

Renewable Energy Market and Applications

Photovoltaic systems

- Resource Availability
5-7 kWh/m²/day of solar irradiation
- Applications
Rural water access, lighting, battery charging, television and radio, air strips.
- Existing Market Opportunities

PV powered water pumps: 300 sites were equipped with solar powered water pumps between 1978 and 1997. They are used to extract water from underground wells and for irrigation. Costs of the equipment amount to 200 to 250 FCFA/m³ water.

PV lighting: Roughly 2,000 individual and 50 public lighting units are currently installed across Mali, while a cooperative agreement between Mali and India has helped to install 350 individual kits, 15 pumps, and 150 public lamps. Currently, the number of private enterprises dealing with the commercialisation of photovoltaic equipment is over 10; Cost: 8,000 to 10,000 FCFA/Wc.

In addition several large public and private corporations and social community centres use photovoltaics, the former for communications systems, and the latter for refrigeration (cost of which is between 15.000 to 20.000 FCFA/Wc).

More than 80% of all installed systems are reported to be still operable. The following PV market study was carried out by AFRITEC Consulting Engineers:

POTENTIAL AND REALIZABLE MARKETS

	Size of Potential market	Size of realizable market
kWp	41,000	1,000
number of kits	820,000	20,000

For this study, the upper income households represent 30% of the realizable market, middle income households 40%, and low-income households 30%¹. The rural population accounts for 85% of the realizable market

- Origin of Hardware

¹ Upper income annually: CFA 1,200,000 to 6,000,000, or approximately US\$ 2,400 to 12,000; Middle income annually: CFA 480,000 to 1,200,000 or approximately US\$ 960 to 2,400

Biomass/gas

- Resource Availability
Jatropha, vegetable oil, sugar cane, crop residues
- Applications
Gasifiers, biogas digestors², biofuels (oil and alcohol)³
- Existing Market Opportunities
- Origin of Hardware

Small Hydro

- Resource
Nearly 1050 MW of electricity are estimated to be stored in 20,000km² of water surface at a production capacity of 5.000 GWh/year.
- Application
Grid electrification
- Existing Market Opportunities
At present, only 50MW of the hydro potential are exploited.
- Origin of Hardware

Wind

- Resource Availability
- Existing Market Opportunities
Wind power is used to pump water and to generate electricity.
- Origin of Hardware
From 1982 hundreds of windmills have been built at an artisan's centre in Ségou; CNESOLER designed, built and marketed a series of small-scale windmills designed for the irrigation of fields and orchards
However, due to the lack of spare parts, the inadequacy of the equipment for the application and technological immaturity several programmes have so far failed (AEROMOTOR windpumps in the 1960's, SAHORES wind pumps in CMDT villages during the 1980's, LESO wind pumps).

² The Malian Textile Company (CMDT) have built several types of biogas digesters for cooking, lighting, and to power industry. Between 1987 and 1991, the division of Agriculture Mechanisation built 50 simple, inexpensive clay digesters for the PSE, and a Catholic mission in Ségou built digesters of various sizes.

³ The Special Energy Programme (PSE) has worked on fuel substitution using the oil of the physic nut (*Jatropha curasm*). During the 1970s, alcohol made from sugar cane was also experimented with.

Solar Water Heating

- Resource Availability
5-7 kWh/m²/day of solar irradiation
- Applications
Crop drying, water heating,
- Existing Market Opportunities
Shell-type solar dryers were recently introduced in the country and have proven reliable; thermal pumps and water heaters used in the past proved to be less so.
- Origin of Hardware
Various solar thermal technologies, especially solar heaters and dryers, have been conceived, tested, and manufactured in Mali by CNESOLER, universities and other research institutions.

Other

CONVENTIONAL TECHNOLOGIES PRESENTLY USED AND SUBSTITUTION POSSIBILITIES

Conventional Technologies	Energy Source	Consumption	Possible Substitutions
Wood or charcoal stove	wood	1-2.5 kg/pers/day	Biogas stove for cooking and solar thermal for water heating
Candle	paraffin	5.5-7.2 g/hour	PV* lighting kit
Oil lamp	cocoa butter	-	PV lighting kit
Kerosene lamp (wick)	kerosene	16-39 g/hour	PV lighting kit
Kerosene refrigerator	kerosene	1 liter/day	PV refrigerator
Generator set (600 W)	petrol	0.475 liter/hour	PV electrification system
Moto pump (2.5 kW)	petrol	0.7 liter/hour	PV pump
Flash light and radio/cassette player	dry cells	2 in 20 hours	PV Charging system + rechargeable cells
Battery powered TV	grid or generator set + transport	2 to 3 recharges per month	PV battery charger or PV electrification kit

* PV = photovoltaic
Future Prospects...

Source: Present Utilization and

RELIABILITY OF RENEWABLE ENERGY TECHNOLOGIES IN MALI

Technology	Number introduced	Power (kW)	% still functioning
Photovoltaic pumps	250	350	80
Telecommunication systems	50	150	>80
Lighting kits	4,000	200	>80
PV refrigerators	40	12	>80
Solar thermal refrigerators	3	n.c.	0
Solar thermal pumps	3	82	0
Solar water heaters	300	-	<10
Solar dryers	60	-	>80
Wind pumps	169	-	<10
Biogas digesters	about 30	-	<10