Productive Use of Thermal Energy

An Overview of Technology Options and Approaches for Promotion

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1. Introduction

According to the estimates of the International Energy Agency (IEA), 2.6 billion people around the world currently rely on traditional uses of energy to cover their basic energy needs. This figure is expected to rise to 2.7 billion by 2030 (IEA, 2011). Over 80 % of these people live in rural areas in developing countries.

The important role played by modern energy services in welfare and economic growth is widely recognised by governments and international donors. Access to energy services is a precondition for economic development. However, access to modern energy services does not necessarily result in economic development, owing to many other factors that influence economic growth. Therefore, energy projects around the world are increasingly looking into promoting productive uses of energy in order to spur economic development.

The potential benefits of promoting efficient thermal energy technologies in the productive sector, notably amongst micro and small enterprises, are frequently overlooked by policy makers and international donors. Biomass, as the most common source of thermal energy, often suffers from an unfavourable reputation as a *dirty* energy source (Kees and Feldmann 2011, Owen et al. 2012). These enterprises often work in the informal sector and are frequently situated in remote areas.

Productive use of thermal energy involves a range of activities, such as cooking, drying, heating, smoking, baking, cooling and manufacturing. Biomass burning and use of solar thermal energy are already embedded in many conventional manufacturing processes in developing countries, but mainly with comparatively inefficient technologies.

This overview focuses on technology options and approaches for the promotion of businesses supplying and utilizing efficient thermal energy appliances. Detailed guidelines on how to plan, design and implement projects to foster productive use of electricity are laid out in the manual *Productive Use of Energy – PRODUSE: A Manual for Electrification Practitioners* (Brüderle et al., 2011). The conversion of biomass into electricity is outside the scope of this booklet and is treated in detail in the publication *Small-scale Electricity Generation from Biomass* (Dimpl, 2011).

This booklet sheds light on improved thermal energy technologies for productive purposes and approaches for promoting these technologies with a focus on micro, small and medium enterprises (MSME) in the agricultural, industrial and commercial sectors. It also provides practical guidance on how to promote effectively the distribution of efficient biomass and solar thermal appliances for productive uses for energy and private sector development practitioners. Though, it does not offer ready-made *one size fits all* solutions, particularly as energy needs and supply, market regulation and business environments vary greatly from country to country.

Each chapter offers a further reading section highlighting recent publications on the topic. Short profiles of Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) energy programme experiences from countries in Africa and Latin America are also included to illustrate opportunities for promoting productive use of thermal energy. Each profile features how a new efficient energy device augmented the profits of a small enterprise.

The reader's feedback is welcomed, in order to gain a better understanding of the topic for future successful support of productive use of thermal energy. Please do not hesitate to contact the GIZ programme *Poverty-oriented Basic Energy Services (HERA)* with your comments at *hera@giz.de*.

FURTHER READING

Brüderle, A., Attigah, B., and M. Bodenbender, (2011): Productive Use of Energy – PRODUSE: A Manual for Electrification Practitioners. GIZ and EUEI PDF, Eschborn, *http://www.produse.org/Manual*

Value chains and production processes based on thermal energy

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economic growth
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2. Value chains and production processes based on thermal energy

Productive use of energy, thus thermal energy, can be a significant driver of economic growth and social progress in developing countries. The use of modern forms of energy can underpin the creation and upgrading of value chains, facilitate diversification of economic structures and livelihoods. Productive uses of energy are those that increase income or productivity. In rural contexts in developing countries, typical productive uses can be found in agro-processing (e.g. drying of agricultural products like coffee, tea, tobacco, or fruits), various industrial industries such as brick making, bread baking, and in the service sector, e.g. in bars and restaurants that use stoves for cooking meals. However, access to energy does not automatically create opportunities for economic growth. Productive uses of energy are those that increase income or productivity (White, 2002).

The *Poor People's Energy Outlook* (Practical Action, 2012) has identified three mechanisms in which energy access can contribute to economic development:

- new energy services may enable completely new types of profitable productive activities
- new or improved energy services enhance existing earning activities in terms of returns by increasing productivity, lowering costs, and improving the quality of goods and services
- new or improved energy services reduce opportunity costs, reducing drudgery, and releasing time to enable new earning activities.

Although thermal energy is mainly associated with value adding processes in the agricultural sector, there are numerous examples of small-scale industrial and commercial businesses that also require thermal energy as an input, as will be illustrated in the following chapters. This chapter looks at value chains and identifies activities that typically involve thermal energy use.

2.1 Thermal Energy in agricultural, industrial and commercial value chains

Small-scale farmers often lack the appropriate facilities and technologies for preserving, storing and processing their harvest. Profit margins for unprocessed agricultural yields are limited and seasonal (Flavin and Hull Aeck, 2005). The return on unprocessed raw crops is only a small proportion of the price at which the final packaged product is sold to end-customers, as prices are low when markets are flooded with supply of the produce in season. Furthermore, if there is no diversification of produce, farmers typically depend on a single wholesale trader as their buyer which further decreases the profit margin.

For these reasons, efficient processing technologies can offer an important lever for increasing the profits of small-scale farmers.

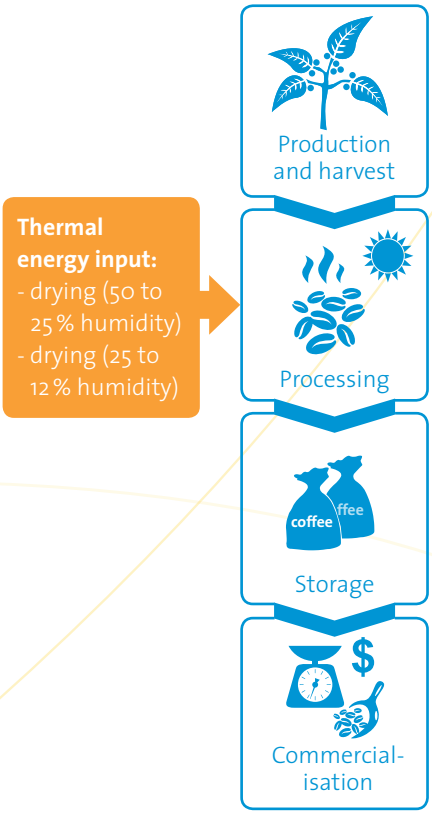
Thermal energy is an important input to many processing stages in **agricultural value chains** (Utz, 2011) as *Figure 1* shows. Reduced production costs can be achieved with the

use of efficient technologies. In Peru, Victoria Esteban Fuentes, a coffee farmer, increased her output by eight per cent with a newly installed solar dryer. The duration of the drying process has been halved, and her income augmented by 30 per cent, owing to the higher price she can now charge for her improved quality coffee beans.

Hence, certain technologies enable the processing of agricultural residues and by-products, which can then be sold, further adding to the farmers' incomes. Drying appliances such as solar dryers allow farmers to preserve fruit for storage and transportation, thus increasing the price they can achieve off-season. The introduction of more efficient processing technologies may also allow to produce higher quality products which can be sold at a higher price. For example, tobacco leaves that are dried at constant temperature and ventilation in improved biomass fuelled barns yield higher profits by achieving high quality standards.

In the **industrial sector**, small-scale production is relatively common in developing countries, owing to small, geographically dispersed markets for simple consumer goods. The industrial sector is characterised by high energy input into the production of goods, with thermal energy playing an important role in many industries. In Zimbabwe, for example, brick making, beer brewing and bread baking are the three most common rural industries. The brick making industry accounts for around 284,000 tonnes of fuelwood consumption per year. The 50,000 breweries and 1,200 bakeries are estimated to consume around 163,000 tonnes and 218,000 tonnes, respectively, of fuelwood per year (Nyabeze, 1995).

Figure 1 Value chain of coffee beans



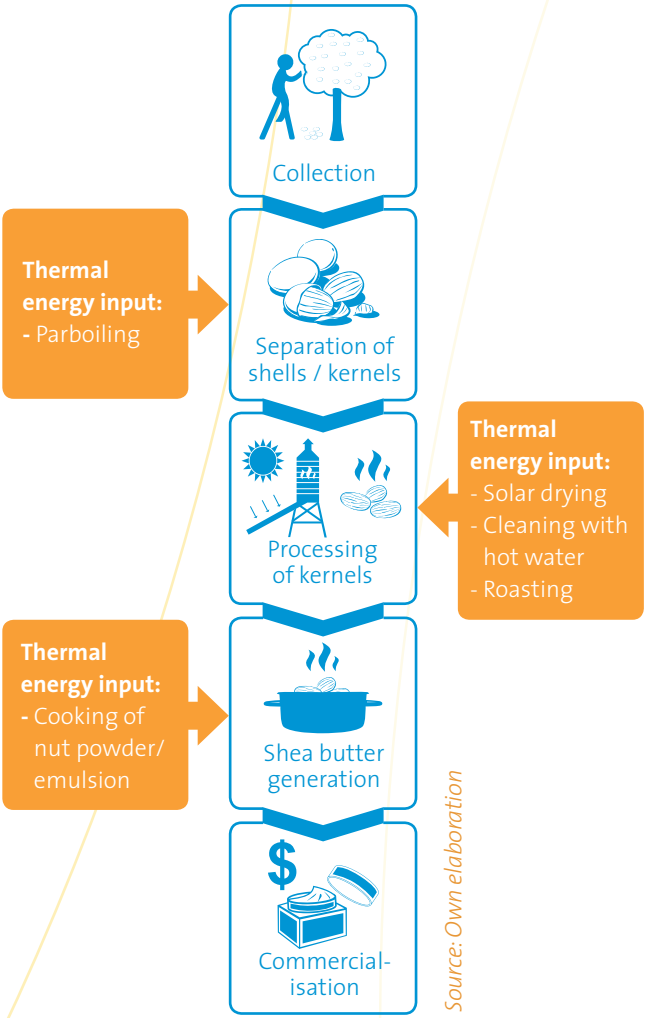
Source: Own elaboration

Figure 2 illustrates the role of thermal energy during the processing of shea nuts into shea butter in Benin: to ease the separation of shells and kernels, the gathered nuts need to be parboiled soon after collection.

After being dried in the sun, the actual processing starts with cleaning the shea kernels with hot water. Before they can be roasted in a pot over a fire, the kernels are dried and crushed. Next, they are ground and the resultant powder is cooked in hot water to separate the white butter. The emulsion needs to be cooked for approximately 1.5 hours to evaporate the surplus water. Normally, all these thermal processes are realised on traditional cookstoves and fires. Fuelwood savings of up to 50 per cent are possible, when efficient cookstoves are used.

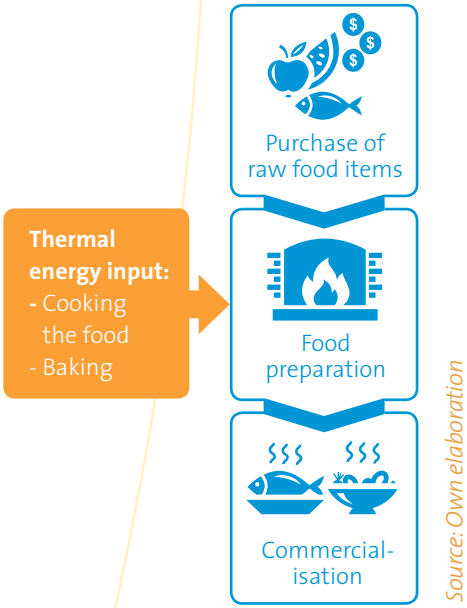
In the **commercial sector**, some services are characterised by relatively low requirements for skills and start-up capital, therefore offering important income opportunities to poor people, using thermal energy. For example, restaurants and street food vending enterprises are often run as informal businesses and exist in large numbers in rural and urban areas in developing countries (Draper, 1996), offering considerable employment generation potential, especially for women (Tinker, 1997). Investment in efficient stoves to enhance fuel efficiency for cooking can help these businesses reduce running costs and increase profits in the long term. For example, restaurants in Kenya use thermal energy to cook meals, mostly using wood as fuel. With an efficient stove, they can enhance their fuel efficiency, reducing fuel costs by 50 per cent. In the long term, these savings increase the income of the restaurants, while also improving the atmosphere and hygiene in the restaurant due to reduced smoke.

Figure 2 Value chain of small-scale shea butter production



Source: Own elaboration

Figure 3 Value chain of a restaurant with thermal energy



Source: Own elaboration

FURTHER READING

Energy For Development - The Potential Role of Renewable Energy in Meeting the Millennium Development Goals by C. Flavin and M. Hull Aeck.
http://www.worldwatch.org/system/files/ren21-1.pdf

Poor People´s Energy Outlook 2012: Energy for Earning a Living by Practical Action.
http://practicalaction.org/ppeo2012

ValueLinks Manual - The Methodology of Value Chain Promotion by A. Springer-Heinze.
The manual offers 12 modules on how to promote value chains for specific agri-businesses, handicraft and manufacturing sub-sectors.
http://www.valuelinks.org/images/stories/pdf/manual/valuelinks_manual_en.pdf

Modern Energy Services for Modern Agriculture, A Review of Small-holder Farming in Developing Countries by Veronika Utz (GIZ), 2011.
http://www.giz.de/Themen/en/dokumente/giz2011-en-energy-services-for-modern-agriculture.pdf

The Integration of micro-enterprises into Local Value Chains by B.Tschinkel (Vienna University of Economics and Business), 2011.
http://epub.wu.ac.at/3095

2.2 Productive processes based on thermal energy and suitable technology options

Many of the entrepreneurs that require thermal energy for their different productive uses run MSME. Though there is no internationally accepted definition of MSME, they range from micro-enterprises with fewer than 10 employees, to small and medium enterprises with up to 250 workers. Micro-enterprises often operating in the informal sector in rural areas produce important export products in several countries. In Malawi, for example, over 30,000 small-holder farmers throughout the whole country constitute the main contributors to the tobacco industry.

In Sub-Saharan African countries, approximately two-thirds of the population work in the informal sector (Grimm, 2012). Enterprises operating in the informal sector often face difficulties in overcoming market barriers, gaining access to modern energy services and managing their way out of poverty towards profitability (Miehlbradt and McVay, 2003).

As these enterprises are often located in rural areas, access to the national grid or other energy services is very limited. It is therefore evident that micro-enterprises are highly dependent on biomass as their main energy source. Process and product upgrading through access to modern energy seems to be an important precondition for micro-enterprises to perform in an efficient way. This in turn is important for business development (Tschinkel, 2011).

2.2.1. Cooking

The high consumption of biomass for cooking with inefficient technologies is a serious environmental, social and economic concern in many countries. In general, traditional cooking causes 4 million premature deaths annually, with women and children most affected, due to smoke exposure. Hence, inefficient cooking worsens global warming due to the emission of greenhouse gases like carbon dioxide and black carbon. Cutting down natural forests causes erosion and desertification of entire regions. When fuel becomes scarce, energy expenditure rises. For business, using traditional cooking methods for producing goods and offering services, fuel purchase is a high operational cost factor.

When analysing the cost-effectiveness of various cooking technologies and fuel types in restaurants or food vending businesses, it is important to consider that these businesses also base their technological decisions on parameters such as cooking time, flexibility and cleanliness of the fuel, as well as the taste of the food.

Efficient biomass cookstoves vary in size, material, design and usage. However, they all aim at making the combustion process more efficient and improving the heat transfer from the fire to the pot, such reducing the amount of required fuel and harmful emissions. Institutional cookstoves for use in commercial kitchens or canteens require in average less than a quarter of the amount of firewood that would be consumed on an open fire to cook an equivalent amount of food. Special stove models have been developed in several countries to prepare local traditional dishes, such as the Mirt stove for baking *injera* bread in Ethiopia. For choosing the most appropriate cookstove model it is essential to consider the available fuel, the fuel manage-

ment and the cooking behaviour. Any expected fuel saving are impossible to gain, when the cookstove is not used and maintained properly. Efficient stoves are not only used in the food processing businesses, but also in certain other industries for manufacturing purposes or in the commercial sector for heating water.

FURTHER READING

Cooking Energy Compendium by GIZ HERA.
A compilation of comprehensive information on clean and efficient cooking energy is available at:
https://energypedia.info/index.php/GIZ_HERA_Cooking_Energy_Compendium

2.2.2. Drying

Drying is an important form of food preservation that is often carried out at farm level right after harvest, or especially with highly perishable crops, at peak harvest time when local markets are saturated. Drying vegetables, fruits and meat with thermal energy enables longer storage times and easier transportation. Without preservation, large shares of harvest can be lost. Up to 70 per cent of agricultural products spoil during the traditional process of open-air drying, especially in tropical and subtropical regions (INNOTECH, 2012).

Agricultural products can be dried open-air or unimproved, directly in the sun, with biomass or in solar dryers. Open-air or unimproved drying takes place when food is exposed to the sun and wind by placing it in trays, on racks, or on the ground. The advantage of drying products directly open-air is that almost no costs for fuel and appliances have to be spent by the farmer. However, the dried products are often of lower quality due to varying temperature levels and contamination of the products with dust, vermin's and leafs. Solar dryers require a certain investment for the set-up of the appliance, but no expenditures for the fuel. The basic function of a solar dryer is to heat air to a constant temperature with solar energy, which facilitates extraction of humidity from crops inside a drying chamber. Ventilation is enabled at a constant rate through defined air inlets and outlets, small ventilators or temperature difference, either due to exposition or vertical height. In direct sun driers the food is put in boxes with a transparent lid. The temperature in the drier is raised due to the greenhouse effect and the air exchange is regulated by vents. The food is not exposed to direct sunlight in indirect sun driers as the fresh air is heated separately from the food chamber. This method is preferable for drying foods which lose nutritional value when exposed to direct sunlight. Hybrid driers combine solar energy with a fossil fuel or biomass fuel (Green and Schwarz, 2001a). Biomass dryer require fuel input which especailly in bigger appliances such as tobacco dryer can be labour and monetary intensive.

A first step when considering solar drying is to compare the different drying options available. Solar drying will only be successful, when it shows tangible benefits in comparison to existing drying methods. In comparison to the traditional way of drying outside in an open field, solar dryers prevent contamination of produce by dust, insects, etc., thereby ensuring quality. They allow small-scale farmers to transform their harvest into storable and tradable goods, which they can sell off-season at higher prices. The constant temperature and ventilation allows a consistent drying process which results in better product quality and higher prices. However, the investments costs of solar dryers vary highly depending on the size of the solar dryer, locally available materials and environmental conditions, such as slope and exposition of the side, rainy seasons.

Project case 1: Coffee processing with solar dryers in Peru

Energising Development Peru promotes solar dryers among individual smallholder coffee farmers for the first drying period, during which the humidity of the beans is reduced to around 25 per cent. The solar dryer improves the drying process by filtering UV radiation, concentrating heat, reducing the relative humidity of the air and thus drying the beans with constant and natural ventilation. However, coffee can only be stored and exported at a lower level of humidity.

A second drying phase is therefore required, that reduces the humidity of the beans to around 12 per cent; this phase takes place in a bigger solar dryer with a capacity for up to 2 tonnes of coffee, which is managed by farmers' associations. Victoria Esteban Fuentes has a farm of two hectares in Santa Anita, Satipo, Peru. Before the adoption of the new solar dryer, approximately 70 per cent of Victoria's coffee harvest met export standards. The solar dryer has increased this rate by eight per cent. Victoria's income has therefore increased by PEN 2,400 (USD 885) or 30 per cent per annum. The investment in an efficient solar dryer certainly paid off for her.

FURTHER READING

Solar Drying Technology for Food Preservation by Matthew G. Green and Dishna Schwarz.
This publication presents possibilities of solar drying with a focus on technical needs, classification of driers and selection criterias. Moreover the publication provides information on moisture content of foods, drier components, the drying process, and the capabilities of solar driers.
http://www.gate-international.org/documents/techbriefs/webdocs/pdfs/e014e_2002.pdf

Solar Drying Equipment: Notes on Three Driers by Matthew G. Green and Dishna Schwarz.
http://www.gate-international.org/documents/techbriefs/webdocs/pdfs/e014e_2002.pdf

Solar Drying, Technical Brief by Barrie Axtell and Tony Swetman.
This manual by Practical Action discusses three basic designs: the solar cabinet dryer, tent-dryer, and solar tunnel.
http://practicalaction.org/solar-drying-4

Solar Drying by Werner Weiss and Josef Buchinger.
Trainings course on the production and sale of solar thermal plants in Zimbabwe.
http://www.aee-intec.at/ouploads/dateien553.pdf

Solar Drying in Morocco by Markus Häuser and Omar Ankila.
http://www.gate-international.org/documents/publications/webdocs/pdfs/g58soe.pdf

2.2.3. Baking

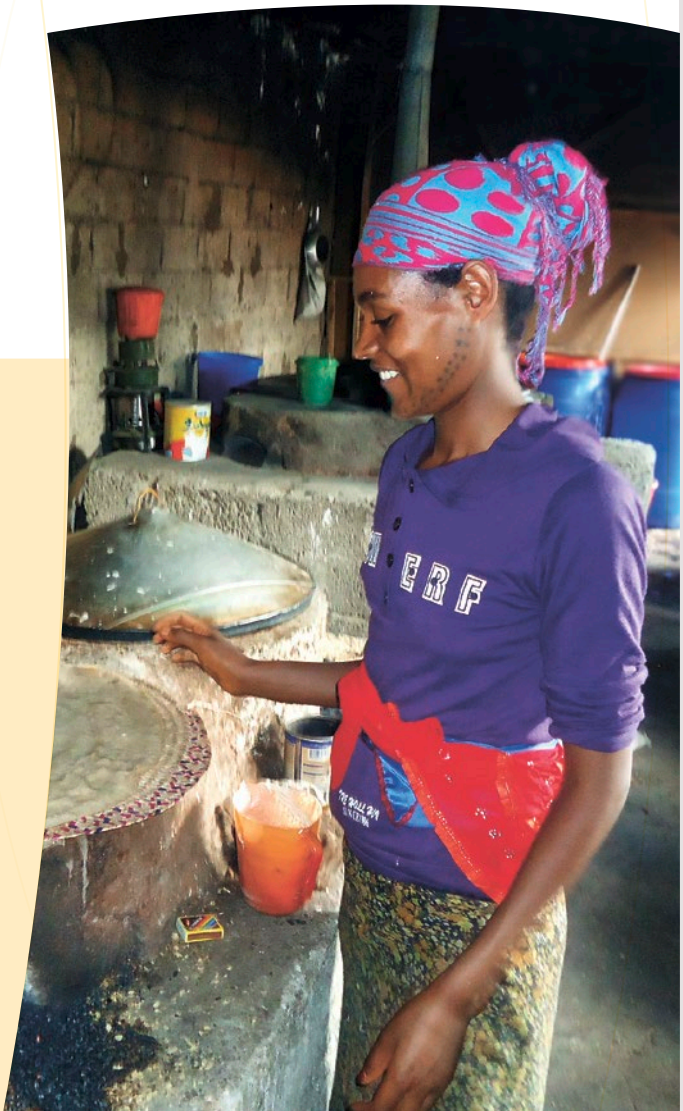
Baking is another essential way of preparing food from raw staple crops. Many different varieties of bread and pastry have emerged from regional traditions around the world. Baking involves very high temperatures (around 250°C) and therefore requires a larger amount of thermal energy input than is required for cooking. The availability and price of fuel is therefore crucial for bakeries, as it constitutes their largest operating cost (Fellows, 2012; Lawson, Joseph, 1989). A biomass fuelled baking oven is a major investment, which can easily exceed the available investment capital of small entrepreneurs, which for example in Mozambique ranges from USD 400 to USD 800. Local oven builders with technical support from GIZ managed to bring the initial cost of investment in a baking oven down by 30 per cent, thus enabling new business opportunities for women's groups interested in starting a bakery.

There are two types of ovens: direct heating ovens heated by fuels in the baking chamber, and indirect heating ovens that have a separate heater or firebox. Both types are constructed from materials such as steel that withstand high temperatures. Insulation of the chamber is very important for increased efficiency. Directly heated solid fuel ovens are typically used by potters, small-scale bakeries and restaurants. This type of oven is relatively low cost, but involves the risk of product contamination by smoke and ash. Fuel is burnt on the stone hearth for 6-12 hours, often overnight. The heat retained inside the oven and in the oven walls is then used for baking, while the oven temperature gradually drops through the course of the day.

Indirect heating ovens can be operated continuously at constant temperatures because the fire can be maintained without interrupting production. The simplest oven designs have a separate firebox with brick or tile-lined flues surrounding the baking chamber. Both types of ovens come in various sizes and with varying capacities. A portable oven model, the BEST bread oven developed in Papua New Guinea, can be brought to a temperature of 240°C within as little as 20 minutes, with a baking time for bread of 20 to 25 minutes (Fellow, 2012).

Project case 2: Efficient stoves for backeries in Ethiopia

Bakers in Ethiopia face various challenges: The *injera* baking process is labour and time intensive. An *injera* baker can only bake on two stoves at a time and each stove only bakes one *injera* at a time. According to data collected by GIZ, baking one *injera* takes on average about four minutes with an hourly rate of 16 *injeras* per stove. The Habesha Tikus Injera Share Company that is located in Addis Ababa and owned by the young entrepreneur Issac Wudu and his two partners is engaged in mass production and distribution of fresh injera. They own eight Mirt stoves and employ four women and two men, providing about 300 quality injeras every day for supermarkets, hotels and households. *Baking with Institutional Mirt stoves has many benefits* said Issac Wudu, *our fuel consumption has reduced by almost 50 per cent: from USD 1,900 to USD 970 per year as compared to the open fire method, and our income has risen from USD 2,020 to USD 2,750; four per cent per year.* After the amortisation of their investment in the Mirt stoves within approximately 15 months, they are now about to expand their business.



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Energy for Domestic Brewing & Bread Baking. by W. Nyabeze. Boiling Point Issue 37 - Household energy in emergency situations.
http://www.hedon.info/BP37_EnergyForDomesticBrewingAndBreadBaking?bl=y#Bread_baking

Rocket Bread Oven Construction Manual, developed by Peter Scott.
The manual is a flexible tool that describes how to build efficient bakery scale wood burning rocket bread ovens.
https://energypedia.info/index.php/File:GIZ-2012_bread_baking_oven_burn_lab_design_en.pdf

Baking. Technical Brief of Practical Action, developed by Peter Fellows.
This is a technical brief about the baking process. March 2012.
http://practicalaction.org/baking

2.2.4. Other productive processes with thermal energy input

Smoking is another method of preserving food using thermal energy. Foods such as fish, meat, vegetables and cheese are cured through extended exposure to the smoke of wood fires. The smoking process reduces the water content of the food by about 10 to 40 per cent. In addition to increasing the durability of the food, smoking changes typical characteristics such as colour, smell, flavour and texture.

The simplest smoking unit comprises four wood stakes surmounted by a metal grate, which can be placed outside or inside the house. The produce is put in boxes and preserved by the smoke. Improved furnaces are brick-built constructions with metal roofs and doors that can be closed for an improved smoking process. Improved smokers consume less fuel and reduce the respiratory health risks of smoke exposure. In Senegal, the investment in improved smoking ovens has reduced the running costs of fish smoking businesses by two-thirds: fuel costs with an improved oven amount to only FCFA 1,000 (USD 1.90) per 100 kg of smoked fish compared to about FCFA 3,000 (USD 5.50) with a conventional smoker (Enda Energia 2007). The Ministry of Environment in Senegal has distributed an efficient smoker that allows for a 100 per cent increase in the amount of smoked fish output at a 58 per cent reduction in fuelwood input compared to the traditional smoker. Practical Action has issued a fish smoker construction manual in Sri Lanka with a detailed description of materials and budget for training (Practical Action, 2010).

Cooling plays an important role in tropical countries, primarily in the preservation of food and medicine and in air conditioning. In the absence of electricity, passive cooling methods such as shade, water evaporation or traditional mud jars can bring temperatures down to 10°C in some cases, but only 25°C in other cases (Holland, 2010). This is often not cool enough for the long-term storage of perishable food items. Heat-driven coolers can be fuelled by solar energy or biomass and transform heat, cooling to minus 10°C.

Heating water is a small but essential element of a wide range of production processes in agricultural, industrial and service sectors. Hot water is needed, for example, in restaurants for cooking and cleaning, in industrial processes for dissolving substances or cleaning equipment, in hotels for hot showers, etc. There are various techniques available for heating water, most of which are based on fuel combustion or the use of solar power.

Solar thermal water heaters enable water heating by using solar energy. The simple idea is that a black surface absorbs the heat from the sun and this heat is then transferred to a liquid, often water or antifreeze in cold regions.

Specially designed collectors and tanks capture and store heat from the sun. Productive use applications of solar water heaters arise in various industries, notably in the

food service and hotel industries. Reliable and sufficient availability of hot water usually implies higher and cleaner service quality, which allows restaurants and hotels to attract more clients or increase prices.

The easiest models of solar water heaters can be constructed with simple materials and do not need any pumps or other electric devices. Effective solar collectors can even be used in winter due to the use of antifreeze.

Locally produced solar water heaters are of low costs for construction and the devices are simple to maintain and to repair. In comparison, the investments for industrial produced solar water heaters are often higher, but these show often good efficiency values. However, the quality of industrial solar water heaters vary greatly and services for maintenance, replacement and repair are required. GIZ experience from Tajikistan showed that the import of glass vacuum solar water heaters from China was not feasible due to a high percentage of glass pipes break during the transport, difficulties to order spare pipes and installation problems of solar water heaters in rural settings.

Table 1 provides an overview of the most important business activities involving thermal energy technologies based on biomass combustion and solar energy for distinct purposes. Each activity is described with its traditional techniques and energy carrier, as well as possible efficiency improvements involving the use of efficient cookstoves, solar dryers, ovens, smokers and water heaters. For GIZ examples, further information can be found in the factsheets or by contacting the projects listed in the final column.

Project case 3: Rocket stoves used for soil sterilisation in Kenya

One energy-intensive farming practice found in various countries in Africa is sterilisation of the soil with hot water in order to kill weeds and harmful germs before seeding. Traditionally, farmers boil water on a three-stone fire for sterilising the soil. This consumes enormous amounts of biomass. With an efficient **rocket stove steriliser**, as promoted in Kenya, water is boiled on a rocket stove, with a water tank built half-way into the combustion chamber. The steam rising from the tank is passed through a pipe into another tank, which holds the soil to be sterilised. It takes 30 minutes to sterilise one load of soil, with only 30 % of the firewood compared to the traditional sterilisation method. To sterilise 10,000 seedlings, a farmer using the improved steriliser spends KES 2,400 (USD 28) on firewood as opposed to KES 8,000 (USD 93) when applying the traditional method.

Table 1 Improved thermal technologies for different productive processes

Type of business	Baseline technology	Improved technologies	Project examples
COOKING			
Restaurants, food vendors, hotels	Traditional stoves, three-stone fires	Efficient biomass stove	**Kenya:** Restaurants with Efficient Cookstoves*
Beer brewing			**Burkina Faso:** Brewing Beer with Efficient Cookstoves*
Shea butter production			**Benin:** Efficient Stoves for Producing Shea Butter*
Soil sterilisation		Rocket stove steriliser with water boiler and vapour pipe	**Kenya:** Rocket stoves used for soil sterilisation *(see project case 3)**
Distilleries of traditional liquors		Efficient stoves and distillers	
DRYING			
Coffee, tea, fruit and cacao processing	Drying on open fields	Solar thermal dryers	**Malawi:** Efficient Barns to Cure Tobacco* **Peru:** Coffee Processing with Solar Dryers* **Bolivia:** Drying Peaches with Solar Dryers*
BAKING			
Bakeries, restaurant, food vendors	Inefficient baking ovens	Efficient biomass ovens	**Uganda:** Bakeries with Efficient Ovens* **Ethiopia:** Efficient Ovens for Bakeries*
SMOKING			
Farms, smokehouses	Inefficient smokers	Efficient smokers, efficient furnaces, biomass, solar thermal, geothermal	
COOLING			
Cooling	Shade, evaporating water or traditional mud jars	Efficient heat-driven coolers, Solar Vaccine Refrigerator	

Source: Own elaboration
**The respective project description are available as seperate factsheets*

FURTHER READING

Fish Smoker – Technical Brief developed by Practical Action .
This construction manual includes pictures and a description of how to build an efficient smoker.
http://janathakshan.com/wp-content/uploads/2010/09/fish_smoker.pdf

Refrigerators in Developing Countries developed by Practical Action.
More information on cooling and refrigerators is available at:
http://practicalaction.org/refrigeration-in-developing-countries-1

Solar Vaccine Refrigerator is a robust, easy to maintain technology that can be made in most countries as materials such as steel, charcoal and ethanol can be found in most places.
http://contest.techbriefs.com/component/content/article/448

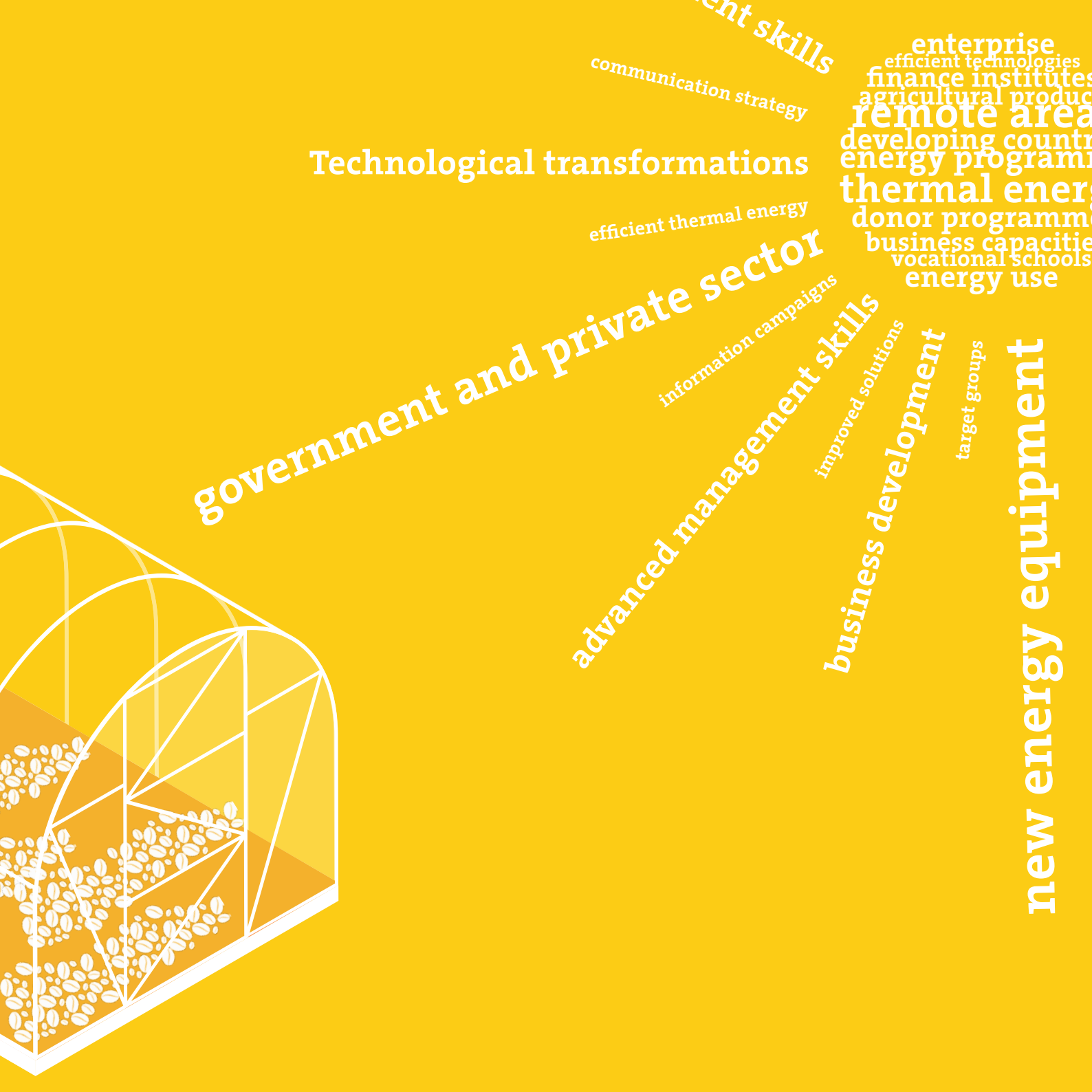
Technical Brief: Solar Water Heating by Amy Punter.
This publication by Practical Action explains how solar energy may be used to heat water and how the technology works.
http://practicalaction.org/solar-water-heating

Construction of Solar Collectors for Warm Water – Practical guide by Regina Drexel and Rostom Gamisonia.
This brochure by Women in Europe for a Common Future shows how to use the energy from the sun for heating water, how to construct a solar water heater and gives an overview of other solar collector models.
http://www.wecf.eu/download/2010/WECF_Construction_of_solar_collectors.pdf

Solar Water Heater with Thermosyphon Circulation by Bernd Sitzmann.
This publication describes briefly the advantages and engineering aspects of solar water heaters with thermasyphon circulation.
http://www.gate-international.org/documents/techbriefs/webdocs/pdfs/e021e_2003.pdf

Promoting productive use of thermal energy

3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vocational schools
energy use
Technological transformations
efficient thermal energy
government and private sector
information campaigns
advanced management skills
improved solutions
business development
target groups
new energy equipment

3. Promoting productive use of thermal energy

Energy programmes can encourage and support the adoption of more efficient technologies by MSMEs in many different ways. This chapter suggests a range of options for programme interventions. Entry points for energy programmes can be at various levels: working directly with entrepreneurs, supporting the development of a local market for thermal energy appliances, working with the government and private sector to improve business development services available to local MSMEs, and advocating for a more conducive regulatory framework for efficient productive energy use.

A distinction is made between activities that are directly addressed at energy use within MSMEs, and those interventions that strengthen business capacities of MSMEs in a broader sense. For the latter, it generally makes sense for energy programmes to consider joining forces with programmes and institutions that specialise in MSME development. Government agencies and donor programmes for private sector support are potential partners that command valuable expertise in designing and implementing business development services. In addition, (micro-) finance institutes, both commercial and non-commercial, typically have indepth knowledge of the MSME landscape at their disposal, given that the success of their finance operations crucially depends on information about their target clients. Local business associations, vocational schools and other educational institutions can also play facilitating roles in the design and implementation of targeted services to strengthen MSME performance.

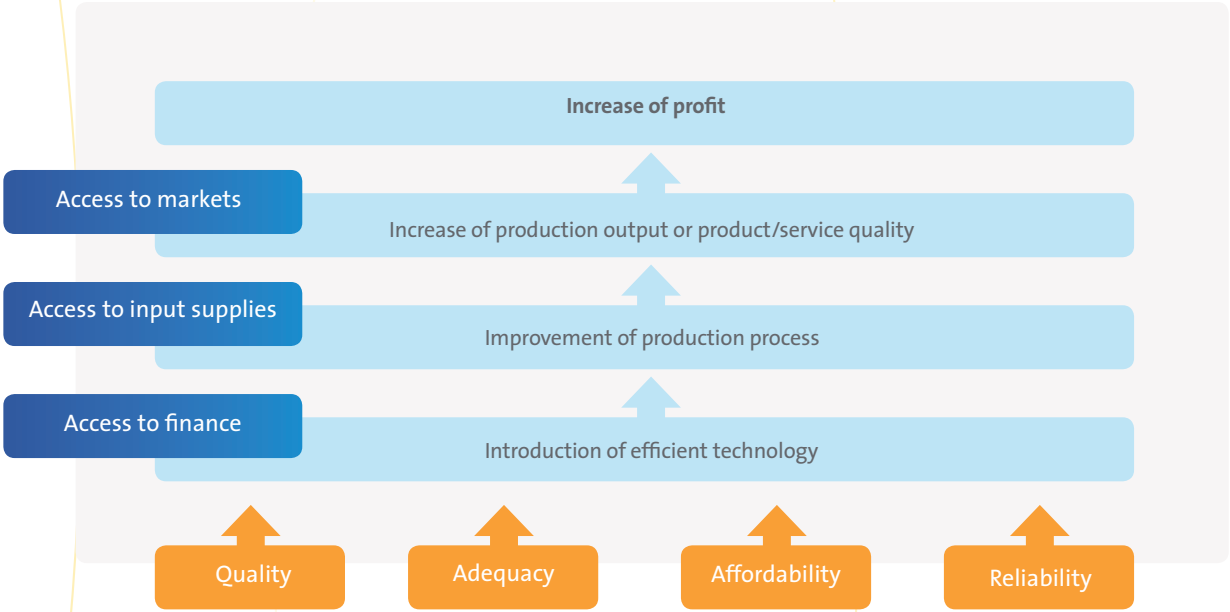
3.1 Opportunities and challenges

As the previous chapter has shown, various technological options for more sustainable and efficient use of thermal energy by MSMEs are available.

There are, of course, many factors other than energy that influence the performance of MSMEs. Technological transformations within an enterprise can sometimes engender new management challenges that require special attention to guarantee continued business success. The adoption of new technologies can result in altered demand for input supplies, e.g. increased demand for agricultural products for processing. Access to markets to sell increased output volumes or higher quality products is often a key constraint for the growth of MSMEs in remote areas. Altered flow of inputs and outputs may also call for advanced management skills on the part of the entrepreneur.

In addition, access to finance at favourable conditions is a precondition for MSMEs that invest in new energy equipment. This is another limiting factor for MSME growth in many developing countries.

Figure 4 Results chain for productive use of thermal energy



Source: Own elaboration

Before deciding to promote a certain productive use of thermal energy, programme planners should conduct a preliminary analysis of the local economic context and market situation (Brüderle, A. et al., 2011). In order to support sustainable economic development, programme interventions need to be targeted at business models that fit within the local economic structures, with a particular focus on the following factors:

- the availability of input products
- the qualifications of the local work force
- infrastructure conditions
- and notably, accessible markets for the sale of the final products.

After the analysis of the viability of a business idea and the respective thermal energy application the main bottlenecks that the targeted MSMEs face need to be identified. Based on this analysis the complementary services of energy and private sector programmes need to be defined for the support of MSMEs. According to their core areas of expertise, energy programmes will focus on issues related to the adoption of more efficient energy technologies by MSMEs and may neglect other factors that are key for improving business performance. For example, they may not have experience in improving access to finance to enable MSME to invest in energy efficient technologies. Hence for non-energy-related issues energy programmes should establish linkages with other actors such as private sector development programmes.

After the identification of viable business models, the availability of efficient thermal energy appliances in local markets and the low awareness of these technologies among MSMEs may be a constraint. In addition, entrepreneurs may hesitate to adopt new technologies, if this involves major changes in people's work practice and daily life. From the perspective of an individual entrepreneur who considers adopting a new energy technology, the key criteria that the appliance and energy supply must fulfil are **reliability, quality, affordability and adequacy** (Practical Action, 2012). All of the elements above are equally necessary for an entrepreneur to translate thermal energy supply into profits. Appliances need to be operational and the supply of energy needs to be guaranteed on a continuous basis to allow for production of goods and provision of services as the market demands. For example efficient solar driers might cause a high investment at the beginning, but they may allow drying of products even by low sunshine rates.

Total energy related costs to be considered in a business plan include investment in the energy technology or appliance, including costs for installation, maintenance and repairs, as well as running costs for fuel, if applicable. Technologies can be considered adequate for a given economic and social context only if they match the level of technical skills of the business owner, and if technical expertise for installation, maintenance and repair is locally available. In the case of certain technologies, entrepreneurs need special training to realise the technical potential of the device. Good cooking practices and techniques are essential for the efficient performance of a stove. Correct fuel preparation (e.g. dry firewood, small pieces of firewood with large surface area)

and fuel saving cooking habits (e.g. preparing ingredients before heating the fire, using a lid) can enhance fuel savings substantially.

However, production processes often have strong traditional and cultural elements, especially in rural areas. For example, encouraging farmers to replace traditional techniques for drying fruits with solar dryers can mean asking them to abandon the knowledge and experience of many generations of ancestors. It can also mean interfering with the calendar of festivities that may be tied to the annual agricultural production cycle. Energy programmes that promote the adoption of new technologies in traditional production sectors therefore need to exhibit sensitivity to local culture when designing their intervention strategies.

In order to facilitate successful technology adoption for productive use, projects need to identify main bottlenecks regarding the MSME itself, the energy efficient appliance market, and the regulatory framework.

Restrictions on the side of the commercial technology users:

- missing or low awareness on available energy efficient technologies
- limited working capital for investment
- insufficient business skills, e.g. in terms of business planning, price calculation
- lack of technical skills to operate the equipment
- lack of capacities and information enabling access to regional, national and/or export markets
- lack of information on governmental business regulations, e.g. tax payments.

Restrictions in the supply of energy efficient appliances:

- insufficient supply and marketing of energy efficient appliances
- lack of finances to investment into energy efficient technologies
- lack of technical skills of technology suppliers, which results in low quality offers, insufficient guarantees and after-sales services (e.g. installations, repair, spare parts).

Bottlenecks at the regulatory framework level:

- many of the MSME work in the informal sector and have therefore no access to certain forms of support from government and other actors
- unfavourable governmental business regulations and services, e.g. rights and obligation of different business forms, tax regulation
- lack of awareness of the multiple benefits of efficient energy technologies on the side of policy makers, local decision makers
- insufficient standards for quality assurance and/or enforcement of standards, e.g. financial institutions are unable to evaluate potential technical performance, durability and thus, the viability of loans.

FURTHER READING

Productive Use of Energy – PRODUSE: A Manual for Electrification Practitioners by A. Brüderle et al.
Module 3 of the manual offers analytical steps for identifying viable productive use opportunities, which need to be adapted partly when applied to businesses based on thermal energy use.
http://www.produse.org/Manual

Local Economic Development (LED).
Participatory approach for analyzing local economic structures and getting an overview of commercial activities in an area in consulatation with private and public stakeholders. Online platform for sharing experiences and resources of people and organizations supporting LED processes at the local level.
www.ledknowledge.org

ValueLinks is a tool developed by GIZ to promote value chains for MSME to foster economic growth. It is oriented towards business opportunities, and consciously builds on the existing or emerging economic potential of the poor.
www.valuelinks.org

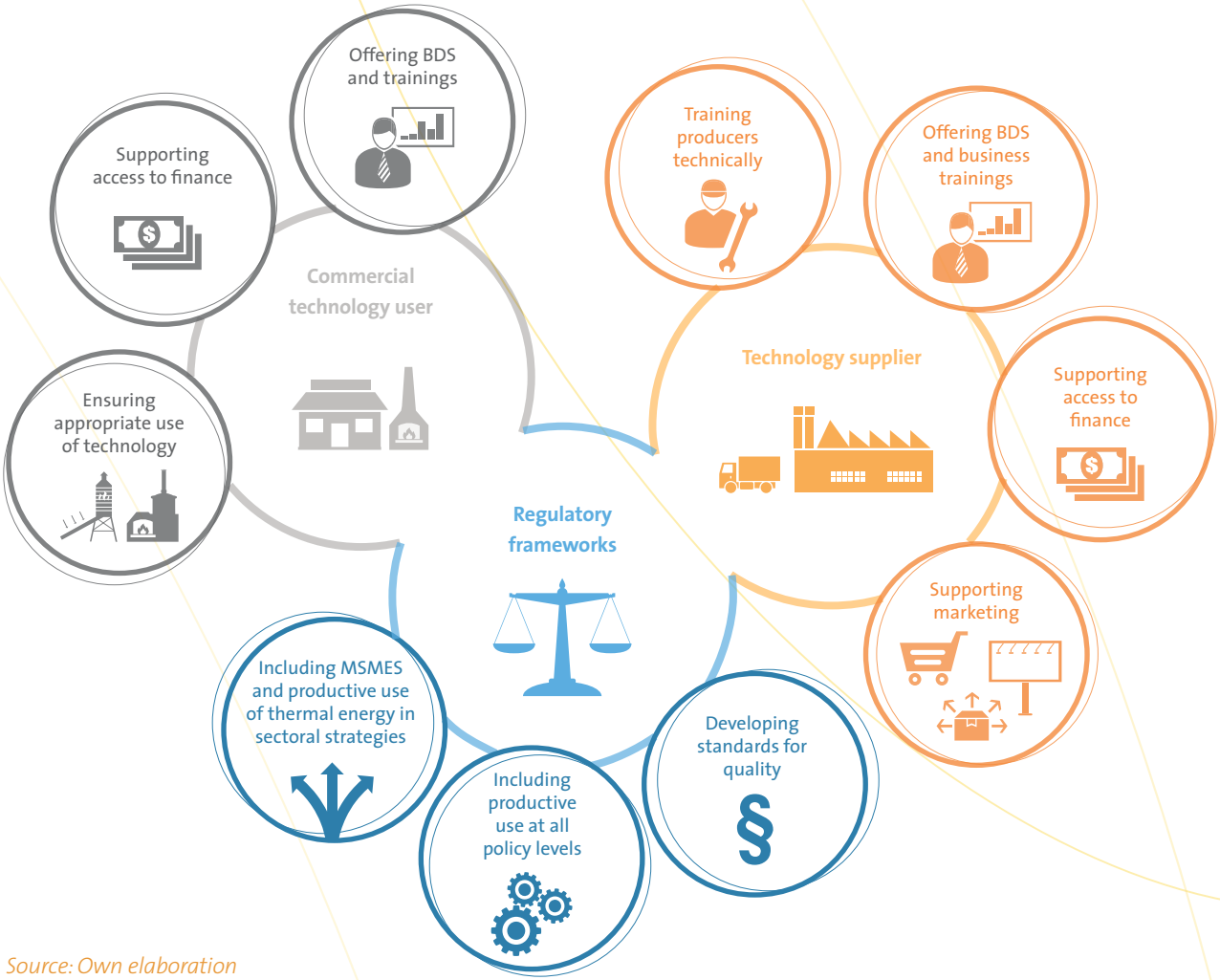
A Practical Primer for Productive Applications by J. Weingart and D. Giovannucci.
ESMAP Department World Bank.
http://www.dgiovannucci.net/docs/Rural_Energy-A_Practical_Primer_for_Productive_Applications_Weingart-Giovannucci.pdf

3.2 Promotion of businesses using thermal energy for productive use

Business promotion for the productive use of thermal energy has two dimensions: those businesses using an energy efficient technology commercially (bakeries, breweries, farmers etc.) and those locally producing these improved technologies. Both need support, business trainings, advice on how to establish links with financing institutions, marketing etc. Furthermore, for both business types on either side of the value chain, enabling regulatory and institutional framework conditions are key to successful business development.

In the following, the three dimensions of business promotion for productive use of thermal energy – businesses adopting of energy efficient technologies, businesses producing energy efficient technologies and the regulatory framework conditions will be briefly discussed. A detailed description of the project cycle and the specific interventions to support business development, business creation etc. can be found in in the manual *Productive Use of Energy – PRODUSE: A Manual for Electrification Practitioners* (Brüderle et al., 2011).

Figure 5 Project context with proposed interventions



Source: Own elaboration

3.2.1. Promoting the adoption of energy efficient technologiesby MSMEs

Creating awareness

Without well targeted information campaigns highlighting the various problems associated with traditional energy use, and describing improved solutions, the promotion of energy efficient thermal energy technologies for productive use is likely to fail.

Projects need to interact with different groups to provide them with information regarding the relevance of thermal energy issues, the work of the project and the different products that are being promoted. Based on the objective a communication strategy helps to clarify messages, target groups and needs for making this communication process target-oriented and effective. It should answer the following key questions:

- Who is the target group?
- Why are they important?
- Which messages and information should reach the respective target group?
- How will the messages be transferred?

The first step for developing a communication strategy is to identify and analyse the target group(s) and to understand what needs to be achieved. To ensure sustainability of the interventions beyond the end of a project, the involvement of different stakeholders is required including governmental and non-governmental institutions as well as organizations specific to the area such as associations.

Only if they recognise the relevance of the topic and if they are willing to carry on different activities once the project has come to an end the probability of continued supply and demand for efficient thermal energy appliances for productive use will be much higher. The next step is to analyse the different information needs of the target groups. Therefore the following information might be helpful to answer:

- What kind of information would interest them?
- What information is needed to convince them of the importance of the issue?
- Which other convincing arguments besides increased profit exist?
- Do the target groups have basic background information about the benefits of improved technologies?

It is also important to consider possible barriers to reach target audiences: bad internet connections, access to mass media, harvest seasons, opening hours of shops and restaurants, hierarchies in ministries and associations, etc. Based on the defined messages and information the information materials need to be elaborated.

The information will be spread via different communication channels such as leaflets, radio or TV spots, street theatre or press releases need to be selected. If mass media are used, they should be selected on the basis of information on the numbers and geographic location of their users.

Business Development Services and trainings

Encouraging the creation of new businesses that use thermal energy requires an inclusive strategy. Such a strategy should be based on market analysis, target group selection, identification of entrepreneurship training and coaching needs to enable individuals for their new role as business people, and coaching support for the newly created businesses along the way. Supporting people with little or no business experience in becoming entrepreneurs requires a long-term strategy. Energy programmes need to be aware that when promoting business ideas that are new to a region or a target community, there may be many hidden challenges. It is therefore advisable to collaborate with other development programmes specialised in local economic development, value chain promotion, or MSME development.

Alternatively, programmes can be targeted at businesses that already use thermal energy as an input, and support technological change within these businesses. Particular attention has to be paid for micro enterprises operating in the informal sector to benefit from Business Development Services (BDS). Many entrepreneurs have very limited (or no) knowledge of the design and function of business plans. Many find it difficult to make realistic price/profit calculations. Others do not know how to calculate the price for their products or services. For some, the difference between profit and turnover may be unclear.

Knowing how to develop a business plan is extremely helpful for any entrepreneur, be it the owner of a small workshop, or the manager of a medium-size stove factory.

The business plan is the most essential document for launching, expanding and managing any successful business. It describes what the business is expected to do, how and where it will be done, and how the business will be financed and managed.

For producers who require access to (bank) credit, a sound business plan is imperative for raising capital and capturing the interest of investors. Lenders and investors require a business plan to evaluate their risks, and to assure them that they will get a fair return on their investment.

A good business plan accomplishes the following:

- draws a clear picture of the business objectives and goals
- provides a thorough overview of the business
- presents the strategy and the financial data supporting it
- shows the potential strengths and weaknesses of the business
- gives a timeline of events and financial milestones against which actual results can be compared
- gives prospective partners and investors a means of determining whether the business warrants their interest — and their money.

Business plans can be very detailed and elaborated, or contain only basic information. The very minimum that needs to go into a simple business plan should include:

- price for products/services to be sold
- basic sales strategies
- availability and costs of raw materials
- cost of labour
- other costs such as taxes, debt service etc.
- strategies to mitigate possible challenges
- monthly sales target.

Additional areas where micro enterprises often need support are bookkeeping and marketing. To meet these needs, GIZ developed the CEFE concept, *Competency based Economies through Formation of Enterprise*. CEFE aims to reinforce enterprise skills using participatory and active learning approaches (*www.cefe.net*). CEFE courses offer comprehensive training modules that use an action-oriented approach and learning through experience. This develops and enhances business management skills and personal competence. It is a highly adaptable concept designed as much for academics as for people with low educational backgrounds (as experiences working with street children have shown). The course's overall objective is to improve entrepreneurial performance through guided self-analysis, by stimulating a business mentality, and through building up business competence.

CEFE courses offer solid instruction complemented by clear methodological guidelines that can be adapted to each participant's needs and requirements.

Alternatively, the Business Development Services (BDS) Forum offers a free-to-use *7 Training Modules for Entrepreneurs* (BDS, 2008). BDS comprise a wide range of services for MSMEs in order to help them operate more efficiently and growing their businesses. BDS concentrate on providing training, consultation and market information to address weaknesses such as low business and technical capacity of enterprises, focusing on (Miehlbradt and MacVay, 2003):

- market access (e.g. marketing, packaging, advertising)
- infrastructure (e.g. storage, transport, access to communication and information)
- governmental business regulations and service providers
- input supply (e.g. linking enterprises to input suppliers, facilitating the establishment of bulk purchasing groups)
- business management (e.g. finance, bookkeeping)
- technical skills and product development (e.g. technology transfer, equipment leasing)
- alternative financing mechanisms (e.g. supplier credit).

Access to finance

In relation to the working capital flows of MSME, the amounts required for purchasing efficient thermal energy equipment can be prohibitively high. Even if such investments reduce production costs tremendously and have relatively short amortisation periods, small businesses may not have the cash available to cover the high up-front cost. Savings and informal loans from friends or family are the most typical modes of finance for investment in MSMEs, but are often highly restricted. Formal financial institutions often hesitate to provide loans for efficient energy equipment in MSMEs if they do not have reliable information about the performance of the technology and guarantees for the appliance.

Designing specific loan products for MSME is beyond the scope and expertise of most energy programmes. Nevertheless, there are a number of activities for improving access to finance for energy-related investments that can be integrated into energy programmes:

- supporting financial institutions in designing specific loan or leasing products for thermal energy equipment
- facilitating linkages between financial institutions, thermal energy equipment retailers, and MSME, farmers and cooperatives, business associations, etc., to overcome information asymmetries and scepticism on both sides
- offering training and coaching in business plan development and accountancy for (informal) MSMEs to help them improve their creditworthiness.

As an alternative to loan products of financing institutions, other payment and loan schemes can be considered. Micro enterprises with low-income levels can often only pay material suppliers, wholesalers and service providers on an assignment-by-assignment basis.

As a solution, wholesalers and suppliers could agree on commission based payments. In the agricultural sector, some other forms of financing can be observed: exporting enterprises contract farmers and train them in quality and management skills in their own interest. Producer cooperatives train their members being paid with crops. MFIs and other commercial service providers also have an interest in well-educated customers and could provide, next to their main services financing options, other BDS as well (Eiligmann 2005).

Project case 5: The Energy Inclusion Initiative - a financing scheme for energy products in Peru

In 2011, the Energy Inclusion Initiative was launched in Peru to promote financing and servicing of certain energy products for rural MSMEs. Initially, the programme covered three products (solar thermal water heaters, solar dryers, improved cooking ovens) and worked through two established MFI partners. The first of these, FONDESURCO, is an NGO with about 11,511 clients, mainly farmers in rural areas in the south of Peru. It has had previous experience with loans and micro-leasing for energy products. The second, Caja Municipal de Ahorro y Crédito (CMAC) Huancayo, has 124,074 clients.

It was selected as a partner of the programme due to its experience with loans for hardware products such as home electrical appliances, laptops and cars, as well as its cooperation with suppliers. CMAC offers its clients favourable loan conditions and after sales services for technical products. Loans to a farmer who wants to purchase a solar dryer vary between USD 100 for a UV plastic sheet and USD 1,100 for the total solar dryer construction. The MFI even provides installation instructions and advice on usage and maintenance. A supervision visit is made one month after the technology has been installed to assure its functionality. The payback period for the loan is up to 2 years.

Plans for 2012 and 2013 foresee an expansion of the programme to a wider base of MFI agencies. The initiative aspires to enable 10,000 Peruvian micro-entrepreneurs to obtain green energy solutions by 2015 (Appui au développement autonome and Micro-Energy International 2011).

Ensuring appropriate use of technologies

Regardless of the technology, enterprises need to be familiar with the correct installation, maintenance and usage of the device. Whether the entrepreneur is able to construct and install the appliance himself or if a service provider has to do the **installation** makes a difference in costs. After the installation all employees **using the appliance** need to be trained to realize the technical potential, and thus the expected energy savings, higher production output and improved product quality. In regard to improved cookstoves, fuelwood and cooking practices are essential for efficient performance of a stove. Hence, correct fuel and cooking preparation can increase fuel savings substantially. Entrepreneurs need to have this information and be able to use their device in the most efficient way.

Furthermore it is important that users of an efficient appliance are aware of **maintenance** requirements in order to guarantee performance of the appliance. Whether this involves additional costs (e.g. support from specialized technicians) or just additional work (e.g. cleaning of solar collector) depends on the technology.

Business owners need to be aware, that lack of maintenance can result in malfunctioning of the appliance and considerable profit losses. Many appliances require the **replacement** of worn out parts or of the entire appliance after a certain period of time. Cost savings and higher profits due to the energy efficient appliance shall enable the business owner to invest into spare parts or to replace worn out appliance. However, often it is observed that appliances are repaired or replaced too late.

3.2.2. Promotion of the supply of energy efficient technologies

Training of producers

A large-scale, successful and sustainable market in efficient thermal energy appliances can only function where there are sufficient qualified entrepreneurs and premises to serve and develop the market without relying on subsidies. The principle that promotion and scaling up of efficient thermal energy technologies should follow an essentially commercial approach is one of the main lessons learnt from numerous stove projects.

Therefore suppliers of these technologies need to be skilled entrepreneurs with access to resources, supplies, finance and markets. Consequently, in order to promote the supply of energy efficient technologies, producers need to be trained in business skills similarly to the methods and approaches described above (BDS and business trainings, access to finance).

Supporting the marketing of energy efficient technologies

Marketing is defined as getting the right product of the right quality to the target users in the right quantity, and at the right price in the right place at the right time and with each business person in the marketing chain making a fair profit.

As a general rule, marketing includes all the activities that lead to increased profitable sales. Producers and suppliers of efficient thermal energy appliances should either adapt their products to the specific needs of their customers or chose their target groups wisely in order to suit their products. Changing habits, i. e. the usage of a particular appliance for a certain activity is a very long-term process. User motives are often unconscious and implicit. The users' motives for switching to a more efficient technology may vary considerably from what the producer assumes (saving time, money, other resources; being modern and hence attracting more customers). Therefore, to determine these factors, quantitative and qualitative marketing research is an indispensable tool to develop the right product and marketing strategy.

The classic marketing approach involves the so called 4 Ps: product, price, place, and promotion. These 4 Ps form the four main pillars of the marketing mix. These include the identification and development of new products, at an appropriate price, through distribution channels and selling in the right places, supported by promotion.

Recently this number has been increased (up to 10 Ps) to include among others people, processes, packaging and so on.

FURTHER READING

CEFE is a comprehensive set of training instruments using an action-oriented approach and experiential learning methods to develop and enhance the business management and personal competencies of a wide range of entrepreneurs.
www.cefe.net

Business Development Services.
Seven training modules for entrepreneurs.
http://www.bds-forum.net/training-modules

Implementing Sustainable Private Sector Development: Striving for Tangible Results for The Poor by A. O. Miehlbradt et al.
This reader focuses on private sector programs that open and stimulate markets to generate significant and expanding benefits for the poor.
http://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/---ifp_seed/documents/publication/wcms_143173.pdf

Developing Commercial Markets for Business Development Services by A. O. Miehlbradt and M. McVay
This publication provides information for tracking pioneering activities, engaging in significant debates, and finding innovative ideas and new approaches to delivering market-based BDS. It is more relevant for experts on business development services.
http://www.ilo.org/empent/Publications/WCMS_143127/lang--en/index.htm

The Rural Energy Enterprise Development Handbook for Energy Entrepreneurs by UNEP and UNF.
This Toolkit covers the topics that must be addressed in a business plan for any energy business. The topics covered range from defining objectives, elaborating financial analyses and determining distribution strategies.
https://energypedia.info/images/1/11/Reed-handbookenergy-entrepreneurs1.pdf

Cooking Energy Compendium by GIZ HERA.
Correct fuel use: Firewood management techniques.
https://energypedia.info/index.php/Firewood_management_techniques

Cooking Energy Compendium by GIZ HERA.
Correct cooking preparation: General Kitchen Management Practices.
https://energypedia.info/index.php/General_Kitchen_Management_Practices

FURTHER READING

Effective Policies for Small Business by A. Gibb.
This publication provides practical guidelines on policy development and strategic planning for micro, small and medium enterprise development for policy makers.
http://www.unido.org/fileadmin/media/documents/pdf/Ammended_pdfs/33163_EffectivePoliciesforSmall-Business.pdf

Making Business Development Services, Markets Work for the Poor by A. Eiligmann.
http://www.value-chains.org/dyn/bds/docs/433/MakingBDSMarketsWorkforthePoor_0505.pdf

3.2.3. Creating an enabling environment for productive use

Politicians and other decision makers often overlook the important role of biomass as a renewable, modern source of energy for the productive sector and neglect the benefits of efficient technologies for small-scale industry.

The political and regulatory framework can either facilitate or inhibit the productive use of thermal energy.

Raising awareness of available efficient thermal energy options and associated business models among decision makers, including energy aspects in sectoral development strategies and developing quality standards for energy appliances are vital for the success of any intervention to support productive use of thermal energy.

3.3. Overview of possible activities to promote thermal energy for productive uses

As we have shown in the previous chapters, interventions for the promotion of productive use of thermal energy should target on commercial thermal energy appliances users, producers and/or suppliers of these appliances, and decision and policy makers. *Table 2* provides an overview of suitable interventions, and gives examples of where these measures have been applied successfully.

The enclosed factsheets *at the end of the publication* provide further details and contact information.

Table 2 Project context with proposed interventions

Interventions addressed directly at entrepreneurs		
Bottleneck to overcome	**Possible activities**	**Example**
Adoption of new technologies: Risk aversion, lack of information on technology alternatives	➤ Organise exposure visits ➤ Organise meetings of business people to discuss risk factors and opportunities ➤ Organise fairs to present appliances ➤ Assist individual businesses and associations with selecting the most appropriate technology	**Kenya:** sensitisation forums on efficient stoves for restaurant owners* **Peru:** technology is directly introduced to farmers' associations* **Bolivia:** farmers' associations receive support for the acquisition, construction or installation of solar dryers.*
Investment capital: On the side of business owners: limited working capital, lack of awareness about credit facilities On the side of MFI: Lack of awareness of energy efficient technologies	➤ Organise workshops to bring together business owners, equipment retailers and MFI representatives ➤ Support the design of specific financing options for energy equipment for MSME	**Malawi:** facilitation of cooperation between microfinance institutions and farmers* **Peru:** cooperation with micro finance institution* **Kenya:** facilitation of cooperation between MFI and farmers* **Bolivia:** facilitation of agreements between farmers and three MFI*
	➤ Develop standardised loan products	**Peru:** development of standardised loan product for solar dryers*
	➤ Subsidies for energy efficient equipment	**Bolivia:** farmers receive financial support to cover input costs for agricultural production* **Peru:** subsidies of up to 20 per cent of the investment costs for associations*

Table continues on page 46

Interventions addressed directly at entrepreneurs		
Bottleneck to overcome	**Possible activities**	**Example**
Production process: Lack of technical skills to operate the equipment	➤ Technical training delivered through local NGOs or training institutes	**Benin:** training for producers of shea butter to improve product quality* **Malawi:** technical training for use of improved barns for tobacco curing*
Business management: Lack of business administration skills	➤ Business management training, radio programmes on business management, counselling services	**Bolivia:** provision of technical assistance, capacity building measures through on-the-job training for small farmers*
Marketing: Lack of skills, capacities and/or information for accessing to regional, national and/or export markets	➤ Facilitate linkages with dealers / traders on a regional, national or export level	**Benin:** support for marketing of shea butter products*

Intervention addressed at the regulatory framework level		
Bottleneck to be overcome	**Possible activities**	**Example**
Neglect productive use in environment, business development and energy strategies at national and subnational level	➤ Support formation of and lobbying by associations of stove producers etc.	**Bolivia:** the project interventions in Bolivia integrate all stakeholders, including those at the municipalities and local authorities. *
Poor knowledge of productive use of thermal energy among policy makers	➤ Raise awareness of productive use of thermal energy among decision makers (e.g. specific workshops and information material for policy makers) ➤ Facilitate interaction between ministries and agencies responsible for environment, energy as well as local and rural economic development	
Lack of awareness of thermal energy use in the productive sector, lack of knowledge of efficient technologies among decision makers at national and local level		

Interventions to support the provision of thermal energy appliances		
Bottleneck to be overcome	**Possible activities**	**Example**
Technological capacities: Lack of skilled personnel for the production of efficient technologies	➤ Training in thermal energy equipment manufacturing	**Uganda:** training of local producers of efficient stoves (various sizes) and baking ovens*
Financing for equipment manufacturers: No linkages between MFI and equipment manufacturers	➤ Facilitate linkages between MFI and stove producers ➤ Invite MFI representatives to trade fairs for energy equipment	**Kenya:** facilitation of linkages between stove dealers and banks*
Technology: Producers are not familiar with efficient thermal energy technologies Materials for improved equipment are not available Technologies do not always meet quality standards	➤ Support design of efficient equipment ➤ Assist manufacturers in sourcing material (e.g. UV plastic foil)	**Malawi:** development of the *rocket barn** **Bolivia:** training for local installers and promoters of solar dryers * **Uganda:** technology development and testing, quality control* **Benin:** implementation of a quality system and optimisation of appropriate technology*
Business management: Lack of business administration skills, training opportunities not available	➤ Offer business management training and coaching tailored to local energy equipment manufacturers	**Kenya:** training on basic business skills for stove suppliers*
Marketing: Lack of marketing skills and insufficient understanding of the market	➤ Offer specific marketing training for energy equipment ➤ Develop marketing strategies jointly with retailers, e.g. calculations of fuel savings for clients, demonstrations, etc.	**Peru:** capacity development of the providers in market expansion, business training* **Burkina Faso:** organising of debates on radio, TV and theatres*

Source: Own elaboration. Where are they available?
** The respective project descriptons are available as seperate factsheets at the end of this publication.*

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