

**ENERGY  
CATALYST**

# Technical Guide: PUE for Services

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# Technical Guide: Productive Use of Energy (PUE) for services

The provision of energy is key to the socio-economic development of rural areas. While energy is used for various consumptive purposes, from lighting and information access to comfort and entertainment, it is not sufficient by itself to trigger development in rural areas. Using energy for productive uses will generate income and therefore economic development.

The residential use of electricity improves the quality of life of the rural community while productive uses of energy (PUE) in rural areas lead to increased rural productivity, more economic growth, and a rise in rural employment.

Next to facilitating and stimulating socio-economic development, stimulating the use of energy for productive uses is essential to make the provision of rural energy a viable business.

The rationale behind promotion of productive uses in energy projects is therefore multi-layered:

- Productive use can maximise the economic and social benefits of energy access. Energy projects with productive use components are more likely to lead to rural economic development than projects that simply focus on the provision of electricity or other forms of energy.
- Incorporating a 'productive use' focus into energy projects makes them more likely to contribute to the achievement of the SDGs.
- Rural electrification projects with a productive use component are more likely to achieve economic sustainability. Enterprises that generate profits through electricity use have a higher ability to pay for energy services than private households who use electricity for purely consumptive purposes.

In line with the Alliance for Rural Electrification (ARE) and the National Renewable Energy Laboratory (NREL), the productive use of clean energy can be defined as **agricultural, commercial and industrial activities that generate income and are powered by clean energy sources. These activities increase productivity, enhance diversity, and create economic value.**

Productive use activities in rural settings primarily include:

- Use in local industries, such as agriculture, livestock and fishing
- Light manufacturing, such as welding and carpentry
- Commercial and retail activities, such as tailoring, printing, catering and entertainment
- Medium-scale production, such as small factories or intensive agro-processing.

This guide will focus on applications of productive use of energy in the services sector. A separate guide focuses on applications in agriculture.

## Energy and services

High-quality, efficient, and off-grid appropriate appliances such as fans, TVs, and refrigerators play an essential role in offering off-grid communities further benefits from their energy system, as well as developing and sustaining the distributed clean energy market in a positive cycle.

In rural areas, the following services can be expected once electricity is available:

- Lighting and electrical appliances in health facilities and schools
- Refrigeration and entertainment in bars, restaurants and shops
- Charging mobile phones and battery shops
- Hair salons
- Secretarial services and internet cafes
- Tailoring
- Transport by e-vehicles

Some of these activities are covered in separate guides (e.g. on health and education), while the remainder will be described in more detail in this guide.

## Refrigeration

Refrigeration can play an important part in the conservation of food such as fish and milk. However, the largest usage of cooling in rural areas is in shops for cool drinks and in bars for beer. Refrigeration for milk and fish are dealt with in the “Productive Use of Energy in Agriculture” and the “Fisheries” guides respectively.

Conventional AC refrigerators typically found in retail markets require a significant amount of power, which makes them incompatible with intermittent grid connections or the limited amount of electricity provided by distributed energy systems. In order to be viable in off grid settings and suitable for rural customers, refrigerators must become considerably smaller, cheaper, and run on far less energy than most conventional products.

Overall, the two primary types of refrigerators sold in off-grid markets are (1) standing or top-opening refrigerators that have one fresh food compartment, and (2) refrigerator-freezer combination units that have one fresh food compartment and one freezer compartment.

The average size of off-grid refrigerators is smaller compared to the traditional on-grid refrigerator market. The capacity of off-grid refrigerators found in the market averages about 130 L, with the average capacity of refrigerator-freezer combination units being 27% larger than refrigerators. The most common product size for refrigerators is between 50 and 99 L, and for refrigerator-freezer combination units between 100 and 149 L.

In research by CLASP it was concluded that:

- For refrigerators that are currently available in off-grid markets, the daily energy consumption is high
- The cost of refrigerators itself is also a critical barrier inhibiting more off-grid consumers getting access to refrigerators
- The pricing of refrigerators varies significantly, and a higher price is not always associated with better energy performance or quality

An off-grid energy supplier in Tanzania piloted the introduction of refrigerators, particular for shops. They found that the energy consumption in the field is considerably higher than was expected from the lab tests. One of the main reasons for this was the very high turnover of the cooled drinks in the fridge, requiring restocking with un-cooled drinks continuously. They also found that, although the monthly payments for the 18 month repayment plan and energy consumption were relatively high, the increase in sales did easily justify this.

## Entertainment

Entertainment, in the form of music and television, is one of the first energy uses that will pop up with the extended availability of electricity. Particular bars do benefit from offering music and television, next to lighting, to attract additional revenue. Sometimes this entertainment is complemented by slot machines and other computer games.

The business case for entertainment is rather straightforward and typically does not require any financing products on behalf of the energy service provider.



*Figure 1 Entertainment at a bar that is connected to the Kiboto island solar mini grid in Uganda*

## Battery charging

In rural areas of developing countries, many households do not have access to electricity, and instead power their radios with dry cell batteries or use candles and kerosene lamps for domestic lighting. Some employ car batteries that are charged in stations for lighting and entertainment.

More recently, energy service companies have started to add battery charging services to their offerings to ensure households that are not reached by local mini grids or Solar Home Systems can have access to electricity.



*Figure 2 Battery charging station using old car batteries at the Tungu Kabiri mini grid in Kenya*

Although the amount of energy that can be delivered by means of batteries is relatively small, it can considerably improve living conditions for its users. Electrically powered lamps improve domestic working conditions at night, in particular for women, and can also enhance studying conditions for children, not only because of the better light but also since they reduce fire hazard and do not emit noxious pollutants. Other services that are highly valued and only require a little electricity are radio and TV for information and entertainment, and air circulation (fans) for basic cooling. Also mobile phones, which are crucial for access to modern communication and help people in rural areas obtain information, can easily be charged off batteries, though they can also be charged directly at the charging station itself.

The provision of energy services through charging of batteries can be done using different business models. It can work on a “fee per charge” basis in which the customer brings in his/her own battery that gets charged for a fixed fee. An alternative to paying a charging fee every time the battery is brought in is charging a flat monthly fee for which the battery owner can come in and get the battery charged as and when required. This model will ensure a more predictable cash flow for the charging station operator, although at the risk of fluctuating energy consumption due to possible fluctuations in the number of charges per month a customer might require. In the third business model, the charging station operator owns the batteries and is swaps empty batteries for charged ones when the customer comes in. This does require investment in batteries, but will ensure that only technically compliant batteries are used with the charging devices. An added benefit is that the customer does not have to wait till the battery is recharged but can be provided with a fully charged battery instantly.

Irrespective of the business model chosen, the operator will be required by funders to have a strategy for battery recycling to ensure old batteries do not end up as waste damaging the environment.

Next to battery charging, the availability of electricity does provide for the charging of mobile phones as well. This can be a stand-alone business or be done on the side of another business. Often, even households will start charging cell phones (at a fee) for people who live outside the electricity distribution area, and in doing so recoup part of their household's electricity connection fees.

### Hair salons

One of the typical small sale businesses associated with the provision of electricity are hair salons. Electricity is used for hair clippers and hair dryers. In mini grids, these small saloons can be part of/attached to existing businesses or houses, while in the case of centralised energy provision through energy kiosks, a hair salon can be one of the businesses operating out of the kiosk. Several mini grid developers are offering rent-to-own schemes in which salon owners can get access to these electrical appliances.



Figure 3 Equipment at a hair salon at the Tungu Kabiri mini grid in Kenya

### Secretarial services & internet access

Services around computers, printers and the internet could perhaps be best classified as ICT offerings. These services could include photocopying, typing of texts and printing. These could either be operating on a stand-alone basis or be integrated in an energy kiosk. Internet services can be provided through a classical internet café or through the provision of WiFi in and around the energy kiosk. A local entrepreneur could sell access tokens to these services.

### Tailoring

Tailoring is a typical cottage industry that could increase productivity by using electrical appliances, such as sewing machines. Substantial productivity gains are possible if tailors start using electric sewing machines. The availability of repair capacity to maintain these appliances is also important.

### Energy kiosks

The energy kiosk model is an approach to provide electricity to low income households in off-grid regions. The kiosk produces electricity, usually using a solar panel, and sells it to users through charging devices. A variety of actors – including multi-national companies, start-ups, governmental initiatives, and non-governmental organisations – are engaged in energy kiosk initiatives. Kiosk models can be simple charging stations for lamps and batteries, or multi-service stations offering retail products, entertainment and education. Successful showcases can be found in Sub-Saharan Africa and India. Although the model works in principle, it seems difficult to create, scale, and replicate projects that have a positive social impact and are economically viable in the long term.

Table 1: Active support programmes for productive use of energy

Programme	Main activities
<b>The Green Mini Grid Help Desk</b>	Funded by the Africa Development Bank as part of the Green Mini Grid Market Development Programme (GMG MDP). Mini grid developers receive technical assistance, from support on demand assessments to technical sizing, capital raising, procurement and installation support, commissioning, and optimisation of operations.
<b>Efficiency for Access Research and Development Fund</b>	Funding into research and development (R&D) projects with the aim of accelerating the availability, affordability, efficiency and performance of a range of low energy inclusive appliances that are particularly suited to developing country contexts and promote social inclusion.
<b>Innovations Against Poverty</b>	Through financial and non-financial services, IAP supports innovative Inclusive Business models that deliver commercial benefits for the private sector and developmental benefits for the low-income population, while paying specific attention to gender equality and environmental sustainability.
<b>Global LEAP Awards</b>	The Global LEAP Awards use a competition-based approach to drive innovation and performance in early stage product markets for off-grid applications, while also building valuable technical and commercial market infrastructure. Awards results serve as core market intelligence for investors, donors, policymakers, solar distributors, and other off-grid market stakeholders.
<b>Low Energy Inclusive Appliances (LEIA) Programme</b>	The Low-Energy Inclusive Appliances (LEIA) Programme is a research and innovation programme that seeks to double the efficiency and half the cost of a range of electrical appliances suited for off- and weak-grid household, small business, and industrial consumers. The programme delivers a range of activities to stimulate the sector, including five principle components that address key market barriers: <ol style="list-style-type: none"> <li>1. Market Stimulation and Incentives</li> <li>2. Testing and Quality Assurance</li> <li>3. Marketplace Education, Communications, and Coordination</li> <li>4. Market Intelligence and Technology Road Mapping</li> <li>5. R&amp;D Co-investments</li> </ol>
<b>Enervising Development (EnDev)</b>	EnDev promotes sustainable access to modern energy services for households, social institutions and small to medium-sized enterprises in developing countries in Africa, Asia and Latin America. The supported energy services meet the needs of the poor, i.e. they are long lasting, affordable, and appreciated by users.

## Industry associations

No specific association exists that looks at productive use of energy in general or in agriculture specifically. However, the **Alliance for Rural Electrification (ARE)** is a good starting point for productive use of energy in rural electrification projects. For standalone applications, the **Efficiency for Access Coalition** can be approached.

## References and further reading

### **EEP Africa Powering Productivity**

[https://eepafrica.org/bfd\\_download/productive-use-of-energy-study/](https://eepafrica.org/bfd_download/productive-use-of-energy-study/)

### **EUEI PDF / ARE - The Productive Use of Renewable Energy in Africa**

<https://www.ruralelec.org/publications/productive-use-renewable-energy-africa>

### **Productive Use of Energy (PRODUSE) - A Manual for Electrification Practitioners**

[http://www.produce.org/imglib/downloads/manual/euei\\_productive\\_use\\_manual\\_med.pdf](http://www.produce.org/imglib/downloads/manual/euei_productive_use_manual_med.pdf)

### **Productive Use of Energy in African Micro-Grids – NREL**

<https://www.nrel.gov/docs/fy18osti/71663.pdf>

### **PU Value Chain Mapping Report by E4I**

[https://greenminigrid.afdb.org/sites/default/files/pu\\_mapping\\_for\\_minigrids\\_in\\_africa\\_february\\_2019.pdf](https://greenminigrid.afdb.org/sites/default/files/pu_mapping_for_minigrids_in_africa_february_2019.pdf)

### **Off-grid appliance performance testing: results and trends for early-stage market development**

<https://link.springer.com/article/10.1007/s12053-019-09793-z>

## Useful contacts

**Efficiency for Access Coalition**

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**Alliance for Rural Electrification (ARE)**

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