst also contributing to climate change mitigation and adaptation?
- Across the Ashden Awards portfolio of successful sustainable energy programmes, are there common success factors in terms of technology development and utilisation?
- Are there common success factors in terms of organisational, enterprise, leadership and financing models?
- Are there common external success factors in terms of public policy, business and financial environments that facilitate successful small and medium-sized clean energy enterprise development?
- Are there common challenges and barriers experienced by Ashden Award winning organisations?
- What are the implications of the research findings for policy makers wishing to stimulate and accelerate the growth of the sustainable energy sector?

Framework for analysis

In order to answer those questions, the research will be framed around the following five issues:

1. How does a low carbon energy technology achieve widespread, mainstream acceptance and use? What factors contribute to expanding the scope of and demand for low carbon energy technologies?.
    a. Growth in demand for the technology, matched by growth in supply or access (‘scaling out’). Factors that may contribute to scaling out include:
        i. Tailoring the technology to unmet needs of target groups.
        ii. Cost savings over conventional technologies.
        iii. Mechanisms to broaden the financial accessibility of acquisition and/ or use of the technology.
        iv. Effective marketing/promotion/training.
        v. Support to development of supply chains.
    b. Increase in acceptance of the technology as a viable, affordable and appropriate energy option by actors involved in making and implementing local through to national policy (‘scaling up’). Factors that may contribute to scaling up include:

i. Government involvement in the development and dissemination of the technology.

ii. Incorporation of the technology in the energy programmes of governments or large corporations.

iii. Endorsement of and support to the technology by international organisations and programmes.

2. Understanding how low carbon technologies can have development co-benefits in terms of poverty reduction.
    a. Types of technologies and technology-related opportunities that have the potential to achieve positive impacts on the livelihoods of the poor (may vary considerably in different countries and environments).
    b. Dissemination strategies and sales arrangements that make technologies accessible to the poor.
3. Understanding how low carbon technologies can have co-benefits in terms of climate change.
    a. Types of technologies, and scales of use achieved through dissemination strategies, that can have a significant impact on emissions reductions and avoided deforestation (as compared with the conventional technologies that they are replacing).
    b. Types and uses of technologies that can assist communities to be better prepared for projected impacts of climate change, including reducing reliance on fossil fuels.
4. Identifying design and delivery factors that may contribute to or block scaling out and scaling up of low carbon technologies that have development benefits. Factors that may potentially play a role include:
    a. Types of enterprises, scale of ambition and their reasons for introducing the technology.
    b. How the technology is developed and disseminated (e.g. technological, entrepreneurial or community-based approaches) – how replicable is the delivery model.
    c. How and by whom decisions are made (leadership).
    d. Financing arrangements offered to buyers and/or users.
5. Understanding the external factors that may contribute to or constrain scaling out and scaling up of low carbon technologies that have development benefits. Factors that may potentially play a role include:
    a. Phases and characteristics of growth in local economies and particularly linkages to buoyant markets.
    b. Financial arrangements for SMEs and their customer base e.g. access to savings and loans mechanisms.
    c. Laws and public policies (including government taxes and incentives).

d. National and local business environment (e.g. availability of capital financing, local sources for parts, local skill base); general economic conditions and trends.

e. Types and levels of international support.

f. Environmental and demographic conditions and trends.

g. Social and cultural norms and expectations.

A diagrammatic representation of this framework is attached at Appendix A.

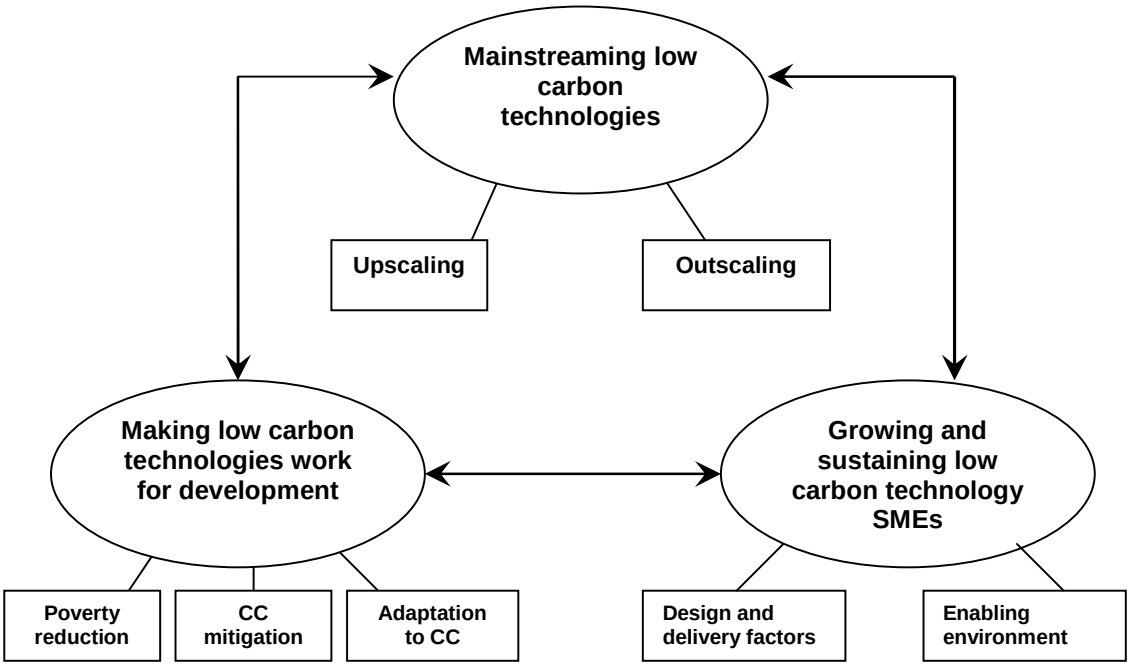
How the research framework will be used

The framework will be employed at each of the study's three levels of analysis:

1. At the full portfolio level project cases will be characterised in terms of realised and/or potential for scaling out against the criteria in the framework. Ten to 12 cases that appear best-suited for further exploration of the research questions will be selected for further analysis;
2. At the more detailed level, the framework will guide interviews and be employed to analyse and synthesise findings across the 10 to 12 cases;

Finally, the framework will provide a basic structure for the final project report.

Appendix A: Diagram of research framework



Annex 3. Questions for Ashden Award-winning projects.

Status update:

- How many clients has your project served to date?
- How many people do you estimate have benefited?
- What is the current size of the microfinance facility?

1. What have been the key factors in your project achieving the success it has?
    a. Technology aspects?
    b. Financing aspects?
    c. Outreach/support?
2. What do you see as the main benefits that people (customers, clients) have gained from your projects?
    a. Have you done any research to quantify those benefits?
    b. What benefits appear to be most important to different groups of clients?
3. To what extent has your project's expansion contributed to employment generation, both direct and indirect?
    a. Are there any studies that have quantified that?
4. How important are the climate change mitigation effects of your project in selling the products and in gaining support from government and other supporters?
    a. Have there been any studies on emissions savings?
5. How do you see the future of your project as climate change becomes a real factor in the environment and economy?
6. What do you see as the key aspects of your 'business model' or way of operating that have allowed you to successfully expand the reach of the project?
7. Starting from the time the project began, what were the most important events or moments that have contributed to growth?
8. At different stages of your development, what markets or types of clients were you aiming to reach? What strategies did you use to reach them?
9. What kind of support has your project been able to gain from others, such as the Government, the World Bank, other donors, and national and international organisations?
    a. How important has this help been?
    b. How could it be made better?
10. How have government policies and the political environment affected you?
11. How has the state of the overall economy affected your project expansion?
12. What other factors outside your control have had a positive or negative influence on your project's ability to expand?
13. How does the future look? What are your targets for the next five years, and how do you plan to achieve them?

Annex 4. Ashden Awards' summaries of projects surveyed[29].

Information on the scale, business model and benefits of these projects is included in the body of the report. For more details please visit the Ashden Awards' case study database http://www.ashdenawards.org/case_studies.

Biogas Sector Partnership (BSP), Nepal
The Biogas Sector Partnership (BSP) in Nepal manages the national programme for installation of biogas plants in rural areas – including quality control, capacity building and accreditation of contractors. It is a non-governmental organisation closely affiliated with the Government of Nepal's Alternative Energy Promotion Centre (AEPC), and supported by international organisations including the Dutch and German Development Agencies.

About 80% of the 4.2 million households in Nepal use fuelwood, cattle-dung cakes and agricultural residues for cooking, and kerosene for lighting. Cooking indoors over open fires, and lighting with kerosene, gives dangerous exposure to air pollutants and a high risk of fire, particularly for women and young children who spend much of their time indoors. In addition, women and girls have the drudgery of collecting fuelwood, which typically takes three hours each day.

Biogas plants provide an alternative by digesting cattle manure to provide biogas for cleaner and safer cooking and lighting. In addition, about 75% of the BSP plants incorporate a toilet, which has sanitation benefits, and the effluent from the biogas plant is a valuable organic compost.

The Energy Research and Training Centre (ERTC), Eritrea
This organisation, part of the Eritrean Government's Department of Energy, has designed a new stove for the cooking of 'injera', a pancake-like bread that is served with most traditional Eritrean dishes. Traditional cooking stoves are very inefficient and require a lot of woodfuel to complete the cooking process.

The improved stove is safer to use. It has an enclosed fireholder, with enhanced ventilation so that the fire burns more efficiently, and a chimney to take smoke out of the house. The stove also burns a wider range of fuels, working well with twigs and leaves and animal dung. Being raised above the floor and, having an enclosed fireholder, the stove is no longer a danger to children.

The main aim of this project is to disseminate the use of this new stove to rural communities throughout the country. ERTC is teaching women how to build the stoves themselves and also paying them to teach other women, who are, in turn, teaching others.

GERES, Cambodia
GERES was founded in 1976 by French engineers and academics. It is an international not-for-profit organisation with a remit to alleviate poverty using renewable energy. In

[29] Source: Ashden Awards' case studies, based on documentation supplied and visits during the Ashden Awards application process

Cambodia, GERES started the Cambodian Fuelwood Saving Project (CFSP) in 1997, in collaboration with the Ministry of Industry, Mines and Energy.

About 95% of Cambodians cook with biomass fuels. This is costly, has adverse health effects and is bad for the environment. Cambodia's great natural biodiversity is threatened by uncontrolled wood consumption. Much of this demand is for timber and a significant amount is turned into charcoal which is the preferred cooking fuel in cities, used by 40% of the population of Phnom Penh.

The CFSP has developed a cheap charcoal stove, the 'New Lao' stove. This uses at least 22% less charcoal than the 'Traditional Lao' stoves which are commonly used in Cambodia. A network of distributors and retailers has been established and a trade organisation has been set up to oversee pricing and quality.

Grameen Shakti, Bangladesh
Grameen Shakti was established in 1996 to promote, develop and supply renewable energy technologies to rural households in Bangladesh. It seeks to improve the livelihoods of people who cannot access grid electricity.

By selling SHS, Grameen Shakti has provided lighting, communications (especially mobile phone charging, radio and television), and has increased employment opportunities. It is the largest single installer of SHS in Bangladesh, and is currently branching out into other energy products including improved stoves and biogas plants.

Solar systems have been installed in schools , clinics and computer centers . This trend is increasing. This impressive number of SHS installations has been achieved by enabling users to purchase their systems on micro-credit with affordable terms, tailored to their specific needs. Funding for the micro-credit system comes from the World Bank and GEF via the Infrastructure Development Company Limited (IDCOL) which provides Grameen Shakti with both subsidy and concessional loans.

Grameen Shakti has started a network of technology centres throughout the country to manage the assembly, installation and maintenance of SHS locally. It emphasises the importance of technicians who know local customs working through local branches, and has trained 2,000 (mainly female) technicians. Grameen Shakti also organizes training for women from user families and an exposure programme for rural school children.

International Development Enterprises, India (IDEI)
IDEI has been marketing treadle pumps to farmers in India since 1991. It was initially part of IDE International, but was legally registered as an Indian not-for-profit body in 2001 and is now an independent organisation based in New Delhi, with six regional offices.

IDEI markets treadle pumps in the rural areas of the Eastern part of India, bringing substantial benefits to farming families. Many farmers in the plains of the North and East of India rely on a single annual crop, but the water table in the region is consistently high so out-of-season crops can be grown under irrigation if a pump is available. Treadle pumps offer a low-cost alternative to expensive and polluting diesel pumps.

Poor farmers can now cultivate and sell a variety of crops outside the normal growing season and bring additional land under cultivation because it can be irrigated. All

components of the pumps are manufactured locally, and IDEI has successfully developed a supply chain of manufacturers, distributors, retailers and installers.

Mwanza Rural Housing Programme (MRHP), Tanzania
MRHP was established in 1990 by the Belgian agency COOPIBO in response to local requests for help to improve the quality of housing. Since 1995, MRHP has become a fully Tanzanian NGO. It operates in five districts of the Mwanza Region of northern Tanzania.

In this region, houses are usually made from mud, and need frequent repairs and rebuilding because of damage from rain and minor earth tremors. There is extensive deforestation which has been exacerbated by the use of wood to make durable, fired bricks. MRHP has set up enterprises making high-quality bricks from local clay, fired with agricultural residues rather than wood. Houses made from the fired bricks are durable, comfortable and clean. The quality of the bricks is such that they are now being used in building programmes in the city as well as in the rural areas.

MRHP has trained local people in brick-making and business management, and has provided loans through a savings-and-credit scheme to start businesses. This has enabled over 50 brick-making businesses to become established in the 70 villages where MRHP works. MRHP operates a large brick-making kiln which is fired using sawdust, and also runs programmes promoting tree planting and improved stoves.

Noble Energy Solar Technologies Ltd (NEST), India
NEST (Noble Energy Solar Technologies Ltd) is a private company founded in 1998 to develop a very small solar lantern, the 'Aishwarya®', as a safe substitute for the kerosene wick lamp.

It is estimated that in India alone, about 100 million households use kerosene wick lamps as their main source of light. Such lamps produce poor quality light and unhealthy fumes, and present a serious fire risk particularly when used in thatched homes. Fluorescent lamps with batteries recharged using solar photovoltaics (PV), can provide much better quality and safer light, but the cost of such a lantern can be prohibitive.

NEST have brought down this cost, by making a PV lantern which is small and light-weight, with strict attention to quality of manufacture. By working closely with a network of dealers and sub-dealers, through whom they provide credit, spares and support, they have enabled very poor people in the most remote villages to buy PV lanterns without subsidies. Over 75% of the Aishwarya lanterns produced by NEST have been sold in this way, throughout the states of Andhra Pradesh and Maharashtra.

Sarvodaya Economic Enterprise Development Services (SEEDS), Sri Lanka
SEEDS is a micro-finance institution which belongs to the Sarvodaya Group, the largest development NGO in Sri Lanka. The aim of SEEDS is to eradicate poverty by promoting economic empowerment for sustainable livelihoods. SEEDS operates an energy financing division to carry out renewable energy lending initiatives. Its main focus is on financing and managing solar home systems (SHSs).

SEEDS works through accredited solar installers to identify potential loan customers. These loans enable poor households in rural areas to purchase SHSs, and receive the benefits of improved light, communications and entertainment. The monthly repayments

are set at a rate which the household can afford to pay, and the loans are paid back over a period of one to four years. Local field officers employed by SEEDS collect monthly repayments, and also carry out checks and minor repairs to the systems.

SELCO India
SELCO-India was founded in 1995. It is a private business which provides photovoltaic (PV) solar-homesystems to provide power for lighting and small appliances, and other solar services, to low-income households and institutions in South India. It works from a head office in Bangalore with a network of local sales and 30 local service centres to provide an effective sales and maintenance service. SELCO employs more than 180 staff.

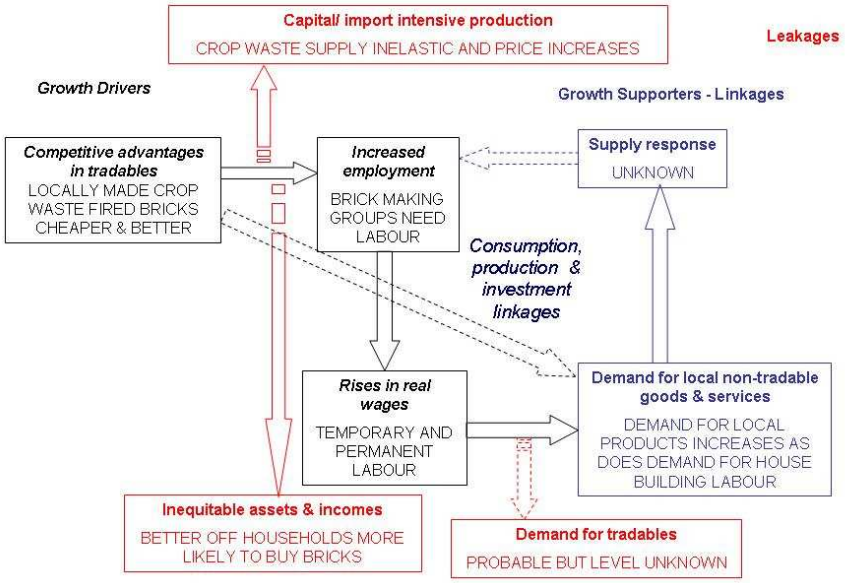
SELCO works closely with microfinance institutions, including the Self Employed Women's Association (SEWA) bank in Gujarat, and is currently expanding its product offering to include improved stoves, solar lanterns and biogas. It has set up a small innovation department at its head office, tasked with looking at new ways of providing people with solar and other energy services, and opportunities for income generation.

SKG Sangha, India
SKG Sangha is a non-profit organisation, founded in 1993. It is based in Karnataka and supplies biogas plants to households in rural areas of South India. It is run by a team of 20 permanent staff, supported by a team of masons and supervisors in each area and around 100 volunteers.

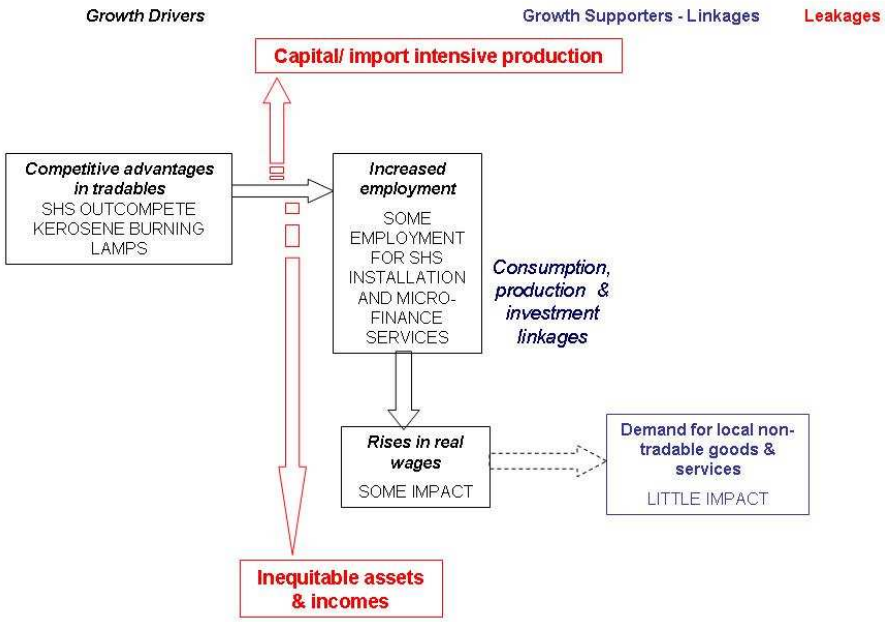
Biogas plants produce methane by digesting cow dung, replacing fuelwood used for cooking. Using biogas saves the time spent on collecting wood and cooking, and the avoidance of indoor air pollution is a huge benefit to health and welfare. The output residue from a biogas plant can be used directly on nearby land as a fertiliser, and SKG Sangha has enabled biogas owners to produce a better quality and saleable fertiliser from the residue, by offering worm composting units with biogas plants.

Annex 5. Effects of LCEA technology introduction on growth of local economies in selected cases

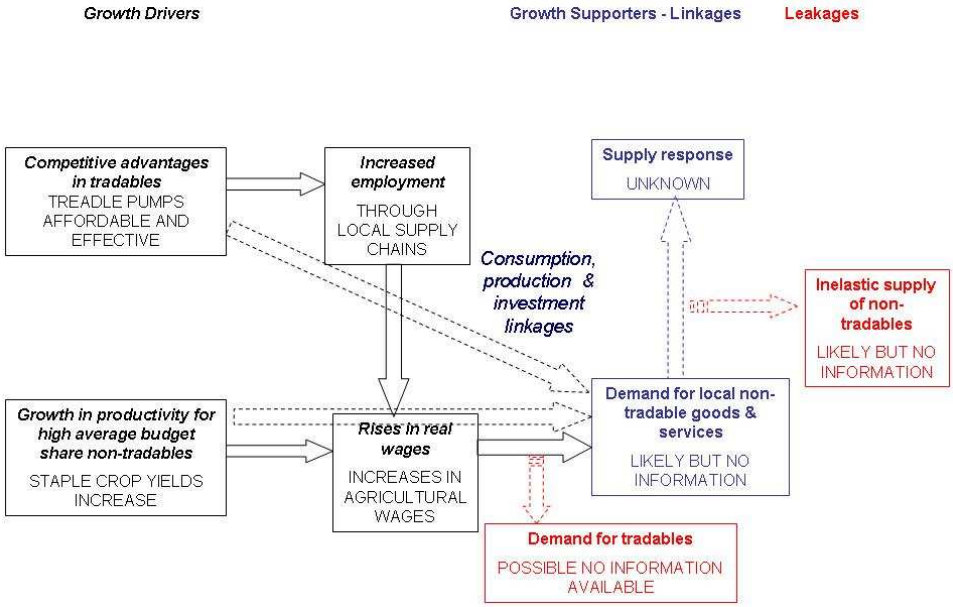
Effect of LCEA technology on growth in local economies – crop waste brick kilns in rural areas, MRHP, Tanzania



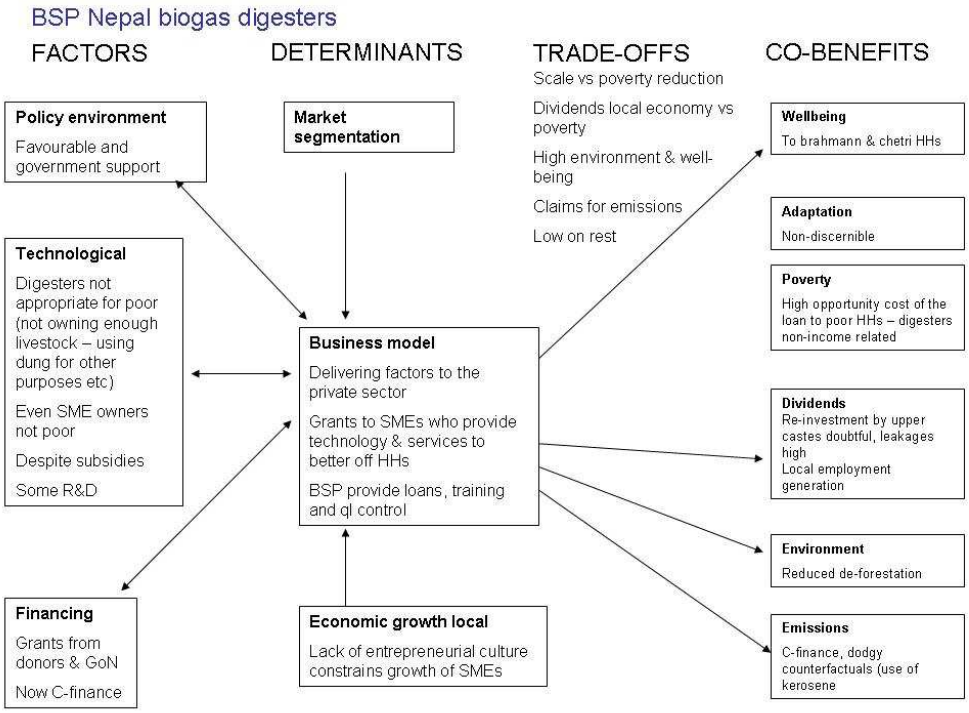
Effect of LCEA technology on growth in local economies – solar home systems, SEEDS, Sri Lanka

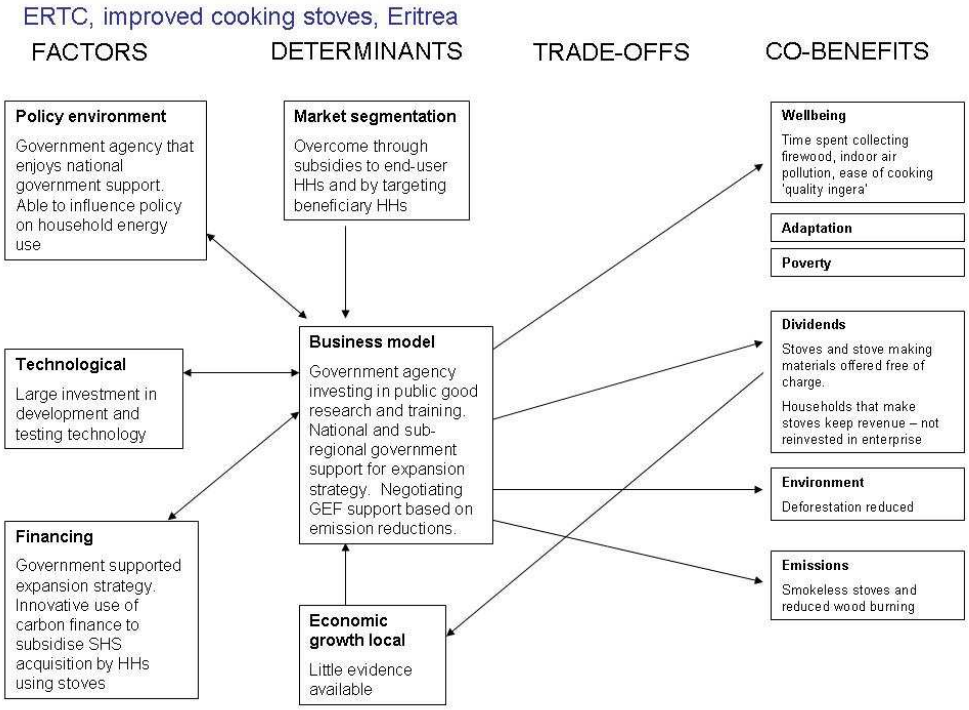


Effect of LCEA technology on growth in local economies – treadle water pumps, IDEI, India

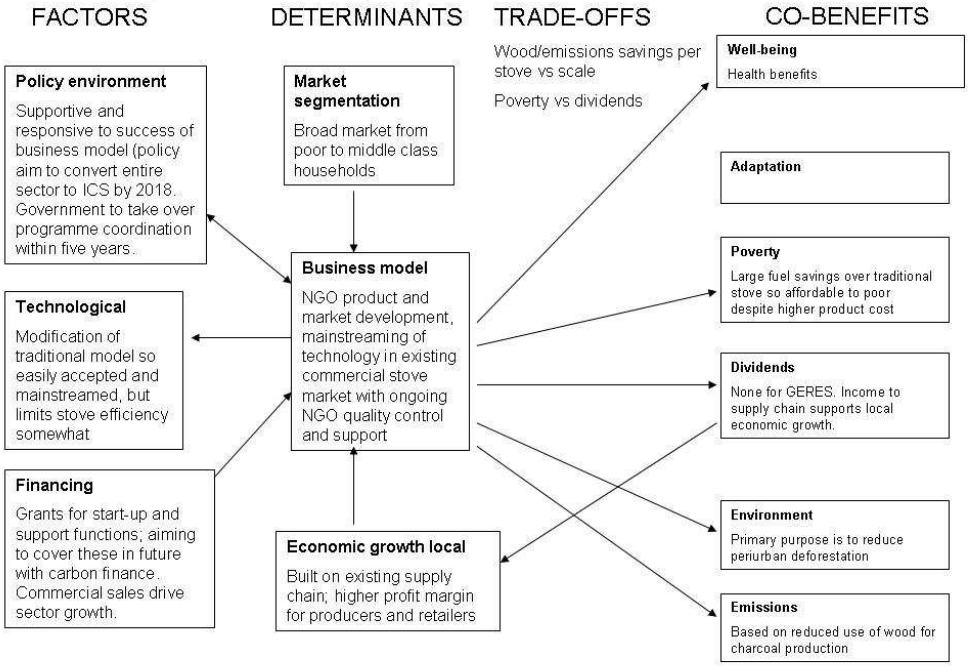


Annex 6. Completed analytical frameworks for each project case

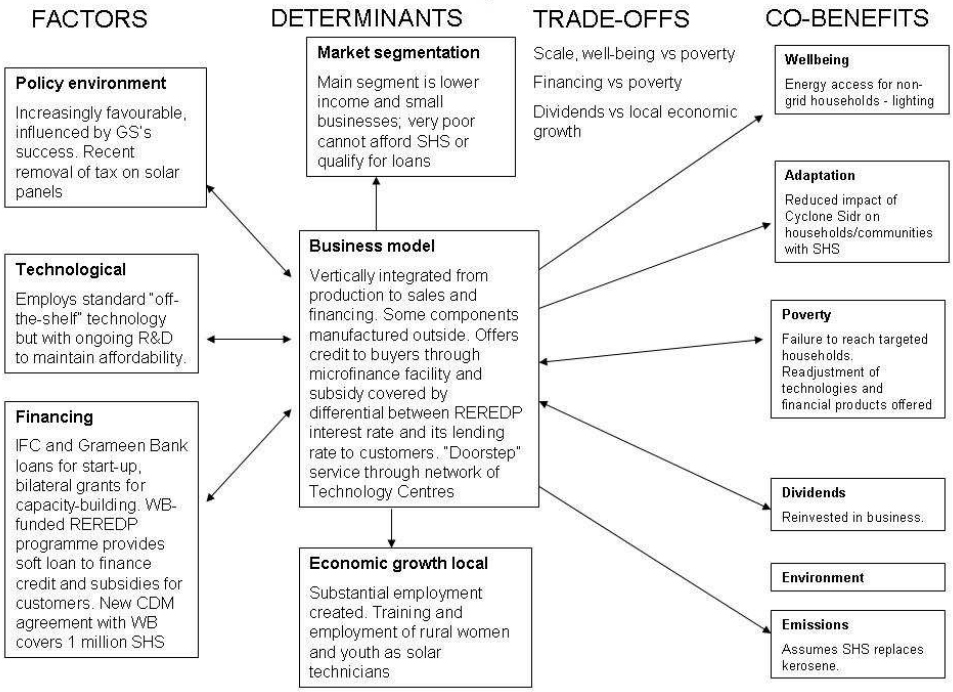




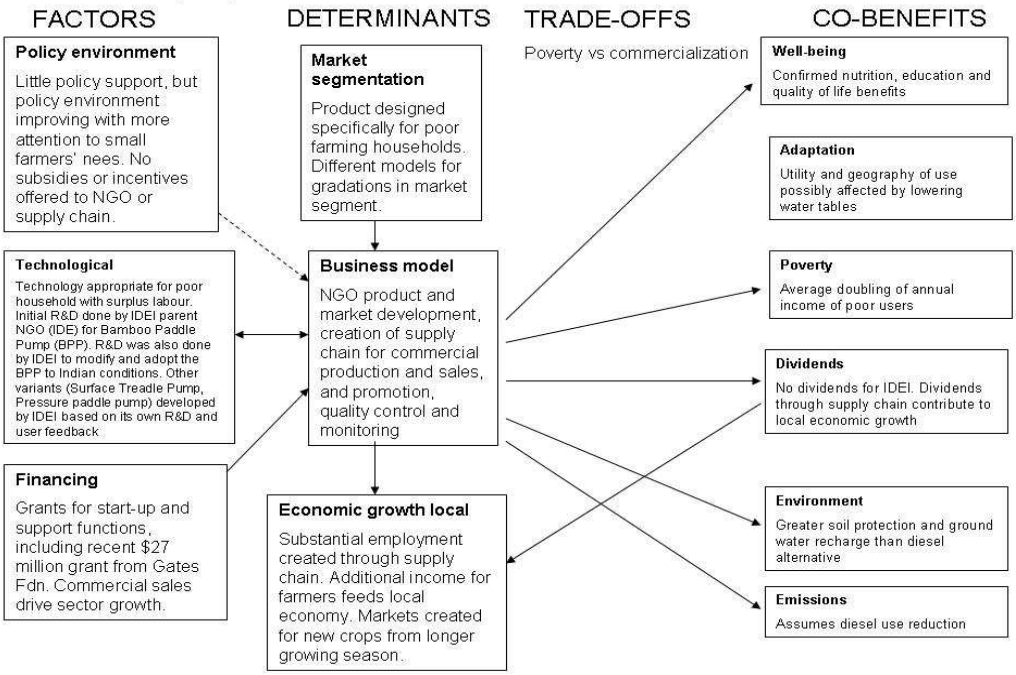
GERES Improved cookstoves (ICS), Cambodia



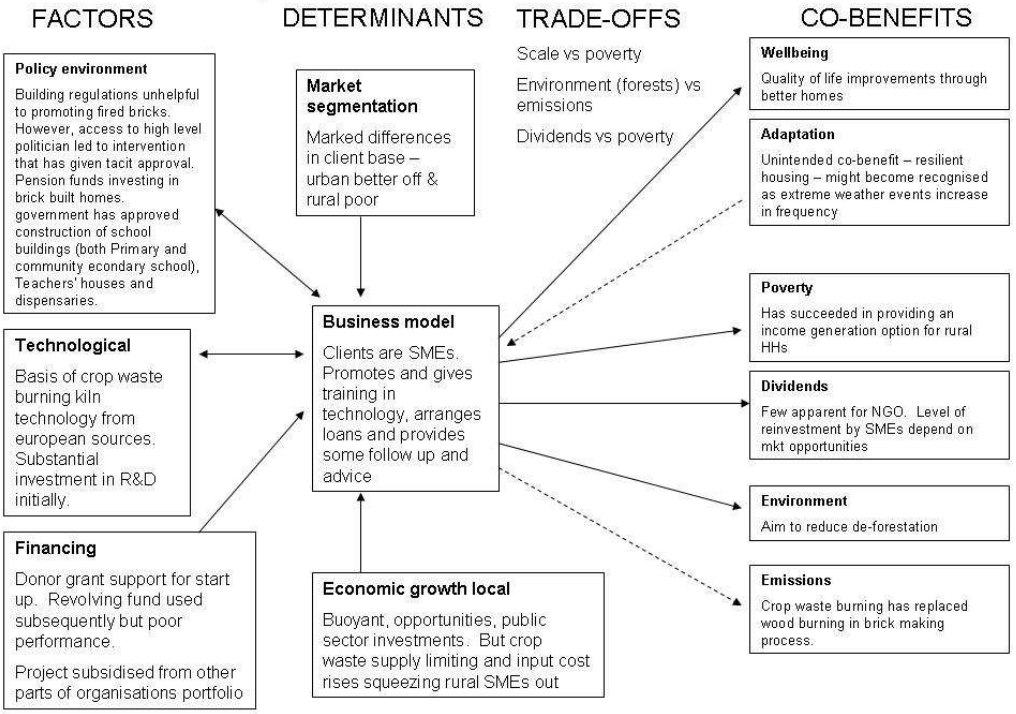
Grameen Shakti solar home systems, Bangladesh



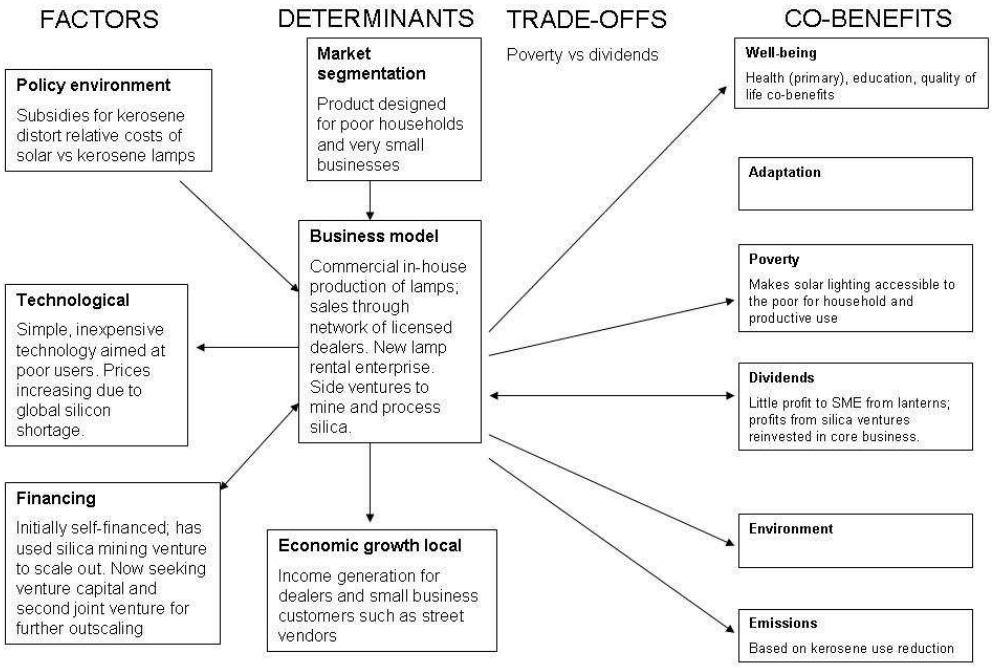
IDEI treadle pumps, India



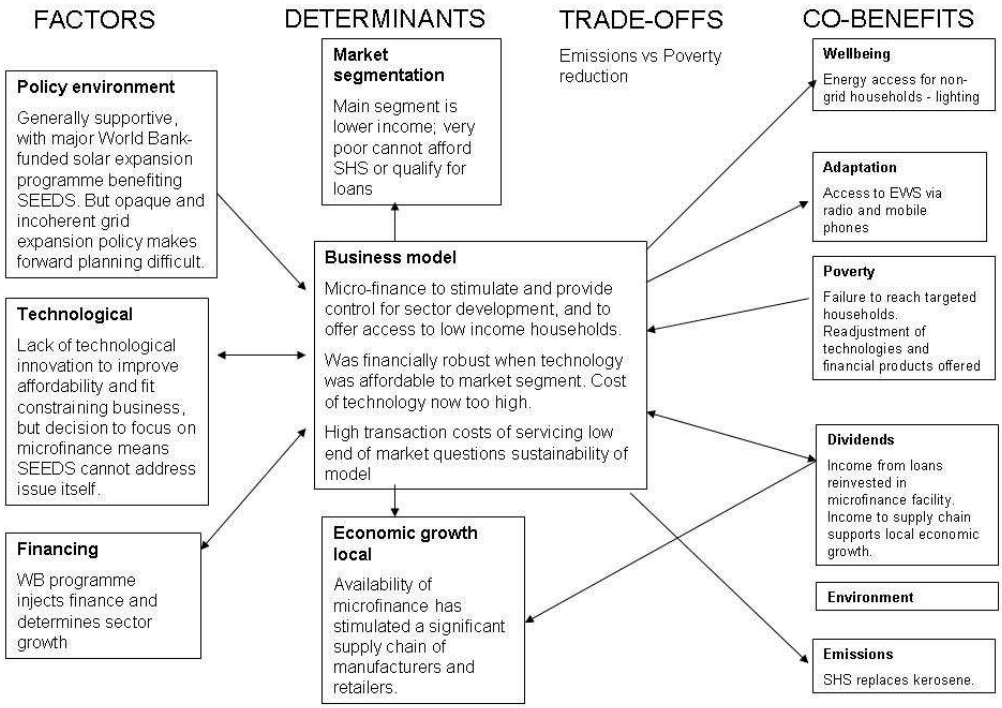
MRHP Tanzania crop waste brick firing



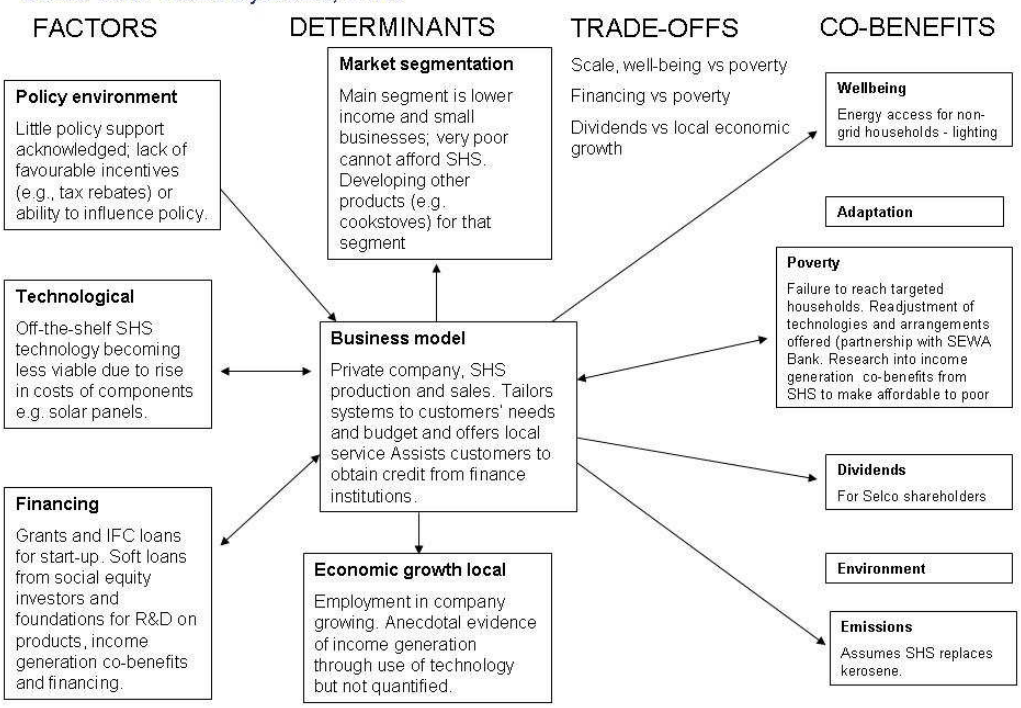
NEST solar lanterns, India



SEEDS finance for solar homes, Sri Lanka



Selco solar home systems, India



SKG Sangha biogas plants, India