Productive Use of Solar PV in Developing Countries

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What are Productive Uses of Energy (PUE)?

PUE are defined as agricultural, commercial and industrial activities involving electricity services as a direct input to the production of goods or provision of services.

- ⇨ Includes home businesses, non-monetary income
- ⇨ Excludes social infrastructure etc.

Productive use of energy can be a significant driver of economic growth and social progress in developing countries:

- underpin the creation and upgrading of value chains
- facilitate diversification of economic structures and livelihoods
- reduce vulnerability to multiple stresses and external shocks.

Productive applications of solar PV

Agricultural activities/ agro-processing

- Pumping systems
- Grain mills
- Lighting for poultry breeding, aeration for fish breeding
- Packaging

Service sector

- Refrigeration in bars, restaurants, shops
- Charging mobile phones and battery shops
- Hair dressers
- Secretarial services and internet cafes
- Tailoring

Tailoring, Senegal

Milk cooling, Mali

Packaging, Uganda

*There is a **huge untapped potential** for **electricity from solar PV** in developing countries, that could be used **for productive purposes** (apart from merely lighting rural homes) to spur economic growth in rural areas.*

Hair cutting, Uganda

Grain milling, Senegal

Water pumping, India

Photo credits GIZ (Wegner, Doumbia, Rammelt, Fabian)

Opportunities

- ⇨ Abundant energy resources
- ⇨ Suppressed demand for goods and services that could easily be set free
- ⇨ Available technologies, machinery

Challenges

- ⇨ Lack of broad-scale application of DC technologies, only selective experience from pilot projects
- ⇨ Need to further develop technologies based on performance in field
- ⇨ Lack of sufficient data to precisely develop business cases
- ⇨ Lack of suitable financing structures
- ⇨ Need for strengthening of technical capacities in rural areas

PV Pumping Systems for Irrigation

- Economic and ecologic alternative to small to medium sized diesel pumps
- Water storage for cloudy days recommended

Solar Irrigation System in India, GIZ/ Pullenkav

Advantages

- Daily operation does not require specially-trained personnel
- Maintenance efforts and costs are low
- No fuel costs

Challenges

- High investment costs
- Lack of sufficient data on economic viability (compared to diesel/grid) and suitability for different field sizes, crop systems and water sources

DC Grain Mills

Challenges

- High start-up current required, need for a start-up resistor which is prone to breakage
- Load must be directly connected to the battery
  - Battery not protected against deep discharge
  - Recurring user training required
- Battery maintenance

DC grain mill in Senegal, GIZ/ Wegner

Impact

- Saving of transport costs to nearest grid-connected mill
- Ease workload on women (those in charge of milling by hand with the help of a mortar and pestle)

DC Grain Mills

Exemplary business scenarios

Product	Application			Payback-Time (at full capacity)
	System	**Expenditure**	**Income**	
BOSS Cereal Mill (Phaesun)	• 1 kWp solar array • Controller • Batteries • Cabling • Mill	~7000€	Purchase price: 0,40 €/kg maize sales price: 0,50 €/kg maize flour income = 0,10 €/kg daily process capacity: 180 kg = 18 €/day Income per month: 360€/month	20 months
Solar Milling	• Stone Mill with 750 W electric motor • Solar array	3790€	income = 0,10 €/kg daily process capacity: 90 kg = 9 €/day Income per month: 180€/month	21 months

Solar Cooling

- Provides for chilled food and bevarages as well as preservation of agricultural products
- Two types of DC refrigeration systems
  - Including battery (significant cost factor)
  - Without battery (“direct-drive”)
- Size of the fridge/ freezer:
  - according the type of business
  - typical unit sizes range from 50l to 240l
    (50 l → fridge can hold appr. 50 cans of 330 ml)

Cattle Farmer in Mali using solar PV for refrigeration of fresh milk, GIZ/ Doumbia

Solar Cooling

Exemplary business scenario: **Kiosk – 50 l fridge/ freezer**

- **Characteristics**

	Type	DC [V]	Power Required [W]	Average energy Use
50l	Fridge	10 - 31	45	114 Wh/d @ 32 °C amb. temp.
	Freezer	10 - 31	90	280 Wh/d @ 32 °C amb. temp.

- **Panel Size**

	Type	Energy Required	Solar Irradiance	System Efficiency	Panel Size
50l	Fridge	0,114 kWh/d	5 kWh/m²/d	59.5 %	38 Watt
	Freezer	0,280 kWh/d	5 kWh/m²/d	59.5 %	94 Watt

- **Exemplary business scenario, Phaesun 50 l fridge**

Product	Application			Payback-Time
	System	Expenditure	Income	
Fridge, 50l (Phaesun)	• 2 panels • batteries • cabling • fridge	2400€	Sale of 45 drinks per day with an extra price of 0,12 € because it is cold = 162 € extra revenue / month	15 month

Service Sector

Shop selling ice cream and other products in a Senegalese village, GIZ/ Kamikazz

Entrepreneur in Burundi using solar PV for cutting hair and charging cell phones and batteries. Upon installation of the solar system, he hired two employees, GIZ/ Heidtmann

Service Sector

Solar Battery Charging Station (SBCS)

- System: PV array, battery, charge controller
- Modes of operation :
  - a fee per charge
  - a monthly fee
  - renting a recharged battery owned by the operator

Solar powerered battery charging station in Mali, mainly used for charging mobile phones, GIZ/ Doumbia

Service Sector

Exemplary business scenario, SBCS Mali

Product	Application			Payback-Time
	System	Expenditure	Income	
SBCS	• 6 panels • Charge controler • Cables/ fitting • building	7.900€	income = 0,8 €/battery Daily charging capacity: 3 batteries = 2,4 €/day Income per month: 48 €/month	Nearly 14 years

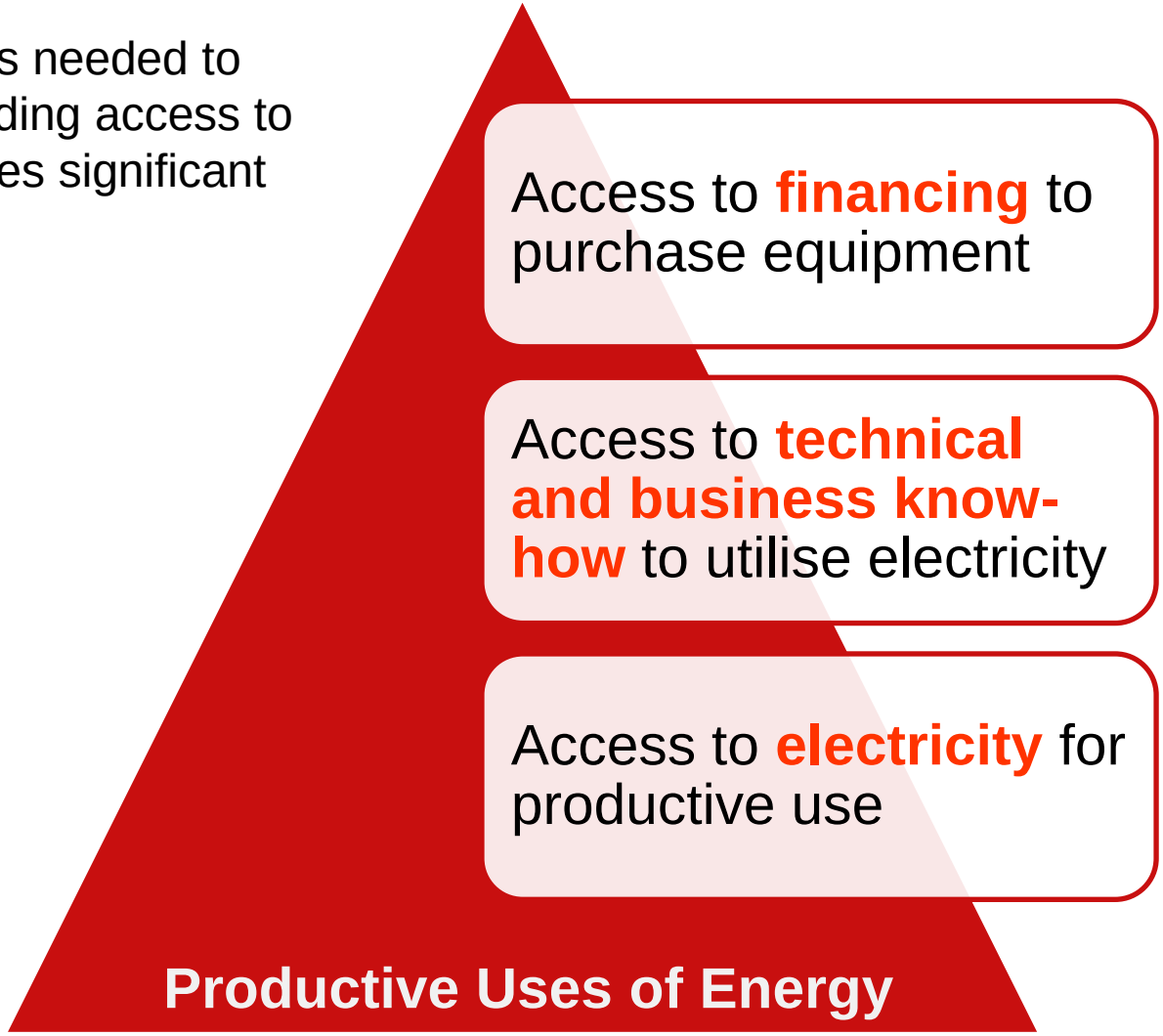
→ **in addition to battery charging, SBCS may include additional services like solar and electric equipment and lantern/ mobile phone charging**

Service Sector

Product	Application			Payback-Time
	System	Expenditure	Income	
Solar Barber (fosera)	• 2x 120W Panels • Controller • Batteries • Machine • Scissors	1000€	Price per cut: 1 € 10 cuts per day: 10€/ day Income per month: 200€/month	5 months
Solar Cinema (fosera)	• 2x 120W Panels • Controller • Batteries • TV and or 5V Phillips Projector	Fosera TV ~ 1100€, Projector ~ 1200€	entry fee per people: 0,20€ 1 session per day, 20 people: 4€/day Income per month: 80€/month	~14 months
Solar Charge Station (fosera)	• 120W Panel • Sundaya Charging Station (30 lamps) • Sundaya WallDock (3 JouleSticks) • 6 Sundaya Joule Sticks to charge cell phones	380€	Charging fee per lamp: 0,15€ Charging fee per phone: 0,08€ Charging 12 lamps, 8 cell phones per day: 2,44€/day Income per month: 48,80€/month	~8 months

Success Factors of PUE

Active support is needed to ensure that providing access to electricity produces significant results.



Further Information

- *http://www.giz.de/expertise/html/2769.html*
- *www.produse.org*

Thank you.

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Poverty-oriented basic energy services

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