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Photovoltaics for Productive Use Applications

A Catalogue of DC-Appliances

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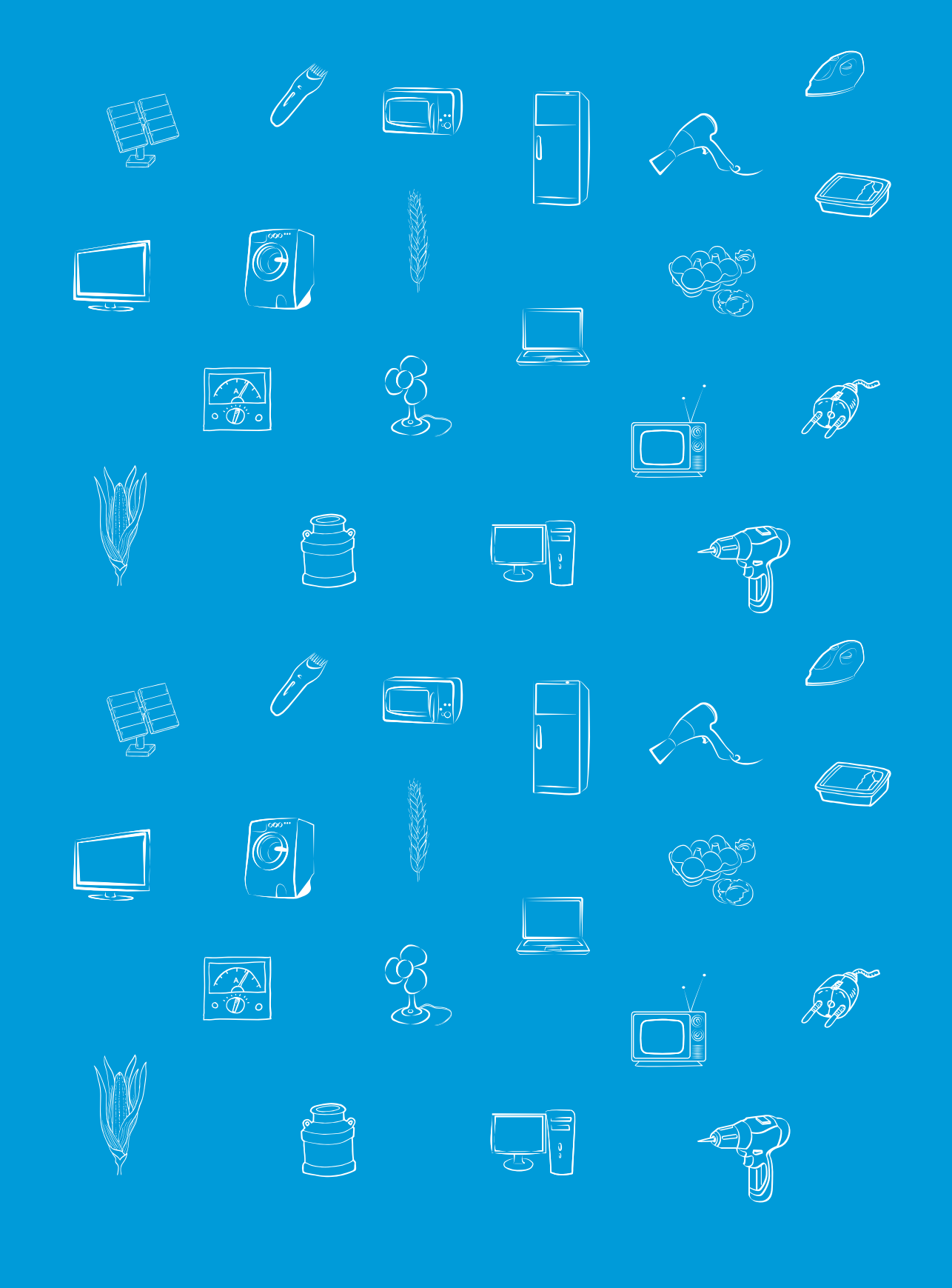

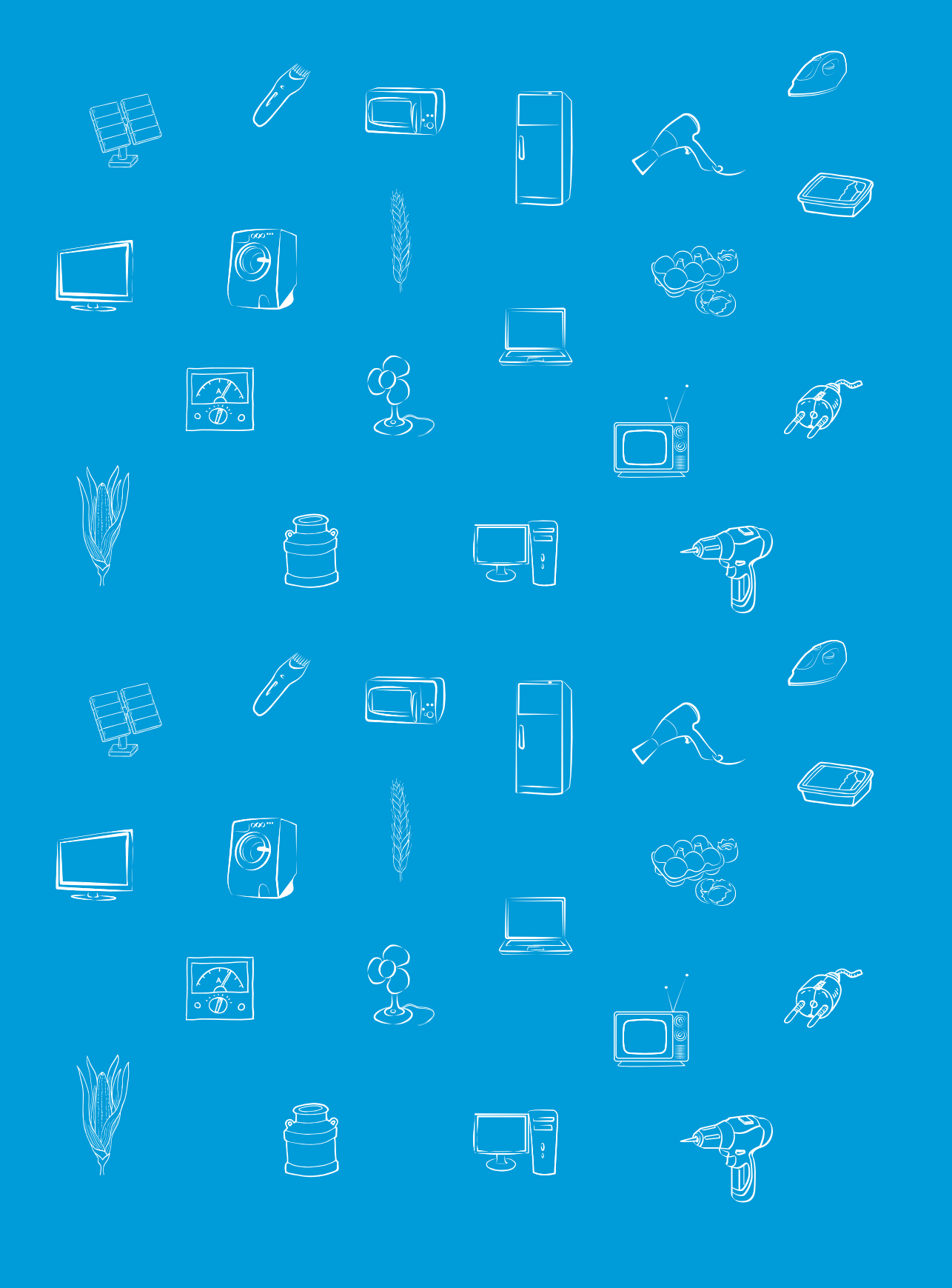

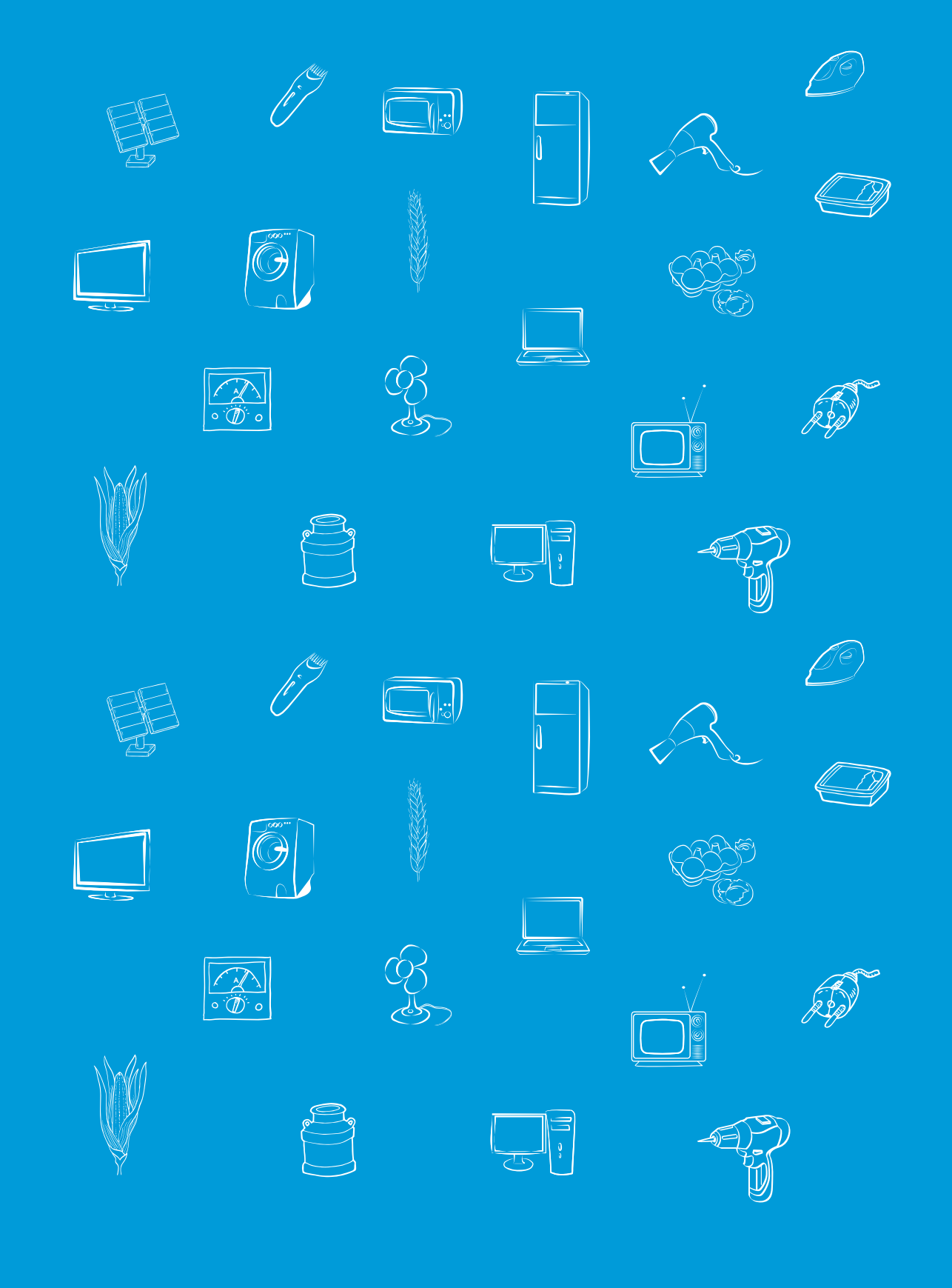

Photovoltaics for Productive Use Applications

A Catalogue of DC-Appliances

Contents

Acronyms

AC	Alternate current
ARE	Alliance for Rural Electrification
CO_2	Carbon dioxide
d	Day
DC	Direct current
	Direct drive
€	Euro
EE	Energy Efficiency
GIZ	Deutsche Gesellschaft für internationale Zusammenarbeit
GWP	Global warming potential
h	Hours
HERA	GIZ Sector Program Poverty-oriented basic energy services
IRENA	International Renewable Energy Agency
LED	Light-emitting diode
PC	Personal Computer
PCM	Phase Change Material
PUE	Productive uses of energy
PV	Photovoltaic
R	South African Rand
RE	Renewable Energy
Rs	Indian Rupees
SME	Small and medium-sized enterprise
SWP	Solar Water Pumping
TV	Television
$	US Dollar
VAT	Value Added Tax
W	Watt
y	Years

Acknowledgements

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It is with deep appreciation that we extend our gratitude to the numerous contributors who have taken the time and made the effort to create this catalogue.

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1. Introduction to the catalogue

About 1.1 billion people worldwide lack sustainable and reliable access to electricity[1]. This is almost 15 % of the world's total population, mostly living in rural areas. Access to energy is a key contributor towards economic development, and the lack thereto is consequently a major impediment not only to economic activities, but also the consequential enabling of social upward mobility. Electrical energy in particular, with its vast technological choices in terms of convenient appliances and efficient production methods, can greatly improve quality and output of services and products especially in rural areas where traditional production means prevail.

In many developing nations, more than half[2] of the population is still based in rural areas. For these communities, significant time is spent securing their energy needs. Be it for regular weekly travels to near-by towns or trading centres where fuel can be obtained, or spending several hours daily to collect biomass fuel. Indeed, what can be done by the single flip of a switch in one part of the world requires a whole day of labour in another part[3].

Currently energy for productive use (PUE) in rural areas mostly relies on fossil fuel sources such as petrol or Diesel. This makes rural businesses vulnerable to fuel price volatility. Furthermore, the dependency on third-party suppliers ceaselessly increases their operating costs. The use of solar photovoltaic (PV) technologies, as decentralised energy systems, can address a number of these challenges. Numerous private and public development initiatives and programmes have dramatically increased the availability of PV technologies in many rural areas, whether through stand-alone solar home systems (SHS) and picoPV systems, or larger institutional systems (for schools, clinics, remote border posts and more), to complex and comprehensive mini-grid installations.

Recommend adding a reference/footnote for the Lighting Global Market Trends 2016 report and Global LEAP market research report here.

Link to LG report: *https://www.lightingglobal.org/wp-content/uploads/2016/03/20160301_OffGridSolarTrendsReport.pdf*

Link to GLobal LEAP report: *http://globalleap.org/s/Global-LEAP-The-State-of-the-Global-Off-Grid-Appliance-Market-Feb-2016-Print.pdf*

However, most of these still cater first and foremost to the consumptive energy needs of communities on a household level. The potential of PV for productive use applications by rural businesses for overall economic empowerment of rural areas remains largely untapped.

[1] SE4All 2015
[2] *http://data.worldbank.org/topic/agriculture-and-rural-development*
[3] Svensson, Souazo Farina 2010

Recent assessments amongst established international manufacturers clearly show that development and marketing of PV-powered appliances has accelerated to levels where a multitude of electrical appliances for productive use, particularly suitable for PV applications, are now readily available. Especially the development for direct current (DC) –powered appliances has been pushed forward by demands in the recreational vehicle and long-haul road transport industry (predominantly household appliances), installation services industry (rechargeable power tools) and agricultural sector[4]. It is these developments that have prompted the compilation of this catalogue, to serve as encouragement towards the greater utilization of PV technologies for productive use in rural areas.

Background

With the publication of this catalogue, the BMZ-funded GIZ sector program 'Basic Energy Services (HERA)' provides a market overview of DC-powered appliances, useful for developing and strengthening business activities in rural areas. This 1st Edition does not claim to provide a conclusive and comprehensive picture but rather to offer an overview of selected appliances available on the market today, complemented with elemental technical details, established distribution channels and, where possible, practical experiences from the field. The catalogue is directed at practitioners and public and private sector actors promoting PV for productive use of energy.

Furthermore, the catalogue serves manufacturers, distributors, governmental and non-governmental organizations and donors as a decision-making tool towards identifying applications suitable for their respective commercial, regional and social settings and conditions.

This 1st Edition is as an initiator towards developing a much more encompassing catalogue of DC-powered appliances for off-grid businesses. In order to achieve this, we extend an invitation to any interested parties to send us data and information on appliances not yet covered in this catalogue. Please contact the publishers of this catalogue through *hera@giz.de* for further details.

Technologies featured in the 1st edition

The technologies featured in this 1st Edition Catalogue of DC Appliances are at different stages of technological maturity. Some of them have been extensively tested, have a proven track-record in the field and have reached a verifiable market standing. Others are innovative, post-prototype and still require more rigorous piloting in field. This level of maturity is reflected in the factsheets, based on information provided by the manufacturers and supplemented by own research and inputs from a pool of external reviewers from academia, the private sector and project implementers.

[4] Lasch & Groh, 2014

Note:
Price information reflected in this catalogue is based on:
- **"as of" – information**
- **status September/October 2015**
- **ex-factory, excluding any taxes.**

Information on prices is thus indicative and needs to be confirmed with the retailer or manufacturer. End user prices may vary significantly over time, and from country to country, depending on shipping cost, taxes and duties. Furthermore, prices are limited to the described application only, excluding balance of system components like batteries or modules and any installation works.

To draw conclusions of the economic viability of each product described in this catalogue many more factors need to be considered, which is beyond the scope of this 1st Edition.

Typically DC appliances operated via a PV system are characterized by higher capital costs and lower operating costs, which highlights their economic viability if assessed over the medium- to long-term. Therefore an economic viability assessment is best conducted on a comparative basis with a non-PV-based energy source, and should include:
→ product life cycle costs
→ costs for service, maintenance and repair
→ fuel savings, considering oil price volatility
→ increase of income
→ change of working patterns and
→ decreasing product costs due to technological development and economies of scale.

Currently ongoing studies on economic feasibility of PV appliances for PUE

Powering Agriculture is surveying solar water pumps, existing irrigation systems and their energy supply. The study shall be published towards end 2015. Furthermore, a handbook and toolbox will be developed to evaluate technical and economic performance of PV for irrigation systems. *(https://poweringag.org, 2015-0820).*

For cooling systems the University of Hohenheim has developed a tool for system calculation and dimensioning, based on climate data and energy measurements, allowing for an economic up-front analysis of a business concept. *(https://www.uni-hohenheim.de/institution/fg-agrartechnik-in-den-tropen-und-subtropen, 2015-08-20).*

How to read this catalogue

Part 1 provides an overview of various productive use applications and associated aspects, such as users of PV appliances. Furthermore it describes relevant technical issues, gives a brief overview of the development of DC mini grids and concludes with a description of challenges when introducing PV-powered appliances for PUE.

Part 2 comprises the actual appliance factsheets. These datasheets for the individual appliances are grouped into sections according to 7 categories.

The factsheets contain basic technical specification and, where available, information on markets and distribution chains. All of the latter information is based on voluntarily provided inputs from project developers, manufacturers and distributors or self-conducted market research. For some products research on market potential of some of the products, their field performance and/or their business potential is not yet available.

Part 3 of the catalogue explores the potential of appliances to establish viable businesses and create net profit in micro, small and medium sized enterprises in rural areas. As detailed and reliable data for assessing the real business potential in rural areas is not readily available, this chapter serves as only to illustrate the business opportunities and prospects, so that it may serve as a guide for more detailed future assessments.

2. PV appliances for productive use

Productive use of energy

Different schools of thought around productive use of energy (PUE) prevail in the international discourse around the issue of rural economic development. Some say PUE covers only those activities which directly lead to monetary income, while others maintain that a broader understanding, in terms of enhancement in welfare through improved health or education, should be included. Additionally, PUE can be further differentiated between 'consumptive use' (i.e. the use of energy services such as household lighting, cooking and private entertainment) and the use of energy for 'community services' (such as health and education). For this catalogue a fairly narrow definition for PUE is adopted and defined as "agricultural, commercial and industrial activities depending on energy services as a direct input towards the production of goods or provision of services." This catalogue focusses on electrical appliances powered by photovoltaic electricity with productive use potential for rural businesses. By using solar energy technologies new business opportunities can be explored, established enterprises can be improved, and profitability may increase through improved production rates, higher quality and greater diversity of services and products, thereby creating additional options for income generation in rural communities[5].

Definition of Productive Use of Energy (PUE):
PUE is understood as "agricultural, commercial and industrial activities depending on energy services as a direct input to the production of goods or provision of services."
PUE promotes socio-economic development by enabling and/or increasing income generation.
PUE can be differentiated from 'consumptive use' (i.e. the use of energy services such as household lighting, cooking and private entertainment), the use of energy for 'community services' (such as health and education).

[5] Attigah /Mayer-Tasch/Rammelt 2015

Users of PV applications for productive use of energy

Opportunities for productive activities in remotely located, rural off-grid areas (not connected to the national grid) are diverse and may range from mobile phone charging to crop irrigation and cottage industries and to manufacturing and repair shops. A business opportunity may be wholly individually operated or involve a number of different stakeholders, like financiers, trade institutions, marketers, or distributors. The type of technology used, particularly electrical appliance for PUE, depends on a number of determining factors, such as regional circumstances, resource availability, access to maintenance services, ability to buy an appliance, skills to operate and even social conditions. The right choice between same technology types is also important, as for instance a PV-powered refrigerator for a shop or restaurant, would be different to a refrigerator required by a fishery cooperative or produce retailers. Particularly where new innovative technologies, such as new DC-powered appliances, are considered, trust and confidence in the new technology needs to be created. Technological maturity, robustness of the product as well as a good after-sales-service and maintenance infrastructure are essential investment choices for entrepreneurs.

Also financing solutions, both to the rural business and in some instances the customers themselves, should be available and tailored to rural circumstances. The importance of micro finance institutions and availability of appropriate credit lines and loan products is evident. However, depending on the type of application, capacity of the micro finance institution and maturity of the technology, a bank may be unwilling to integrate financing instruments for the respective technology into its portfolio. Business capacity building for rural businesses and awareness raising in financial institutions should be one area of work for development projects that aim to push productive uses of energy.

Direct Current versus Alternating Current

Since the late 19th century, due to advantages in generation and transmission, grid electricity is provided as alternating current (AC). Hence the vast majority of electrical appliances used in homes, commerce and industry are designed to accommodate AC power. However, AC has a number of disadvantages, particularly since it relies on extensive infrastructure and transformer electronics. Especially for solar-based isolated grids or stand-alone systems, a direct current (DC) system has some advantages. DC is typically generated directly by a solar PV system and easily stored in a battery bank. Using DC power directly from the PV generator or the battery avoids the transformation to AC via an inverter. This reduces costs as well as electricity losses.

Whereas the majority of electrical appliances used, run on AC, especially entertainment and media equipment mostly require direct current (DC) and use an AC adapter when connected to the grid. Furthermore, many DC appliances, while being highly efficient, are available in a robust and simple design, which makes them easier to maintain and repair.

"Off grid areas do not have access to grid electricity and thus they are not familiar with the common AC gadgets. High efficient DC gadgets can be introduced easily in this area, no question of changing AC eco systems.[6]"

In comparing AC and DC systems Lasch and Groh identified some key advantages of DC:

- All modern appliances such as LED lights, televisions, mobile phones, laptops etc. that run on AC are also fully functional on DC in the same voltage range.
- On a DC grid no frequency synchronization is necessary which results in:
  - Easier adding up or scaling up of DC system (energy sources) in parallel.
  - Good grid reliability.
  - Modular growth of DC generators and storage devices is possible, improving the ability to meet a changing demand.
  - Unscheduled outages should not occur.
- Power factor is not a concern in DC systems. A DC system can even operate at very low loads, e.g. a single light, for several hours without significant losses. In AC systems relatively low power consumption is associated with relatively high losses in generators and inverters.
- DC systems are less expensive as no conversion from DC to AC is needed.
- DC system has no inductive or capacitive losses.
- Management of harmonics distortion is much easier in DC than AC.
- DC motors (cooling fans, irrigation pumps etc.) are more efficient than conventional AC motors.
- DC requires a simple two wire distribution network.
- DC floating systems are less prone to shocking hazards (neutral grounding is necessary in AC)

[6] Chowdhury, 2015

DC mini grids

Due to the advantages of DC and the technological development of highly efficient DC appliances, more and more DC mini grids are being implemented. In fact, small solar DC grids can be a cost effective electrification solution for off-grid areas.

Nevertheless some requirements of DC grids should be adhered to in order to ensure a consumer friendly and functioning DC electricity supply. These factors should be considered at planning stage and when purchasing new devices and appliances:

- For voltage equalization a DC/DC converter is required.
- When planning a DC-grid all electrical applications should have a lower voltage level than the overall grid.
- The consideration of the correct voltage level is important for all electronic devices. Standardized plugs make sure that an appliance is connected to the right voltage level (e.g. a 5 V mobile phone plug only fits into a 5 V socket or port; all USB ports run on 5 V).
- Type and quality of the battery is very important for battery-based appliances.

Types of batteries for PV applications

Battery systems ensure the reliability of PV-based energy services throughout periods without sunshine. According to the IRENA battery storage report 2015 the market for battery storage technologies has developed rapidly over the last couple of years[7].

Batteries can be distinguished into two main types:

- Batteries designed to provide a high current for a short period of time, like automotive batteries (power storage).
- Storage systems providing a low current for a longer period of time (energy storage).

Because of this differentiation it is not possible to use automotive batteries for electrification.

There are currently four main families of batteries on the market, named according to the active material used in the battery: Lead, Lithium, Nickel and Sodium based Batteries[8]. (The table presents some characteristics, advantages and disadvantages of each battery type.

[7] IRENA, 2015
[8] ARE 2013

Table 1 Comparison of battery types

Types of batteries	Lead acid batteries (Pb-acid)	Lithium-ion batteries (Li-ion)	Nickel batteries (Ni-CD; Ni-MH)	Sodium batteries
Commercialised	1890	1992	1956	
Types	• Sealed valve regulated batteries • flooded batteries		• Sealed batteries (< 10Ah) • flooded batteries (10Ah – 1500Ah)	
Efficiency including	70 – 75 %	80 – 90 %	90 %	95 %
Energy density	100 Wh/l / < 30 Wh/kg	300 – 400 Wh/l / 100 – 150 Wh/kg	150 Wh/l / 50 Wh/kg	120 – 140 Wh/kg
Life cycles (number)	500 – 2000	100 – 5000	3000	4500
Life time	5 – 25 y (depending on temperature and charging model)	5 – 15 y (depending on temperature and charging mode)	5 – 25 y	10 + y
Cycle life time (50% DoD)	500 – 3000	1500 – 10000	2000 – 4500	
Cycle life time (80% DoD)	300 – 1600	1000 – 5000	1500 – 3500	
Self-discharge	3 – 5 %/month	3 – 5 %/month	N/A	N/A
Charging time	Several hours	Minutes to hours	Minutes to hours	Minutes to hours
Cost per kWh nominal (End consumer)	200 – 400 €	1000 – 2200 €	1000 €	N/A
Requirements at installation site	• Requires ventilation, depending on technology	No special requirements		
Recycling efficiency	> 95 %	50 %	75 %	N.A.
Advantages	• Mature technology • low investment costs	• High energy density • long life expectations • no requirements at installation site • low maintenance efforts	• Mature, robust and very versatile technology • insensitive towards extreme temperatures • resistant to overcharging and deep discharge	• Insensitive towards extreme temperatures
Disadvantages	• Short cycle life • slow charging • maintenance requirements • Pb on disposal	• High costs, • little experience, • safety: danger of fire • limited storage time due to • self-discharging → reload required	• Maintenance requirements • relatively high costs • for Ni-Cd: Cd on disposal	• Limited cycle life

(Source: IRENA 2015, ARE 2013, DCTI 2015, HTW 2015, Hoppecke 2013)

Costs

Until now, a comprehensive model that allows for an accurate calculation of the total costs involved in a storage system is yet to be developed. Many factors have an impact on total cost, such as initial installation cost (capital cost) as well as peripheral appliances like inverters. Furthermore cost related to transport and installation in remote areas should not be underestimated and management, maintenance and operation cost need to be considered.

Battery lifetime

The lifetime of a battery depends mainly on the number of charging and discharging cycles. Other important factors are overcharging, deep discharge or the speed of charging.

Depth of discharge (DoD) measures how deeply a battery can be discharged without damage. DOD varies depending on the type of battery. Each battery has its recommended threshold level of DOD e.g. 50 % for lead-acid batteries and 70 – 100 % for lithium-ion batteries.

Coupled to a PV system a battery runs through a whole cycle per day, discharging and charging once. Estimating an operation time of 20 years of the whole PV system, this would result in 7,000 cycles for the battery bank. Whereas this number of cycles is in line with the characteristics of lithium-ion batteries, lead based battery systems would have to be exchanged at least four times during system operation.

Sizing of the battery system

The system must be capable of covering variable demand and demand trends while maintaining battery function and avoiding extra cost due to system over sizing. For instance, the installation of a relatively large battery compared to the capacity of the generator will lead to a situation of prolonged partial state of charge that will result in the shortening of the life of most types of batteries. On the contrary, the installation of a battery that is too small will lead to a higher number of cycles and will again shorten its lifetime.

Recycling

It is important to emphasize that components and materials extracted from end-of-life batteries are not only critical for the environment; moreover, they have an intrinsic financial value, and can mostly be used to produce new products. Therefore, an adequate collection and recycling should be foreseen and included in any business model.

How to calculate energy consumption of appliances

Understanding how much electricity an appliance uses is essential when determining its level of energy efficiency, its running costs (for instances where electricity is supplied on a fee-for-service basis) and the size of the PV system when a stand-alone solar solution is sought.

How to calculate the electricity consumption of an appliance:

1. All appliances have a technical specifications label or sticker attached to it. This label provides information on Watts (W), Ampere (Amps), Volts (V), frequency (Hz) and some other data.
2. Using the Watts data and multiplying it with the number of hours that the appliance would operate for over a set time would equal the consumption (in Watt hours – Wh). The higher the Wh the higher the consumption.
3. Example: an 80W DC egg incubator runs for a total of 20 hours every day. Therefore the incubator consumes 1600 Wh every day (or 1.6 kilowatt-hours). An energy efficient egg incubator, with improved insulation, might also need 80W of power, but only runs for 12 hours every day (thus only 960 Wh or 0.96 kWh). A PV system with batteries to supply the energy efficient incubator therefore can be about 40% smaller and thus cheaper.

Challenges and barriers of PV systems for productive use

As shown before, PV systems have strong advantages which are relevant to rural businesses in an off-grid area.

However, a number of challenges have to be considered when deploying a PV system in a rural area, regardless whether it is a stand-alone solar home system or more complex mini-grid.

The main barriers for PV-powered appliances are described below, along with general recommendations on how to overcome these.

Energy Efficiency

Appliances powered by PV, no matter whether they are running on DC or AC power, should be highly energy efficient. The capacity of an installed PV system has to correspond to the energy required by the user. Inefficient appliances consume more energy and the size of a PV system needs to increase, possibly to a point where the investment is no longer economically feasible. Efficient appliances allow for proper dimensioning of the PV system, reduce overall costs and enable better business performance. The higher investment costs for energy efficient products are compensated for by reduced investment costs and operational costs.

The Global Lighting and Energy Access Partnership (Global LEAP) is an initiative of the Clean Energy Ministerial *(http://www.cleanenergyministerial.org)* to catalyze markets for off-grid energy products and services through the promotion of quality standards and energy efficiency, with a particular focus on off-grid appliances. The Global LEAP Awards *(http://globalleap.org/awards),* an international competition that identifies the world's best, most energy-efficient off-grid appliances, provides a clear market signal about appliance quality and energy efficiency. The Global LEAP brand is used to promote and differentiate Winner and Finalist products *(http://globalleap.org/s/Global-LEAP-Awards-Winners-Finalists.pdf)* in the marketplace.

Consumers can also look for energy labels like the Energy Star or the European Energy Label that qualify the product as energy efficient.

High investment costs

High investment costs are a barrier for many high quality PV-powered products and especially for DC appliances. If buying decisions are made only on short term cost comparison, e.g. comparing the investment costs of two products, the higher costs might act as deterrent. A costs analysis over a longer time period can clearly demonstrate the long-term advantages and facilitates a wiser purchasing decision. Furthermore innovative lending schemes may help to overcome the initial barrier of high up-front costs.

Global LEAP's procurement incentives program *(http://globalleap.org/incentives)* helps address this challenge by providing incentives to off-grid energy companies that procure and sell high-quality, energy-efficient Global LEAP Awards Winner and Finalist appliances. These incentives, funded through the Results Based Financing Facility *(https://www.gov.uk/guidance/result-based-financing-for-low-carbon-energy-access-rbf)* implemented by Energising Development *(http://endev.info/content/Main_Page)* (EnDev), reduce risk across the supply chain, lower upfront costs, and bring high-quality, energy-efficient off-grid appliances to market at scale.

Service and maintenance infrastructure

The service and maintenance infrastructure involves the technical know-how for repairing appliances and the availability of spare and wear parts. In many rural areas a functioning service and maintenance support infrastructure does often not exist, which may lead to a reduced product life time and a loss of trust and confidence in the technology.

This challenge is best addressed by the manufacturers: the products should be of high quality, robust and with low maintenance effort; if feasible it should be easy to repair, ideally with locally available spare parts.

References to quality control procedures can help to identify high quality products. Furthermore high quality producers are listed on the website of Lighting Africa. *(http://www.lightingafrica.org).*

Non-availability of new and energy efficient products on local markets

Local markets often lack a diversified product range and new technologies are not readily available.

In many cases highly energy efficient DC appliances have to be purchased from international retailers, which is a high barrier for people in rural areas.

Low awareness among consumers

Most people hesitate to invest in a new and unknown technology.

Information and awareness raising campaigns, as well as high quality products with sound reputation, will help to spread information, raise knowledge levels, ensure good experiences with products, and ultimately trust in the technology.

The main factors for the success of modern high efficient PV appliances are the local availability through a wide distribution network, consumer trust in the technological solution and technical knowledge for maintenance and repair.

3

3. Factsheets

The following section comprises the essence of this Catalogue on DC Appliances for Productive Use of Energy – the data factsheets for individual DC appliances (and with few exceptions AC appliances). The focus is on appliances that can be directly connected to a DC power source, e.g. a PV (photovoltaic) system.

The market of DC appliances is still evolving and although DC appliances have some clear benefits over AC products, many manufacturers are reluctant to modify their products. Some very interesting and innovative products applicable for PUE run on AC power. In other cases appliances are equipped with a brushless DC motor, but their connection for power supply is configured for AC plugs and the manuals and guarantee only refer to AC. Therefore you may find a selection of AC-current products in this catalogue.

Categories of productive use of energy in the catalogue:

Lifestock breeding	Poultry incubators, milking machines
Food production	Water pumping
Food processing	Grain mills, husker, polisher
Food storage	Cooling
Food for sale	Kettles, buttermaker, coffee maker
Tailoring	Sewing machines, weaving loom
Workshop tools	Cordless power tools
Media and entertainment	IT, secretarial services, cinema, etc.
Energy services	Charging mobile phones and battery, DC/DC inverter, DC-kWh-meter, etc.
Haircutting & other services	Haircutter, hairdryer, washing machines

3.1

3.1 Livestock breeding

Description

Livestock husbandry is a major component of agriculture, whether on a large or subsistence scale, and is thus critical to economies in developing countries. It is an important source of social prestige and income for millions of smallholders and subsistence farmers.

In rural communities, livestock related earnings, which includes meat and dairy production as well as egg or live animal sales, can be a significant source of cash income and form the basis for their livelihoods.

PV-powered applications can be implemented by small scale livestock farmers at different stages of the value chain. It encompasses solar well or borehole pumping for livestock watering, solar circulation pumps for fish ponds, solar lights for livestock security, or solar thermal energy for drying of fish, meat or animal skin.

Technology Status and Development over the past years

The technological status of DC appliances for livestock breeding varies widely. Whereas water pumping and light appliances are well developed and available worldwide at competitive prices, other, more specialised equipment still has to undergo more rigorous field testing and is lacking international distribution structures.

Nevertheless, the development of DC-powered appliances like milking machines and egg incubators has progressed significantly.

Type of equipment presented in his catalogue

Dairy, fish and meat processing and storage as well as water pumps are covered in this catalogue under sections 3.1 and 3.2. In this section we focus of DC-powered appliances that assist farmers in their day to day livestock farming: milking machines for dairy farmers, egg incubators for poultry farmers and solar fences.

Poultry incubators

Poultry farming can be supported by PV in mainly two different ways:

- → Extension of light hours to 12 – 14 hours per day (i.e. daylight mimicry), in order to stimulate hens to lay more eggs.
- → Electricity for heat supply to incubate eggs.

As PV lights and the vast selection of options available on the market today, are not part of this catalogue, focus instead is on egg incubators.

The artificial process of hatching eggs is tricky and energy consuming. It requires a constant temperature range of 36 to 39°C and relative humidity range of 50 % to 70 %. To maintain these conditions stable heat supply is required. As a lot of small poultry farmers live in rural, off-grid areas constant energy supply is rare. A PV-system can bridge power cuts, reduce expenses for fuel.

Incubation of poultry eggs has different income generating effects. It helps small scale farmers to maintain their own flock over time, while also allowing for the sale of surplus animals on markets.

In this catalogue we present some energy efficient DC-coupled poultry egg incubators that, supplied via a PV system, present a technological solution for PUE in rural areas.

Milking

For dairy farmers milking is a very labour or energy intensive process. Solar-powered milking machines can support farmers in reducing both these major overheads and can be applied independently from the electric grid.

Electric fences

Electric fences are useful for restricting the roaming of cattle and other livestock to specific areas, without the need of erecting permanent conventional fences. Similarly they are used to protect crops and orchards from livestock. Electric fences are a convenient rangeland management tool, particularly if coupled to rotational grassing practices. Instead of using the tensile strength of conventional multi-wire fences, with securely anchored support poles every few meters, to stop livestock from leaving a field, an electric fence discharges a non-lethal electric shock on contact. Thus only one single wire is necessary, making the construction of the fencing far easier and much faster. Solar-powered fences in particular are very efficient and effective appliance for rural areas.

Further information

Things that should be taken into account prior to installing a solar fence:

- Never electrify a barb wire fence, as it can cause serious harm to any animal that comes in contact with the fence, as the barbs might prevent the animal from leaving the fence.
- Consider size and number of the animals to be kept in or out of the fence to determine the required electric charge.
- Clear vegetation away from the fence as constant contact will consume too much electricity.
- Solar powered electric fence kits come with certain specifications that must be followed to prevent injuries.
- Dry soil does not conduct electricity nearly as well as more moist ground. In a more arid climate, more than the recommended amount of grounding rods should be added to the fence in order for it to function properly.
- The electric fence charger should be installed on a firm mounting surface, while also ensuring that it is in direct sunlight.
- The electric fence controller should be covered to ensure that it is protected from rain or other weather elements.

Poultry farming

FS1 Egg incubator WQ-42 Engokho

Engokho Kuku Farmers,
Lazarous House, Inn Rm. 17, Nairobi, Kenya

Product Description

This egg incubator has a capacity for 42 chicken or 168 quail eggs and can furthermore cater for duck, ostrich, turkey, goose, reptile, emu and other bird eggs. The incubator has an automatic temperature control.

Target Group

Smallholder poultry farmers

Product Specification

Type of product	Egg incubator
Load	80 W
AC- or DC-coupled	DC
Voltage of system	12V – 120 V or 220V – 240 V AC 50/60 HZ
Capacity of solar panel	120 W
Product life span	10 – 15 y

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price Kenia	30,000.00 Kshs	≈ 252 €

Technology and Market Development

- → 2 year warranty
- → Offers project development, training and assists in identifying an appropriate financing scheme
- → Main market focus: East Africa

Links

http://www.kuku.co.ke/42-eggs-incubator.php#.VaPCIvncKzU

FS2 Semi-automatic Poultry Incubator Lifeway Solar

Lifeway solar devices,
1st Floor, Central Arcade, Azad Road,
Cochin – 682 017, Kaloor, Cochin, Kerala, India.

Product Description

This semi-automatic unit has capacity for hatching 100 quail, 40 chicken or 25 goose eggs. It is supplied with fully automatic heat control and thermal insulation around the fibre glass cabinet. As there are no internal moving components, egg turning is done manually by turning each egg 4 or 5 times per day. This ensures that hatchlings are not trapped and injured.

Target Group

Smallholder poultry farmers

Product Specification

Type of product	Egg incubator
Load	26 W
AC- or DC-coupled	DC
Voltage of system	12 V
Capacity of solar panel	40 Wp
Capacity of battery @C10	26 Ah

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price India	40,000.00 Rs	≈ 545 €

Technology and Market Development

- → This project has been approved by IIT Madras, Chennai and financed by L-Ramp
- → Cooperation with NGOs is envisaged
- → Distribution rights include training and support in cooperation with local institutions
- → Solar poultry incubators are distributed among villagers in Jhabua Dist. MP, Ananthapur and Ananthapur, India
- → Financing support is available

Links

http://www.lifewaysolar.com/prdt_pincubator.htm

FS3 Fully automatic Poultry Incubator Lifeway Solar

Lifeway solar devices,
1st Floor, Central Arcade, Azad Road,
Cochin – 682 017, Kaloor, Cochin, Kerala, India.

Product Description

Lifeway has developed poultry incubators with a capacity of 200 chicken or 500 quail eggs as a fully automatic solar powered system. The fibre glass double skinned box with puff insulation further improves temperature stability and operational efficiency.

Target Group

Medium-sized poultry farmers

Product Specification

Type of product	Egg incubator
Load	175 W
AC- or DC-coupled	DC
Voltage of system	24 V
Capacity of solar panel	200 Wp
Capacity of battery @C10	Minimum 26 Ah

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price India	50,000.00 Rs	≈ 680 €

Technology and Market Development

- This project has been approved by IIT Madras, Chennai and financed by L-Ramp
- Cooperation with NGOs is envisaged
- Distribution right includes training and support in cooperation with local institutions
- Solar poultry incubators are distributed among villagers in Jhabua Dist. MP, Ananthapur and Ananthapur, India
- Financing support is available
- Poultry incubators can be rented on a monthly basis

Links

http://www.lifewaysolar.com/prdt_pincubator.htm

FS4 Egg Incubator NANS

NANS/Thomas International,
Rajiveer Pinheiro (Partner), Old No. 169,
New No. 306, Linghi Chetty Street,
Chennai – 600001, Tamil Nadu, India

Product Description

A solar powered egg incubator with capacity of 264 chicken, 189 duck, 663 quail, 96 goose or 6 ostrich eggs. The incubator has an automatic egg turner, turning eggs every 90 minutes allowing a hatching rate of 98 %.

Target Group

Medium-sized poultry farmers

Product Specification

Type of product	Egg incubator
Load	250 W
AC- or DC-coupled	AC
Voltage of system	220 – 240 V

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Links

http://www.thomaseximp.com/egg.html

Milking

FS5 Solar Milking Machine Lifeway Solar

Lifeway solar devices,
1st Floor, Central Arcade, Azad Road,
Cochin – 682 017, Kaloor, Cochin, Kerala, India.

Product Description

Solar-operated milking machines prevent air and noise pollution from diesel generators, thus reducing disturbance and avoiding various diseases generated from unhygienic milking practices. Includes a 10 watt LED light for early morning milking.

Target Group

Dairy farmers

Product Specification

Type of product	Milking machine
AC- or DC-coupled	DC
Voltage of system	24
Capacity of solar panel	230 Wp
Motor and pump	24 V/1 Hp DC motor & suction pump
Capacity of battery @C10	200 Ah, 12 V

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price India	70,000.00 Rs	≈ 950 €

Links

http://www.lifewaysolar.com/products.htm

FS6 Mobile Milking Machine Siddon Biotech

Siddon Biotech & Equipments,
23/2, 2nd Main, 40 Ft Road, P N S Layout,
Subbaiahna Palaya, Bangalore, India.

Product Description

Solar powered mobile milking machine. This electrical milking machine reduces noise disturbance and unsanitary conditions. This milking machine is available as single bucket machine, which serves for 10 to 15 cows, or as double bucket machine, for 20 to 25 cows.

Target Group

Dairy farmers

Product Specification

Type of product	Egg incubator
Load	250 W
AC- or DC-coupled	AC
Voltage of system	220 – 240 V

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price India	40,000 Rs	≈ 545 €

Links

http://www.siddon.in/cattle_products.html

FS7 Mobile Milking Machine Wenzhou Marice

Wenzhou Marice Animal Husbandry Machinery Technology, Zhejiang, China.

Product Description

Mobile milking machine for cows or buffalos. Robust construction means easy maintenance. Large and heavy duty wheels improve mobility and manoeuvrability. Goat milking machine also available.

Single and double buckets available.

Target Group

Cattle farmers

Product Specification

Type of product	Milking machine
Motor	24V / 1 Hp DC motor
AC or DC coupled	DC
Voltage of system	12 V
Capacity of solar panel	230 Wp
Capacity of battery @C10	200 Ah
Autonomy days	1

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price	800 – 1,000 $	≈ 700 – 900 €

Links

http://www.alibaba.com/product-detail/Solar-Energy-Milking-Machine-Mobile-Cow_852480837.html?spm=a2700.7724838.30.10.mc95Qn&s=p

Solar Fences

FS8 Adjustable Solar Electric Fence Controller Thunderbold

Thunderbold Magnum Solar

Product Description

This solar fencer can electrify 3 to 5 miles of single-strand fencing wire, with adjustable solar panel's angles. The solar fencer is designed to keep only animals confined to a specific area by emitting an electrical shock. A ground rod (not included) is required to properly ground this solar fence control. Other features include:

- Over-discharge protection circuit
- Protected on/off flip switch
- Copper terminal posts marked red (positive) and black (negative) for quick and easy hook-up
- Impact resistant housing
- Rechargeable 4.5 amp hour, 6 volt lead-acid battery
- Fully charged in 8 hours of direct sunlight
- 2-1/4 in. keyhole mounting holes for easy installation

Target Group

Livestock farmers

Product Specification

Type of product	Electric fence
Load	1.3 W
AC- or DC-coupled	DC
Output voltage	8.7 V
Battery type	Lead Acid
Weight	1.6 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail price USA	70 $	≈ 62 €

Technology and Market Development

- Available via harbour freight

Links

http://www.harborfreight.com/solar-fencer-47454.html

FS9 Solar Electric Fence Charger Zareba® (2 – 30 miles)

Zareba

Product Description

Patented mechanical heliotropic capability allows the energizer to turn to face the sun, regardless of the direction the T-post faces. Made in the USA, this charger can be used in conditions with no weeds or light weeds. The solar panel features compartmental damage-resistant construction. Other features include:

- 360° rotation allows charger to rotate on T-Post to face the sun
- Can be used with steel, aluminium, poly wire, poly rope or poly tape
- Low-impedance technology allows for longer battery life
- One year limited warranty includes damage caused by lightning
- Service experts available to for installation questions

Target Group

Livestock farmers

Zareba® Systems Solar Charger Options

Model Number	Range	Input Voltage Output Voltage	Animal Controlled	Weed Controlled	Battery Type (Included)	Number of Warranty Years, Includes Lighting Damage**
ESP2M-Z	2 miles	Input Voltage: 4 VDC, .02 A Output Voltage: 8 KV +/- 20% open circuit voltage	Small animals including rabbits, chickens, and pets	Light	4 volt battery	1-year limited warranty
ESP3M-Z	3 miles	Input Voltage: 6 VDC, .02 A Output Voltage: 7.2 KV +/- 20% open circuit voltage	Small livestock and nuisance animals	Light	6 volt battery	1-year limited warranty
ESP5M-Z	5 miles	Input Voltage: 6 VDC, .02 A Output Voltage: 8.2 KV +/- 20% open circuit voltage	Large and small livestock and nuisance animals	Up to Moderate	6 volt battery	1-year limited warranty
ESP10M-Z	10 miles	Input Voltage: 6 volt input Output Voltage: 7.5 KV +/- 20% open circuit voltage	All livestock and nuisance animals	Up to Heavy	6 volt battery	1-year limited warranty
ESP30M-Z	30 miles	Input Voltage: 6 VDC, .02 A Output Voltage: 7.8 KV +/- 20% open circuit voltage	Small, large, and exotic livestock and predators. Not recommended for small animals.	Up to Heavy	12 volt battery (2 6-volt batteries in line)	2-year limited warranty

* In ideal conditions
**Register your Zareba® Systems charger online at ZarebaSystems.com

Product Specification

Type of product	Electric fence
Load (W)	1.3 W
AC- or DC-coupled	DC
Output voltage	6 V
Battery type	Lead Acid
Weight	1.6 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price	136 – 350 $	≈ 120 – 300 €

Technology and Market Development

All of Zarebas solar fence controllers use low impedance technology to maintain maximum energy levels. They can compensate for energy loss caused by vegetation or fence load, enabling them to power long fences with moderate weeds. The solar energizers feature 4, 6, 9, or 12 volt batteries.

Links

http://www.zarebasystems.com/store/electric-fence-chargers/solar-powered

3.2

3.2 Food Production – Water Pumping

Description

Restricted water supply affects people's daily lives, their sanitation requirement and of course their options for productive activities. Water pumping systems deliver water from boreholes, wells, canals or reservoirs and are a key infrastructural development in rural areas. For remote areas with high sunshine hours but without access to reliable electricity, solar water pumping has a well-established track record and several high quality products are available today. Solar energy is a good energy source particularly as highest demand for water typically matches highest solar energy availability, particularly in the tropics with wet and dry seasons.

Field irrigation can have a positive effect on farming activities on numerous levels, although the type of irrigation technology is critical (for instance drip irrigation is far more sustainable than flood irrigation). It may lead to a higher output, reduce costs in daily operation due to lower or no consumption of fossil fuels and can create additional income through increased harvest.

Irrigation aside, Solar Water Pumps (SWP) can be used for:

- village water supply
- livestock watering
- tourism sector, e.g. game water holes, lodges, swimming pools
- aquaculture (pond management)
- hydroponics (or similar area intensive crop production).

Technology Status and Development during the last years

A variety of DC-powered pumping systems in different sizes are available from manufacturers worldwide. These range from surface pumps to submersible pumps. Water tanks are generally part of the infrastructure, as it allows for water storage. SWP are usually not connected to batteries, as the water tank in essence becomes the storage vessel. SWP is an established and reliable technology with extensive experiences available regarding their economic viability. Good distribution networks do exist and retailers in most developing countries make local purchase of pumps and spare parts possible.

Daily operation or maintenance of pumps requires no specially trained personnel. The operation and maintenance costs are low and cost amortisation compared to diesel pumps can be achieved in less than 2 years in most instances. It is important to focus on efficiency of the pump as the difference in cost between a poor performing pump and an efficient pump is lower than the additional cost required for a larger PV panel. Accurate sizing of the array is also important in keeping costs down.

By replacing a diesel system with a SWP, CO_2 emissions can be reduced and water systems (like rivers, canals or aquifers) are less contaminated with oil pollution. In addition noise pollution and the emission of particulate matter are reduced.

During recent years technological development led to further improvements of SWP:
→ easier planning, installation and maintenance
→ screw type pumps with higher efficiency to achieve higher pumping heads
→ new generator concepts with better starting characteristics and variable voltage
→ efficiency of SWP has increased significantly during the last years.

Types of equipment presented in this catalogue

Surface pumps
This section includes pressure, delivery, and booster pumps. Surface pumps are mounted on the surface and extract water from shallow wells or from reservoirs for pumping into pipelines over considerable distances (dependent on friction losses due to pipe diameter) and uphill to a total head of around 100 meters (depending on technology and power availability).

Submersible pumps
Submersible pumps have a hermetically sealed motor close-coupled to the pump body. The whole assembly is submerged in the fluid to be pumped. The main advantage of this type of pump is that it prevents pump cavitation (also referred to as water or air hammer), a problem associated with a high elevation difference between pump and the fluid surface, where water bubbles trapped inside the pipe implode and may cause physical damage.

Pump inverters
A pump inverter monitors and controls the system's operation. Moreover it converts the DC power produced by the PV modules into AC power, which is required for some pumps of high pumping volumes or very high total heads.

Further information

A SWP System usually consists of the following elements:
→ **solar components** – PV modules, solar inverter, optional batteries (in exceptional cases)
→ **pump components** – pump inverter, motor, pump
→ **water storage or distribution system** – tank, reservoir, pipeline distribution system.

Decision for a SWP System:
When choosing a new SWP system proper planning, based on the available water source yield and correct assessment of the individual requirements, are important.
→ Proper sizing of pump with regard to
  – daily water demand or seasonal patterns of use
  – water availability including well yield and expected drawdown (i.e. the extent to which the water level reduces as a result of pumping)
  – flow range (litres per hour9 and pumping head (total meters of water level to reservoir or tank).
  – Some SWP pump volumes as low as 1.9 litres per minute which allows implementing them in wells with very low yield. Typically such wells cannot be utilized with any other technology except hand-operated pumps).
→ Planning tools should be provided by manufacturer.

Pump efficiencies have improved significantly over the last years. High efficient pumps with low energy demand facilitate right dimensioning of the solar system and therefore are cost efficient.
- **While rehabilitating an old pumping system, particularly an AC type pump, with photovoltaic, it should be considered to replace the old pump by a new, more efficient one. This can lead to significant reductions in power requirements.**

Surface Pumps

FS10 Solar Surface Slow Pump Dankoff

Dankoff Solar Pumps,
1730 Camino Carlos Rey, Suite 106,
Santa Fe, NM 87507, USA

Product Description

It is used to draw water from shallow wells, springs, cisterns, tanks, ponds, rivers and streams and push it up to 137 vertical meters and through miles of pipeline. It is approved for drinking water applications.

Target Group

Various pumping applications

Product Specification: Models 1300, 1400, 2500, 2600

Type of product	Water pump
Type of pump	Surface, positive displacement pump
AC or DC coupled	DC coupled 12, 24, 48 V DC
Pumping head	137 m
Suction capacity	(6 m) at sea level. Subtract 1ft. for every 1000ft. altitude (1 m for every 1000 m)
Water output	0.75 – 23 l/min
Load of pumping motor	40 – 675 W
Solar energy to hydraulic efficiency	90 %
Product life time	15 – 20 y, Wearing parts last 5 – 10 y
Weight	5 – 13 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Market development and distribution chains

First developed in 1983

Risks and Barriers:

Pump does not tolerate dirt – water MUST be filtered

Links

http://www.dankoffsolarpumps.com/pumps

FS11 Surface Pump Dankoff SunCentric

Dankoff Solar Pumps,
1730 Camino Carlos Rey, Suite 106,
Santa Fe, NM 87507, USA

Product Description

Does not require filtration – tolerant of dirt. Applicable for irrigation, livestock watering, domestic water, pond management. Easy to repair, no special skills necessary, detailed instruction manual is available. It is approved for drinking water.

Target Group

Various pumping applications

Product Specification: Models 1300, 1400, 2500, 2600

Type of product	Water pump
Type of pump	Surface, positive displacement pump
AC or DC coupled	DC coupled 12 – 36 V DC
Suction capacity	3m at sea level. Subtract 1 m for every 1000 m altitude
Water output	19 – 265 l/min 200 m^3/d
Load of pumping motor	40 – 675 W
Capacity of PV modules required	117 – 1112 W
Product life time	15 – 20 y, Wearing parts last 5 – 10 y
Weight	5 – 13 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Market development and distribution chains

- On the market since 1989
- A pump controller is not required
- No routine maintenance required

Risks and Barriers

- NOT for pressurized applications
- Pump must be sheltered from rain and direct sunlight

Links

http://www.dankoffsolarpumps.com/pumps/

FS12 Surface Pump Dankhoff Solar Force Piston Pump

Dankoff Solar Pumps,
1730 Camino Carlos Rey, Suite 106,
Santa Fe, NM 87507, USA

Product Description

This piston pump draws water from a shallow well, spring, pond, river or tank. It can push water up hill and over long distances for home, village, irrigation or livestock uses. It has low power demands and can operate under low light conditions. The pump does not require filtration – tolerant of dirt. Easy to repair, no special skills necessary, detailed instruction manual is available. It is approved for drinking water.

Target Group

Various pumping applications

Product Specification: Models 1300, 1400, 2500, 2600

Type of product	Water pump
Type of pump	Surface, piston pump
AC or DC coupled	DC coupled 12, 24, 48 V DC
Suction capacity	7.6 m at sea level. Subtract 1 m for every 1000 m altitude
Water output	19 – 34 LPM
Load of pumping motor	70 – 403 W
Product life time	20-year life expectancy
Weight	53 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Market development and distribution chains

- Proven design, easy to repair with ordinary tools
- Maintenance intervals: 5 – 10 years
- Tolerant of dirt and dry run
- Includes mechanical drive as back-up

Risks and Barriers

- NOT for pressurized applications
- Pump must be sheltered from rain and direct sunlight

Links

http://www.dankoffsolarpumps.com/pumps/

FS13 Surface Pump Dankhoff Solaram

Dankoff Solar Pumps,
1730 Camino Carlos Rey, Suite 106,
Santa Fe, NM 87507, USA

Product Description

A very efficient solar pump, applicable for high-lift conditions. It starts pumping at very low light conditions.

Target Group

Various pumping applications

Product Specification: Models 1300, 1400, 2500, 2600

Type of product	Water pump
Type of pump	Surface pump Neoprene diaphragm backed by piston
AC or DC coupled	DC coupled V DC
Suction capacity	7.8 m at sea level. Subtract 1 m for every 1000 m altitude
Water output	11 – 34 l/min
PV capacity required	170 – 1815 W
Product life time	20 y
Size	710 x 420 x 410 mm
Weight	68 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Market development and distribution chains

- → Simple to maintain and easy to install
- → Tolerant of dirt and dry run
- → Linear current booster (pump controller) is required to facilitate starting and prevent stalling in low light conditions

Links

http://www.dankoffsolarpumps.com/pumps/

FS14 Surface Pumps Lorentz PS-CS-F

Lorentz,
Siebenstücken 24,
24558 Henstedt-Ulzburg,
Germany

Product Description

TZ PS centrifugal pumps are designed for water transfer, livestock watering, drinking water, and pond management and irrigation applications where a surface pump is required. A controller provides inputs for monitoring storage tank levels, controlling the pump speed and uses maximum power point tracking technology to optimize the water volume.

Target Group

Various pumping applications

Product Specification: centrifugal pump series

Type of product	Water pump
Type of pump	Surface, centrifugal pumps: PS600 CS-F, PS1800 CS-F, PS4000 CS-F
AC or DC coupled	DC coupled
Pumping range	40, 50, 70 m respectively
Water output	8.3, 8.5, 59 (m^3/h) respectively
Solar energy to hydraulic efficiency	90 %

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Market development and distribution chains

- → Proven in service record
- → Fast and simple installation
- → Designed for use in remote and harsh conditions
- → Smart modular design for simple and cost effective servicing and repair
- → Cost effective spare parts philosophy

Links

https://www.lorentz.de/pdf/lorentz_ps_surface_general_en-en.pdf

FS15 Surface Centrifugal Pumps Lorentz PSk2-CS

Lorentz,
Siebenstücken 24,
24558 Henstedt-Ulzburg,
Germany

Product Description

PSk2 centrifugal pumps are designed for larger scale water projects.

Target Group

Various pumping applications

Product Specification

Type of product	Water pump
Type of pump	Surface, centrifugal pumps: PS 7k2, PS 9k2, PS 15k2, PS 21k2, PS 25k2, PS 40k2
AC or DC coupled	DC coupled
Open circuit voltage	Max. 850 V DC
Pumping range	90, 80, 80, 80, 40, 90 m respectively
Water output	14, 120, 279, 306, 457, 499 (m^3/h) respectively
Solar energy to hydraulic efficiency	90 %

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Market development and distribution chains

- → PSk2 is simple to specify, install and maintain
- → Include a wide range of sensor inputs and inbuilt monitoring and management
- → Remote monitoring and management is possible
- → Smart modular product design for simple and cost effective product repair

Links

https://www.lorentz.de/pdf/lorentz_psk2_surface_en-en.pdf

FS16 Surface Irrigation system ONergy

SwitchON/ONergy,
1A, D. L. Khan Road, Kolkata – 70002, India

Product Description

AC-powered low head surface pump with remote monitoring capability, allowing farmers to control their own water supply via GSM. Reliable irrigation and pumping system that replaces diesel and irregular grid pumps, farmers have access to safe and secure irrigation facilities.

Target Group

→ Regional focus: India: Kolkata, West Bengal
→ Target Group Smallholder Farmers

Product Specification

Type of product	Water pump
Type of pump	Surface pump
DC or AC coupled	AC
Pumping range	6 – 25 m
Water output	10 – 600 K
Load of pumping motor	0.45 kW – 22 kW
Capacity of PV modules required	0.75 – 36 kWp
Battery	Not required
Product life time	Panels: 25 y

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Market development and distribution chains

→ Implementation of 3 solar irrigation systems in West Bengal charging farmers on a pay-as-you-go basis. The project is jointly funded by NABARD
→ Microfinance scheme is available

Links

http://www.onergy.in/product_details.php?id=18
http://switchon.org.in/India/projects-2/agriculture/solar-irrigation/

FS17 Pressure and Delivery Pumps SHURflo 2088

SHURflo,
3545 Harbour Gateway South Suite 103,
Costa Mesa, CA 92626, USA

Product Description

The Shurflo 2088 series pumps are small diaphragm pumps. They are used in a variety of transfer and dispense-on-demand applications. These pumps are not designed for continuous heavy duty use. Applications where flow up to 13.5 litres per minute is required.

Target Group

Recreational vehicles, remote homes, cabins and marine

Product Specification

Type of product	Water pump
Type of pump	Surface pump
AC or DC coupled	DC coupled 12 or 24 V DC
Water output	6 – 13.5 l/min
Size	Max. 300 x 150 x 130 mm
Weight	2.5 – 6.5 kg

Price “as of”

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Links

http://legacy.shurflo.com/pages/new_industrial/Industrial/solar/solar_home.html

FS18 Surface Irrigation Pump Sunflower

Futurepump,
Nairobi, Kenya

Product Description

A photovoltaic powered piston pump with manual back-up is portable. Robust hardware design, all components can be replaced and maintained with basic mechanical skills. Versatile, can be adapted as suction pump or deep lift pump, Applicable to bore holes as small as 2".

Target Group

Seasonal vegetable farmers; Smallholder plots of one-acre with access to surface water or a well of maximum 24 feet of head

Product Specification

Type of product	Water pump
Type of pump	Surface pump (piston pump)
AC or DC coupled	DC coupled
Water output (l/d)	12,000 l /24 h
Hydraulic energy required	900 l/h @ 6 m 2,000 l/h @ 1 m
Load of pumping motor	Max. 75 W
Electrical to hydraulic efficiency	60 – 70 %
Solar energy to hydraulic efficiency	70 %
Capacity of PV modules required	80 Wp
Product life time	10 y
Size	Pump: 60 x 23,5 x 64 cm Module: 67 x 40 x 92 cm
Weight	Pump: 28.5 kg PV Module: 8 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price Kenya (Pump & PV module)	400 $	≈ 355 €

Market development and distribution chains

- → The pump is currently available in Kenya; expansion into the region is planned
- → Distribution is undertaken by Futurepump with clustered groups of farmers
- → All farmer feedback is incorporated into R&D for further development and troubleshooting
- → Payment plans are available from Futurepump

Links

http://www.futurepump.com

Submersible Pumps

FS19 Submersible and surface pump 3'' Grundfos SQFlex

Grundfos,
Schlüterstr. 33, 40699 Erkrath

Product Description

Being designed for continuous as well as intermittent operation, the SQFlex system is suitable for water supply applications in remote location. Eleven different pump models cover a wide range of heads and flows.

- → Can pump water at very low light levels
- → Low weight, installation in 3", 4" or larger boreholes, only an on/off switch is needed
- → Horizontally or vertical installation
- → Protection against dry running, over-voltage and under-voltage, overload and over-temperature
- → Built-in MPP-Tracking for DC application
- → High motor reliability through carbon/ceramic bearings, excellent starting capabilities

Target Group

Various pumping applications

Product Specification

Type of product	Water pump
Type of pump	Submersible Helical rotor pump
DC or AC connected	Optional DC- or AC connected · 30 – 300 V DC, PE · 1 x 90 – 240 V –10%/+6%, 50/60 Hz, PE
Load of pumping motor **Pump capacity**	MSF 3 permanent-magnet motor 900 W, Max. speed: 3600 min-1
Battery	Optional (30 – 300 V DC, maximum current 8.4)
Weight	9.4 – 12.4 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

Easy to install, maintenance confined to periodic cleaning of solar panels, few and simple components

Risks and Barriers

SQF pumps are applicable in thin, clean, non-aggressive, non-explosive liquids, not containing solid or long-fibred particles larger than sand grain (maximum sand content: 50 g/m^3)

Links

http://de.grundfos.com/products/find-product/sqflex.html

FS20 Submersible Centrifugal Pump Grundfos SQFlex 4”

Grundfos,
Schlüterstr. 33, 40699 Erkrath

Product Description

Being designed for continuous as well as intermittent operation, the SQFlex system is especially suitable for water supply applications in remote location. Eleven different pump models cover a wide range of heads and flows. The SQFlex 4” is a centrifugal pump for low heads and large flows.

Target Group

Various pumping applications

Product Specification

Type of product	Water pump
Type of pump	Submersible Centrifugal pump
DC or AC connected	Optional AC or DC coupled – 30-300 V DC, PE – 1 x 90 – 240 V –10%/+6%, 50/60 Hz, PE
Load of pumping motor	Max. 850 V DC
Pump capacity	Permanent magnet motor Max. 1,400 W Speed: 3,600 min-1
Battery	Optional

Price “as of”

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

SQFlex System components: SQF submersible pump

- → CU 200 SQFlex control unit, IO 100 SQFlex switch box, IO 101 SQFlex switch box, IO 102 SQFlex breaker box, charge controller
- → Easy to install, maintenance confined to periodic cleaning of solar panels, few and simple components

Links

http://de.grundfos.com/products/find-product/sqflex.html

FS21 Submersible Pump Lorentz PS Helical Rotor

Lorentz,
Siebenstücken 24,
24558 Henstedt-Ulzburg,
Germany

Product Description

The PS helical rotor pump systems are submersible pumps for 4'' and 6'' wells. It is designed for drinking water supply, livestock watering and smaller irrigation applications.

Target Group

Seasonal vegetable farmers; Smallholder plots of one-acre with access to surface water or a well of maximum 24 feet of head.

Product Specification

Type of product	Water pump
Type of pump	Submersible helical rotor pump PS200HR, PS600HR, PS1200 HR, PS1800 HR, PS4000 HR
AC or DC coupled	DC coupled
Pumping range	50, 180, 240, 250, 450 m respectively
Max. flow rate	2.6, 2.6, 2.5, 3.9, 2.5 m^3/h respectively
Solar energy to hydraulic efficiency	90 %

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Market development and distribution chains

- Modular system consisting of a pump, pump motor and controller
- Smart modular design for simple and cost effective servicing and repair
- All electronics are kept above ground providing, simple servicing, ease of access and a low cost of ownership
- Designed for use in remote and harsh conditions
- Cost effective spare parts philosophy

Links

https://www.lorentz.de/pdf/lorentz_ps_hr_general_en-en.pdf

FS22 Submersible Centrifugal Pump Lorentz PS

Lorentz,
Siebenstücken 24,
24558 Henstedt-Ulzburg,
Germany

Product Description

The LORENTZ PS range of DC-powered submersible centrifugal pumps has been designed specifically to pump larger volumes of water efficiently using solar power. It is designed for drinking water supply, livestock watering and smaller irrigation applications.

Target Group

Various pumping applications

Product Specification

Type of product	Water pump
Type of pump	Submersible centrifugal pumps PS150 C, PS600 C, PS1200 C, PS1800 C, PS4000 C
AC or DC coupled	DC coupled
Pumping range	20, 30, 40, 100, 160 m respectively
Max. flow rate	4.0, 12, 21, 53, 79 m^3/h respectively
Solar energy to hydraulic efficiency	90 %

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Market development and distribution chains

- Designed for use in remote and harsh conditions
- Simple, efficient and reliable
- High efficient pumps can achieve flow rates of 79 m^3/hour and are applicable for 4" and 6" wells
- Smart modular design for simple and cost effective servicing and repair
- Modular system consisting of a pump, pump motor and a controller
- All electronics are kept above ground providing, simple servicing, ease of access and a low cost of ownership
- Cost effective spare parts philosophy

Links

https://www.lorentz.de/pdf/lorentz_ps_hr_general_en-en.pdf

FS23 Submersible Irrigation Systems ONergy

SwitchON/ONergy,
1A, D. L. Khan Road, Kolkata – 70002, India

Product Description

SwitchON-ONergy solar irrigation system with remote monitoring capability, allowing farmers to control their own water supply via GSM. Irrigation and pumping system that replaces diesel and irregular grid pumps.

Target Group

- Smallholder farmers
- Regional focus: India: Kolkata, West Bengal

Product Specification

Type of product	Water pump
Type of pump	Submersible
DC or AC connected	AC and DC
Max. pumping head	30 m – 310 m
Load of pumping motor **Pump capacity**	0.45 – 22 kW
Capacity of PV modules required	0.9 – 64 kWp
Battery	Not required
Product life time	Panels: 25 y

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Market development and distribution chains

- Implementation of 2 solar irrigation systems in West Bengal charging farmers on a pay-as-you-go basis. The project is jointly funded by NABARD
- Successful microfinance scheme available in South India

Links

http://www.onergy.in/product_details.php?id=18
http://switchon.org.in/India/projects-2/agriculture/solar-irrigation/

FS24 Submersible Pump SHURflo 9300

SHURflo,
3545 Harbour Gateway South Suite 103,
Costa Mesa, CA 92626, USA

Product Description

The SHURflo solution for remote water pumping needs. It is designed to be strong and lightweight. For shallow wells a pump controller should be used. Additional features include:

- → Water blocked electrical connector
- → Corrosion proof housing with stainless-steel fasteners
- → Internal bypass feature for pump protection
- → For 4" wells or larger

Target Group

Drip irrigation, stock and wildlife watering, remote homes and cabins

Product Specification

Type of product	Water pump
Type of pump	Positive displacement 3 chamber diaphragm pump
AC or DC coupled	DC coupled, 24 V, 4.1 A
Pumping range	70 m
Max. flow rate	230 – 320 l/h
Size	Ø 95 x 305 mm
Weight	2.7 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Market development and distribution chains

- → Long -life 24 V DC operation
- → Dry running capability without pump damage

Links

http://legacy.shurflo.com/pages/new_industrial/Industrial/solar/solar_home.html

FS25 Submersible Pumps SunPumps SDS (Series D, Q, T)

SunPumps,
325 East Main Street, Safford,
Arizona 85546, USA

Product Description

The SunPumps Solar Diaphragm Submersible Pumps are positive displacement submersibles designed to be an economical solution for “solar water pumping”.

Target Group

Various pumping applications

Product Specification

Type of product	Water pump
Type of pump	Diaphragm submersible
DC or AC connected	12 – 30 V DC
Max. pumping head	230 – 80 ft
Flow rate	1.1 – 18 l/min
Well diameter	4 – 5”
Depth range	24 – 70 m

Price “as of”

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

→ Repair kits are available

Links

https://www.sunpumps.com

FS26 Submersible Pump SunPumps SCS

SunPumps,
325 East Main Street, Safford,
Arizona 85546, USA

Product Description

Sun Pumps SCS series submersibles are maintenance-free DC-powered pumps specifically made for water delivery in remote locations.

Target Group

Various pumping applications

Product Specification (several models of the SCS series)

Type of product	Water pump
Type of pump	Submersible
DC or AC connected	DC (30 – 180 V)
Depth range	4 – 189 m
Well diameter	4 – 6”
Flow range	15 – 870 l/min
Depth range	24 – 70 m

Price “as of”

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

→ The PCA series controller provides pump protection for over-voltage and over-current as well as current boosting in low sunlight conditions

Links

https://www.sunpumps.com/

Direct Drive / Pump Inverter

FS27 Pump Inverter EMPO-NI Solar Direct Drive SDD5.5-850-M

EMPO-NI,
Wernigeroder Str. 102 D-40595 Düsseldorf Germany

Product Description

The Solar Direct Drive "SDD" has been developed to operate standard industrial 3-phase electrical motors from a few hundred Watts up to several horse powers (hp) where grid electricity is not available. Its case structure is designed to meet a protection degree of IP54 (IP65) permitting to install the device outside. Since flexibility has been a crucial design objective, the EMPO-NI Solar Direct Drive is capable to operate with almost every manufacturer's PV panels and driving any standard industrial 3 phase motor in typical applications like pumping and ventilation.

Target Group

Medium scale: The agricultural sector and industrial customers

Product Specification

Type of product	Pump inverter
Voltage rage	300 V – 850 V (input) 300 V – 750 V (MPPT range)
Power range	550 W – 5.5 kW

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Links

http://www.empo-ni.de/SolarDirektAntrieb.html

FS28 Pump Inverter MPP ILK

ILK Dresden,
Institute for Air Handling and Refrigeration,
Bertolt-Brecht-Allee 20, 01309 Dresden

Product Description

The solar pump inverter is directly connected to the DC-voltage of the solar generator and supplies e.g. pumps or compressors which formerly were supplied by diesel generators. Additional features include:

- → Standard variable frequency drive with MPP-control
- → Input voltage range adapted to solar generator
- → For maximum power from the solar generator, the load is adjusted for matching the maximum power point (MPP) of the generator by varying the input resistance
- → Frequency drive controls load power consumption according to output voltage

Target Group

Medium scale: The agricultural sector and industrial customers

Product Specification (several models of the SCS series)

Type of product	Pump inverter
AC- or DC coupled	Converts DC to AC (320 V DC)
Capacity of PV modules required	2 – 15 kWp

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Market development and distribution chains

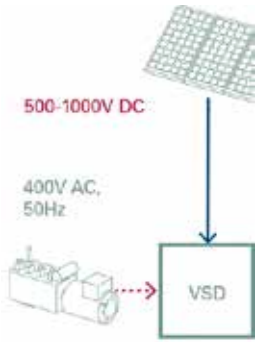
- → Allows the adaptation of diesel powered pumps to a solar system

Links

http://www.ilkdresden.de/leistungen/produkte-prototypenbau/detail/solare-kuehlung/subject/solartechnik/

FS29 Pump Inverter JUWI solar Variable Speed Drive (sVSD)

Juwi Solar,
Energie-Allee 1, 55286 Wörrstadt, Germany



Product Description

Power supply to asynchronous standard pumps, with Maximum Power Point Tracking (MPPT) and protections (over voltage protection, recognizes minimum water flow, integrated soft starter and current limiter).

Target Group

Large scale: The agricultural sector and industrial customers.

Product Specification

Type of product	Pump inverter
AC- or DC coupled	Converts DC to AC 55 – 1,000 V DC 400 V AC
Pump power supply	Starting from 30 kW
Frequency adaptation	20 – 55 Hz

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Links

http://www.juwi.com.au/fileadmin/user_upload/.com/Off-Grid/BB_Solar_Pumping_FINAL_Web.pdf

3.3

3.3 Food Processing – Milling

Description

Graining cereal crops is a basic, traditional business prevalent in rural areas. In rural areas of developing countries it is still very common to mill cereals by hand for daily food preparation. This takes a lot of time and is an arduous work mainly carried out by woman and children. Mechanized processing of crops and cereals saves time and effort and also ensures a better quality of flour. Electric and fuel driven mills are usually located in larger rural towns, but they require high quantities of grains to operate efficiently. Often therefore, crops have to be carried over long distances to such facilities, which adds even more costs and effort to the farmers.

Grains mainly processed include: maize, barley, wheat, millet, teff, and sorghum. Typical diesel-driven mills have a capacity of 25 to 1,800 kg of grain per hour. For scattered rural settlements smaller mills are sufficient, since average daily consumption per family is about 2.5 kg.

Solar PV power can be used to drive an electrical AC or DC motor that powers a grain mill. With advancement in technology and rapidly falling prices of PV technology, solar milling has become increasingly economically viable.
Factors that make solar milling attractive:

- Rural farming does not produce high quantities and thus a smaller milling technology is more appropriate.
- Scattered communities, and remoteness of the villages without connection to the electrical grid.
- Tropical high solar radiation with predictable sunshine hours over the year.

Technology Status and Development during the last years

Several manufacturers offer AC grain mills that can be connected to a PV system via an inverter. DC-driven grain mills that can be connected directly to a PV system are not as prevalent, but are available on the market or are in advanced stages of research[9].

Solar powered grain mills offer advantages compared to conventional crop processing:

- Time saving due to faster milling process and reduced logistical effort for transporting raw grain.
- Generation of additional income, e.g. if grain is milled for others on a fee-for-service basis.
- Reduction in transportation costs as crops do not have to be delivered to a nearest large-scale mill.

[9] University of Ulm

Types of equipment presented in this catalogue
- Grain Mills
- Huller, Sheller, Husker, Grater, Polisher
- Oil Press

Further information

Equipment

A PV powered grain mill consists of the following components:
1. The mill (hammer, stone, roller mills, etc.)
2. Photovoltaic array
3. Control panel
4. Inverter (if an AC mill is used)
5. Battery (if the mill is to be used during times with low or no solar irradiation)

Challenges
- **High start-up current** is required or a start-up resistor is needed which is prone to breakage. A manual starter, a soft start device or a starting current limitation can prevent problems caused by high starting current.
- In case the mill is directly connected to the battery, the battery is not protected against frequent deep discharges. To prevent **deep discharge** occurring, user training or a battery controller is required.
- Service is needed for **battery maintenance** and the exchange of batteries should be included in the estimated service and maintenance costs.

The grain mill should be dimensioned in accordance to the amount of grain to be milled on a daily basis. Furthermore the associated power system has to be dimensioned accordingly, taking into account the high start-up current.
Key factors to be defined for proper planning and sizing:
→ Amount of grain that is to be milled per day on average, and in peak times? Can the system power the mill for a sufficient amount of time?
→ Are there seasonal variations?
→ Output of the mill (in kg/d)? Does the output vary according to the type of grain?
→ Does the mill offer any further grain refinement?
→ What is the market area of the mill, i.e. how many farmers will likely make use of the milling service and from how far will people come to the mill with the raw grain?

Grain Mills

FS30 Grain Mill AgriSol 750W

AgriSol, (project coordinator)
Project Support Services PNG, (manufacturer),
PO Box 1912, Lae 411, Morobe Province, Papua New Guinea

Product Description

The AgriSol grain mill is suitable for different varieties of grain. AgriSol offers food processing equipment with add-on modules for household electrification, village lighting and productive use applications. The technology is robust and easy to use.

Target Group

→ Small scale farmers, cooperatives
→ Regional focus: Pacific, Africa

Product Specification

Type of product	Grain mill
Type of grain	maize, millet, sorghum etc.
Production capacity per hour	25 – 50 kg/h
Motor	750 W
AC/DC	DC
Battery	Lead-acid, AGM, Gel
Capacity of battery @C10	120 Ah+
Charge Controller	20 – 40 A
Stand by time	1 – 2 h
Capacity of PV modules	4 – 8 x 125 W 24 V

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail price USA	3,250 $	≈ 2,900 €

Technology and Market Development

Replacement of components:
→ Battery replacement every 2 – 5 years
→ DC brushes every 2 – 5 years

Links

http://www.agrisolenergy.com
http://psspng.com

FS31 Grain Mill BOSS Pro Farina

Phaesun GmbH,
Brühlweg 9, 87700 Memmingen, Germany

Product Description

Obtain flour from most common cereals like maize, wheat, barley, millet, teff and rice.
With auto stop device and security switch for empty hopper.

Target Group

Smallholder farms, rural communities, cooperatives or projects in off-grid areas.

Product Specification

Type of product	Pure granite 500 mm stone mill
Type of grain	Adjustable grinder for different sorts of grain
Hourly output	45 – 160 kg (depending on grain)
Motor	Standard 3-phase asynchronous motor 3 x 230/400V, 50Hz, 750 W
AC/DC	AC
Control Panel	Links PV array to the stone mill
Placement of above components	Indoor
Battery	Optional: “direct drive system” batteries only upon request
Capacity of PV modules	900 W
Packaging	2 wooden boxes (suitable for sea or air freight)
Size	1,000 x 670 x 230 mm
Weight	185 kg

Indicative production capacity per hour

(may vary depending on hardness of grain)

Wheat	55 – 260 kg/h
Maize	40 – 110 kg/h
Barley	40 – 110 kg/h
Millet	45 kg/h
Teff	45 kg/h
Sorghum	45 kg/h

Price “as of”

(individually to be confirmed with retailer/supplier)

Retail Price	5000 €

Technology and Market Development

- → Phaesun maintains close and long-lasting relationships with local distributing partners in several African countries
- → Experiences from the field used for product optimization and leading to tailor-made system solutions
- → Local business partners are provided with service and maintenance structure as well as spare parts and technological optimization for the end user

Links

http://order.phaesun.com/index.php/phaesun-boss-kit-pro-farina.html
http://www.phaesun.com

FS32 Grain Mill Solar Milling

Solar Milling/Seine Tech,
Alemanya, 58 (Polígon Industrial),
08700 Igualada (Barcelona) Spain

Product Description

This solar mill represents an affordable system to facilitate appropriate cereal/food processing technology. Features include:

- → Complete milling equipment designed for grinding dry cereals
- → Simple to operate, incurs no running costs, only very low maintenance cost
- → Direct drive system without conveyor belt and batteries
- → Target Group: smallholder farms, rural communities, cooperatives or projects in off-grid areas

Target Group

Smallholder farms, rural communities, cooperatives or projects in off-grid areas

Product Specification

Type of product	Pure granite 500 mm stone mill
Motor	Standard 3-phase asynchronous motor 230/400V 50 Hz; Made in the EU, CE certified.
AC/DC	AC
Electricity consumption	4.4 kWh/d
Control Panel	Links PV array to the stone mill
Placement of above components	Indoor
Battery	Optional: “direct drive system” batteries only upon request
Capacity of PV modules	750 W
Autonomous days	Zero
Product life time	Long lasting
Packaging	2 wooden boxes (suitable for sea or air freight)
Size	2.16 m^3
Weight	475 kg

Indicative production capacity per hour

(may vary depending on hardness of grain)

Wheat	35 – 150 kg/hour
Maize	35 – 150 kg/hour
Barley	30 – 110 kg/hour
Millet	25 kg/hour
Teff	40 kg/hour
Sorghum	35 kg/hour

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

→ Basic milling technology equipped with standard 3-phase motor that can be adapted to various conditions

Links

http://solarmilling.com

FS33 BOSS Kit Pro Mill

Phaesun GmbH,
Brühlweg 9, 87700 Memmingen, Germany

Product Description

The BOSS grain mill enables to produce flour from different kinds of most common cereals (maize, wheat, barley, teff,millet, rice etc), spices and nuts from the sun energy. The efficient engine is run by an adapted Off-Grid solar system with high efficient solar modules and electronics and a battery storage to have power available at any time. The wooden mill is installed on a a stable structure with an aperture to easily fill a flour wagon or flour sacks. The mill funnel can be filled with up to 25 kg of cereals.

Target Group

Smallholder farms, rural communities, cooperatives or projects in off-grid areas.

Product Specification

Type of product	Grain mill with bag filling and 25kg filling funnel
Motor	Mill motor 1000 W, 230 V
AC/DC	AC
Control Panel	MPPT collar charge controller IP54, 1500W/24V
Battery	Maintenance-free VLRA batteries with rack, 1000 Ah/2V
Capacity of PV modules	2400 Wp
Output	500-800 g/minute (depending on cereal type and desired fineness level)
Weight	1100 kg

Indicative production capacity per hour (may vary depending on hardness of grain)

Wheat	50 kg/hour
Maize	30 kg/hour
Barley	30 – 50 kg/hour
Sorghum	30 kg/hour

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

- → Phaesun maintains close and long-lasting relationships with local distributing partners in several African countries.
- → Experiences from the field used for product optimization and leading to tailor-made system solutions.
- → Local business partners are provided with service and maintenance structure as well as spare parts and technological optimization for the end user.

Links

http://www.phaesun.com

Huller, Sheller, Husker, Grater, Polisher

FS34 Rice Huller AgriSol RHT-1 AC, 250W

AgriSol, (project coordinator)
Project Support Services PNG, (manufacturer),
PO Box 1912, Lae 411, Morobe Province, Papua New Guinea

Product Description

This rice huller is designed for brown rice production. AgriSol offers food processing equipment with add-on modules for household electrification, village lighting and income generation. The technology is robust, easy to use and competitively priced.

Target Group

- Small scale farmers, cooperatives
- Regional focus: Pacific, Africa

Product Specification

Type of product	Rice huller
Type of grain	Rice
Production capacity per hour	35 – 40 kg/h
Motor	250 W
AC/DC	DC
Battery	Lead-acid, AGM, Gel
Capacity of battery @C10	80 Ah+
Stand by time	1 – 2 h
Charge Controller	10 A
Capacity of PV modules	240 W (2 x 120 W) 24 V
Size	25 x 55 x 83 cm
Weight	33 kg

Price “as of”

(individually to be confirmed with retailer/supplier)

Retail price USA	850 – 2,500 $	≈ 750 – 2,200 €

Technology and Market Development

Replacement of components:

- Battery replacement every 2 – 5 years
- Rubber rollers every 6 months
- DC brushes every 2 – 5 years

Links

http://www.agrisolenergy.com
http://www.psspng.com

FS35 Rice Huller AgriSol 375W

AgriSol, (project coordinator)
Project Support Services PNG, (manufacturer),
PO Box 1912, Lae 411, Morobe Province, Papua New Guinea

Product Description

The AgriSol rice huller produces brown rice. AgriSol offers food processing equipment with add-on modules for household electrification, village lighting and income generation. The technology is robust, easy to use and competitively priced.

Target Group

- Small scale farmers, cooperatives
- Regional focus: Pacific, Africa

Product Specification

Type of product	Rice huller
Type of grain	Rice
Production capacity per hour	70 kg/h
Motor	375 W
AC/DC	DC
Battery	Lead-acid, AGM, Gel
Capacity of battery @C10	120 Ah+
Stand by time	1 – 2 h
Charge Controller	20 A
Capacity of PV modules	240 W (2 x 120 W) 24 V

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail price USA	3,000 $	≈ 2,650 €

Technology and Market Development

Replacement of components:
- Battery replacement every 2 – 5 years
- Rubber rollers every 6 months
- DC brushes every 2 – 5 years

Links

http://www.agrisolenergy.com
http://www.psspng.com

FS36 Rice Polisher AgriSol 375W

AgriSol, (project coordinator)
Project Support Services PNG, (manufacturer),
PO Box 1912, Lae 411, Morobe Province, Papua New Guinea

Product Description

The AgriSol Rice polisher produces white rice and bran and is normally part of the rice huller. AgriSol offers food processing equipment with add-on modules for household electrification, village lighting and income generation. The technology is robust, easy to use and competitively priced.

Target Group

→ Small scale farmers, cooperatives
→ Regional focus: Pacific, Africa

Product Specification

Type of Product	Rice polisher
Type of grain	Rice
Production capacity per hour	60 kg/h
Motor	375 W
AC/DC	DC
Battery	Lead-acid, AGM, Gel
Capacity of battery @C10	N/A
Stand by time	1 – 2 h
Capacity of PV modules	Normally part of the rice huller

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail price USA	1,000 $	≈ 880 €

Technology and Market Development

Replacement of components:
→ Battery replacement every 2 – 5 years
→ DC brushes every 2 – 5 years

Links

http://www.agrisolenergy.com
http://www.psspng.com

FS37 Maize Sheller/Thresher AgriSol 100W

AgriSol, (project coordinator)
Project Support Services PNG, (manufacturer),
PO Box 1912, Lae 411, Morobe Province, Papua New Guinea

Product Description

AgriSol offers food processing equipment with add-on modules for household electrification, village lighting and income generation. The technology is robust, easy to use and competitively priced.

Target Group

→ Small scale farmers, cooperatives
→ Regional focus: Pacific, Africa

Product Specification

Type of product	Maize tresher
Type of grain	Maize
Production capacity per hour	250 kg/h
Motor	100 W
AC/DC	DC
Battery	Lead-acid, AGM, Gel
Capacity of battery @C10	120 Ah+
Charge Controller	20 – 40 A
Stand by time	1 – 2 h
Capacity of PV modules	Product is typically part of the grain mill

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail price USA	500 $	≈ 440 €

Technology and Market Development

Maize sheller/thresher typically comes as part of maize milling package, i.e. with grain mill. Replacement of components:
→ Battery replacement every 2 – 5 years
→ DC brushes every 2 – 5 years

Links

http://www.agrisolenergy.com
http://www.psspng.com

FS38 Cassava Grater AgriSol 250W

AgriSol, (project coordinator)
Project Support Services PNG, (manufacturer),
PO Box 1912, Lae 411, Morobe Province, Papua New Guinea

Product Description

AgriSol offers food processing equipment with add-on modules for household electrification, village lighting and income generation.

Target Group

→ Farmer, cooperatives
→ Regional focus: Pacific, Africa

Product Specification

Type of product	Cassava grater
Type of grain	Cassava
Production capacity per hour	100 kg/h
Motor	250 W
AC/DC	DC
Battery	Lead-acid, AGM, Gel
Capacity of battery @C10	80 Ah+
Charge Controller	10 A
Stand by time	1 – 2 h
Capacity of PV modules	2 x 125 W 24 V

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail price USA	1,750 $	≈ 1540 €

Technology and Market Development

Replacement of components:
→ Battery replacement every 2 – 5 years
→ DC brushes every 2 – 5 years

Links

http://www.agrisolenergy.com
http://www.psspng.com

Oil-Press

FS39 Oil Press BOSS Kit Pro Press

Phaesun GmbH,
Brühlweg 9, 87700 Memmingen, Germany

Product Description

The Phaesun Pro Press solar oil press is ideal for the pressing of different crops. The solar oil press with its speed regulation achieves excellent pressing results due to the very efficient engine. The solar oil press is available as complete kit with high quality components for a reliable and professional usage day by day.

Target Group

Smallholder farms, rural communities, cooperatives or projects in off-grid areas

Product Specification

Product	Oil press
Type of grain	Adjustable speed for different sorts of grain
Motor	1.5 kW/230 V AC oil press
AC/DC	AC
Inverter	3 kW/24V inverter
Battery	1000 Ah/2V
Capacity of PV modules	2400 Wp

Price “as of”

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

- → Phaesun maintains close and long-lasting relationships with local distributing partners in several African countries
- → Experiences from the field used for product optimization and leading to tailor-made system solutions
- → Local business partners are provided with service and maintenance structure as well as spare parts and technological optimization for the end user

Links

http://order.phaesun.com/index.php/kits-40892/bosskits-40949/phaesunbosskit-propress-41482/phaesun-boss-kit-pro-press.html
http://www.phaesun.com

3.4

3.4 Food Storage – Cooling

Description

Cooling demand is increasing in rural areas, as it allows for storage of fresh or frozen food as well as medicines and vaccinations. Cooling appliances can thus have significant influence on quality of health and income generation.

As most 120/240 V AC powered refrigerators rely on relatively constant energy supply, conditions in rural areas often present a challenge when it concerns maintaining a continuous cold chain. Especially high outside temperatures combined with unreliable electricity supply lead to frequent interruption in power supply. DC appliances combined with a PV-system offer a good alternative for rural areas, because they present a reliable power source combined with the capacity to bridge power disruptions. They should contain a well-insulated cooling cabinet and have the ability to maintain their temperature for extended time periods without electricity supply.

Technology Status and Development During the Last Years

High efficient 12 V DC fridges, which can easily be powered by basic PV systems, are available in a number of sizes, but are still high cost niche products. They are mainly produced in Europe and North America and distribution chains are only slowly expanding to Africa and Asia.

Most cooling appliances have to be combined with a battery bank, to ensure around the clock electricity supply. A few, innovative ones use a cooling technology that provides cooling load over several days. These battery-free appliances use an ice bank around the cabinet to safeguard the required cooling temperature during non-availability of power (e.g. night time).

Refrigerants used in DC cooling appliances:

- **R-134a is a halo alkane refrigerant with a low ozone depleting potential and a global warming potential (GWP) of 1430.**
- **R-600a, Isobutene, has a GWP of 3 and is the most common refrigerant in Europe.**
- **Some appliances' cooling cycle work on the basis of hydrocarbon, which is non-toxic.**
- **Freezers are only available using HFC-refrigerants.**

Energy Efficiency

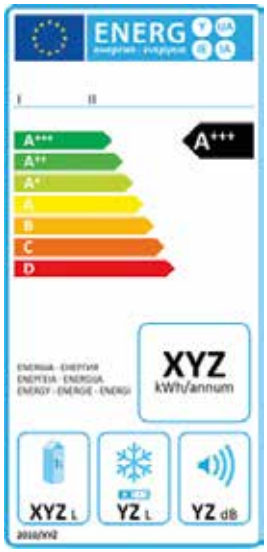
Energy efficiency performance is crucial when choosing the right refrigerator to be connected to a PV power system. To determine the efficiency one has to multiply the power (Watts) of appliance with its daily operating hours to obtain Watt/hours per day (or kilowatt/hours [kW/h]). The higher the watt/hours (or kW/h), the lower the efficiency. As this data is not always reliably available, an energy rating system was introduced in many countries. One such rating system is the European Energy Label. The label has been developed for different types of appliances according to their respective specifications.

For refrigerators and freezers the label contains information on:

- → Annual power consumption relative to a reference consumption that is based on the storage volume and the type of appliance (refrigerator or freezer)
- → Annual energy consumption in kWh
- → Capacity of fresh foods in litres for refrigerators and combined appliances
- → Capacity of frozen foods in litres for freezers and combined appliances
- → Noise during operation in decibel (db).

While the label has been primarily developed to rate AC refrigerator and freezers, it offers reference data for DC appliances.

To date the most efficient conventional refrigerators are rated A+++ and can realize energy savings of about 60 % compared to the efficiency class A.



Example of EU Energy label for a refrigerator

In most cases DC appliances use commonly available refrigerating compartments as basis and then integrate the DC technology. Due to this fact, DC appliances are often classified as A++.

Climate Class

The capacity of a cooling appliance to achieve the estimated cooling temperature at the indicated electricity consumption depends on the ambient temperature: A refrigerator situated in a high temperature environment requires more power to achieve and hold the cooling temperature inside. Climate classes indicate the ambient temperature range for which the appliance is constructed and will achieve the targeted cooling temperature.

Table 2 The four climate classes

Climate class	Ambient temperature	Remark
SN (Sub-normal)	10 to 32°C	
N (Normal)	16 to 32°C	
ST (Sub tropical)	16 to 38°C	This category allows a 10 % higher energy consumption compared to an appliance of climate class normal to achieve the same energy label (e.g. A++)
T (Tropical)	16 to 43°C	For regions with very high temperatures; this category allows a 20 % higher energy consumption compared to an appliance of climate class normal to achieve the same energy label (e.g. A++)

Table 2: Definition of Climate Classes for Refrigerators and Freezers

Types of equipment presented in this catalogue

Freezers

Freezers offer the opportunity of freezing goods at temperatures of –10 to –20°C with a cooling volume of up to 300 litres.

Refrigerators

Refrigerators are of the same size as freezers and offer the opportunity of cooling goods to temperatures of 2 to 8°C. Fridge/freezer combinations combine both functions, cooling and freezing (through a separate freezing compartment).

Walk-in cold rooms

Special sort of cooling appliances are reefers or walk-in cold rooms. They consist of an insulated container, often equipped with a PV-system powering the cooling technology. These large-scale cooling solutions are suitable for large quantities of goods. They may be applicable for market places, in the agricultural sector or for fisheries.

CoolBot

CoolBot is a micro-controller that is used in combination with conventional air conditioners to cool down any insulated room to create a walk-in cooler.

The CoolBot works with any conventional air conditioner and can easily be combined with a PV system. Using this micro controller a ~ 35°F (2°C) walk-in cold room can be created.

The appliance is designed as a low cost cooling alternative for rural areas, and can be used for example for fruits and vegetables, fish or flowers.

For further information please visit: *http://storeitcold.com/techsupport.html*

Further information

Consumer hints to check the quality of a refrigerator
While choosing a refrigerator, a basic quality check should be conducted based on the following points:

- **Size:** The size of a refrigerator effects its energy consumption and its price. Therefore a consumer should ask himself what quantity of products should be cooled in the refrigerator and procure the appropriate size.
- **Energy Label:** the label indicates the efficiency of an appliance. Does the manufacturer present an internationally accepted energy label?
- **Energy consumption:** This information should be provided by the manufacturer. The data sheet should include information with regard to
  – Energy consumption (kWh/24h)
  – Standby time (time the cooling temperature can be held without electricity supply)

Freezers

FS40 Freezer – Dulas solar VC series

Dulas International,
Unit 1 Dyfi Eco Park, Machynlleth,
Powys, Wales, SY20 8AX, UK

Product Description

Stand-alone solar refrigerators and combined refrigerators with freezers for vaccines and blood for use in health centres. The Dulas solar is available with cooling volume of 65 l, 150 l and 200 l. Additional features include:

- High efficiency, low carbon footprint, long lasting
- Flexible, reliable vaccine storage solutions
- Ice pack freezing
- Robust, high quality materials
- Rapid, even cooling
- LED display for fridge and freezer temperature
- Low maintenance
- Supplied with: locking door, external temperature indicator, air circulation basket, instruction manuals

Target Group

Basic freezing applications

Product Specification VC 150-2

Type of product	Freezer
Cooling volume	Gross volume: 33.1 L Waterpack freezing capacity: 2.4 kg/24 h Waterpack storage capacity: 26 x 0.6 L 100 kg/h
AC- or DC coupled	DC, 12 V
Energy consumption	during freezing: 1.06 kWh/24 h 32°C = 380 Wh / 24 h 27°C = 270 Wh / 24 h
Autonomous days/ stand by	@ 43°C: 3 h 22 min
Type of refrigerant	CFC free
Size	92.9 x 128.5 x 78.1 cm

Price "as of"

(individually to be confirmed with retailer/supplier)

VC65-2	3,550.00 €
VC150-2	4,600.00 €
VC200-1	3,350.00 €

Technology and Market Development

→ WHO/UNICEF certified
→ Appliance can be supplied as a complete kit including solar panels, batteries, charge controller and accessories

Dulas offers on-site training for installation and maintenance to ensure the ongoing success of the cold chain program and technical support via email and telephone – See more at: *http://www.dulas.org.uk/pns/international-solar-solutions/solar-refrigeration-training*

Links

http://www.nccvmtc.org/PDF2/2_028.pdf
http://www.nccvmtc.org/PDF2/2_029.pdf
http://www.dulas.org.uk/products/vc150-solar-medical-refrigerator.cfm
http://www.dulas.org.uk/pns/international-solar-solutions/solar-refrigeration

FS41 Freezer – Phocos FR Series

Phocos AG,
Magirus-Deutz Str. 12, 89077 Ulm, Germany

Product Description

The Phocos FR series are available at a cooling volume of 50 l, 165 l and 225 l. Additional features include:

- Shutoff at low voltage
- Top-quality craftsmanship guarantees a long useful life
- 11 cm thick insulation layer made of polyurethane ensures minimal thermal losses
- Scratch-proof steel-panel housing
- The refrigeration system is equipped with a maintenance-free, brushless DC compressor
- The patented low-frost system reduces the formation of condensation water and ice
- Easy-to-clean aluminium lining, lockable lid (except for the model FR 50 R)
- Interior lighting
- Adjustable interior temperature

Target Group

Basic freezing applications

Product Specification

Type of product	Freezer (Phocos FR165)
Cooling volume	165 l
Nominal power	40 W
AC- or DC coupled	DC, 12 V or 24 V
Energy consumption	@ 21°C: 300 Wh/24 h
Ambient temperature (Climate class)	–10 to 43°C
Type of refrigerant	R-134a
Size	98 x 76 x 98 cm
Weight	51 kg

Price “as of”

(individually to be confirmed with retailer/supplier)

Retail Price	2,070 €

Technology and Market Development

Delivery: 114 units/40 ft container (50 l), 72 units/40 ft container (165 l), 56 units/40 ft container (225 l)

Links

http://www.phocos.de/de/products/fr-50-165-225l
http://www.phocos.com/sites/default/files/document/Phocos_datasheet_FR_e_web_0.pdf

FS42 Freezer – Steca PF 166/240

Steca Elektronik GmbH,
Mammostraße 1, 87700 Memmingen, Germany

Product Description

The Steca PF is available with a cooling volume of 166 l or 240 l. It can be used as refrigerator or freezer, its function is adjustable and the temperature is fully programmable. Additional features include:

- → Automatic detection of voltage
- → Suitable for all DC applications
- → Low maintenance, easy to clean, lock with two keys
- → Also suitable for mobile use
- → Auto-dimming for reduction of own consumption
- → Reverse polarity and deep discharge protection
- → Power breakdown display and temperature alarm

Target Group

Basic freezing applications

Product Specification

Type of product	Freezer
Cooling volume	166 l
Freezer temperatures	-20 to -10°C
Nominal power	40 – 100 W
Energy efficiency class	A++
AC- or DC coupled	DC 10, 24 V
Energy consumption	166 l; Inside temperature: -10°C: 259 Wh/d @ 25°C 346 Wh/d @ 30°C 589 Wh/d @ 40°C
Ambient Temperature (Climate class)	10 to 43°C
Capacity of PV modules required	70 W
Type of refrigerant	190 g R134a
Battery	Not included
Size	917 x 872 x 709 mm
Weight	47 kg

Price “as of”

(individually to be confirmed with retailer/supplier)

Steca PF 166	900 €*
STECA PF 240	1,440 €*

(*prices dated from Oct. 2015; net prices excl. tax and additional system components)

Technology and Market Development

→ Compliant with European Standards (CE)
→ Abstinence of ozone destroying materials according EC 1005/2009 (CFC-free)
→ Developed in Germany
→ Manufactured according to ISO 9001 and ISO 14001

Links

http://www.steca.com

FS43 Freezer – SunDanzer DCF

SunDanzer,
11135 Dyer Suite C, El Paso, Texas 79934 USA

Product Description

The SunDanzer DCF is available with a cooling volume of 165l, 225l, 390l or as commercial reefers in 10', 20' or 40'-containers. The SunDanzer is applicable for remote areas, off-grid and intermittent grid. The low energy consumption requires smaller PV system.
Additional features include:

- → Thick insulation and optimized refrigeration system
- → Rugged scratch resistant galvanized steel exterior, easy to clean aluminium interior
- → With lockable lid and interior light
- → Low cost refrigerator or freezer for rural areas
- → Patented low-frost system, automatic control with adjustable thermostat

Target Group

Basic freezing applications

Product Specification

Type of product	Freezer (DCR165)
Cooling volume household units	165 l
Energy consumption	@ 32°C: 441 Wh/24 h
Capacity of PV modules required	75 W
Type of refrigerant	Using R-134a (halo alkane refrigerant) as refrigerant
Size	102 x 76 x 94 cm
Weight	54.4 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price	700 €

Technology and Market Development

High technological standard, high energy efficiency.

Links

http://www.sundanzer.com

FS44 Freezer – Smart solar ice maker (Steca PF166)

University of Hohenheim,
Institute of Agriculture Engineering,
Tropical & Subtropical Group,
Garbenstr. 9, 70599 Stuttgart
Steca Elektronik GmbH,
Electronics Services, Mammostraße 1,
87700 Memmingen, Germany
Phaesun GmbH,
Brühlweg 9, 87700 Memmingen, Germany

Product Description

A DC-powered domestic refrigerator is operated by an additional control unit to produce ice only in solar radiation hours. The compressor speed and inner cabinet temperature are adjusted depending on actual solar radiation. The system can run with a small battery (10 Ah) but achieves 35 % more ice production with a 65Ah battery. The capacity of ice production ranges between 8 and 14 kg/d depending on location and daily irradiation.

Target Group

Basic freezing applications

Product Specification VC 150-2

Type of product	Freezer
Cooling volume	160 l
Cooling Temperatures	Depending on solar radiation between -3°C and -20°C
Nominal power	40 – 100 W
AC- or DC coupled	DC
Energy consumption	700, 1000, 1340 Wh/d
Energy efficiency class	A++
Ambient temperature (Climate class)	20 to 40°C
Capacity of PV modules required	400 Wp
Autonomous days/ stand by time	3
Type of refrigerant	R134a
Battery	Minimum: 10 Ah Optimum: 65 Ah (for a higher ice production)

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price	1,200 €*

(*Price dated from Oct. 2015; Smart solar ice maker using Steca PF 166, excluding net prices excl. tax and additional system components)

Technology and Market Development

- → Developed by Steca (Freezer) and the University of Hohenheim (additional control unit)
- → Distributed by Phaesun (whole system)
- → R&D phase until 2017; In-field test 2015 – 2017 in Tunisia

Links

http://www.uni-hohenheim.de/einrichtung/fg-agrartechnik-in-den-tropen-und-subtropen

Refrigerators

FS45 Absorption refrigerator Dometic RML 9430/9435

Dometic GmbH,
In der Steinwiese 16, 57074 Siegen

Product Description

Refrigerator using absorption cooling technology. This type of fridge is absolutely silent. They allow you the freedom to use a wide variety of power sources – mains or battery powered, LPG or solar panels (AES models). Its outstanding characteristics include high performance, reliability and a completely silent operation, together with convenient features and a long service life.

Target Group

Basic freezing applications (applications where a silent refrigerator is preferred)

Product Specification

Type of product	Refrigerator
Cooling volume	Without freezer compt.: 151 l With freezer compt.: 146 l Freezer compt.: 12 l
Cooling temperatures	7 to 12°C
AC- or DC coupled	230 V AC/ 12 V DC
Energy consumption	3200 Wh/24 h
Ambient temperature (Climate class)	SN
Size	468 x 1293 x 555 mm
Weight	37 kg

Price “as of”

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

Care must be taken to always ensure good ventilation to dissipate process heat

Links

http://www.dometic.de/product/dometic-rml-9430-9435

FS46 Portable Cooling Box Dometic RCW42/RCW50

Dometic GmbH,
In der Steinwiese 16, 57074 Siegen

Product Description

Roto-moulded polyethylene refrigerators and freezers using compressor technology with CFC and HCFC-free refrigerant. Additional features include:

- Big vaccine storage capacity
- Big pack storage capacity
- TCW 2000 SDD is a Solar Direct Drive unit
- These products are really robust for intensive use.
- 100 mm polyurethane foam and silicon gasket provide optimal insulation allowing an operating temperature range 0 to 43°C.
- Separate compartments, each for refrigerating vaccines and freezing icepacks.

Target Group

Basic freezing applications (particularly vaccine cooling)

Product Specification

Type of product	Vaccine freezer
Cooling volume	Vaccine 14 l & ice 2.4 l / Vaccine 24 l & ice 2.4 l
Nominal power	DC, 12/24 V
Energy consumption (Wh/24 h) / (32°C)	610 Wh/24 h
Ambient temperature (Climate class)	0 to 43°C
Type of refrigerant	R134a
Battery	Yes
Size	500 x 550 x 920 mm / 830 x 720 x 980 mm
Weight	43 kg / 71 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

Fully WHO immunization standard

Links

http://www2.dometic.com/delu/Europe/LuxembourgDE/Medical-Systems/Cold-Chain/Kuhlschranke-Gefrierschranke/products/?productdataid=79120

FS47 Portable Cooling Box Dometic TCW3000 DC/TCW2000 DC BL53 POS

Dometic GmbH, In der Steinwiese 16, 57074 Siegen

Product Description

Roto-moulded polyethylene refrigerators and freezers using compressor technology with CFC and HCFC-free refrigerant. Additional features include:

- Big vaccine storage capacity
- Big pack storage capacity
- TCW 2000 SDD is a Solar Direct Drive unit
- These products are really robust for intensive use
- 100 mm polyurethane foam and silicon gasket provide optimal insulation allowing an operating temperature range 0 to 43°C
- Separate compartments, each for refrigerating vaccines and freezing icepacks
- TCW3000 exists as ice lined vaccine refrigerator. The same model is available as a vaccine freezer. A pre-set point of –20°C can be changed by a technician

Target Group

Basic freezing applications (particularly vaccine cooling)

Product Specification

Type of product	Vaccine freezer
Cooling volume	Vaccine 110 l or ice 48 l Vaccine 76 l & ice 15.6 l
AC- or DC coupled	DC 12/24 V
Energy consumption (Wh/24 h) / (43°C)	1,820 Wh/24h refrigeration
Ambient temperature (Climate class)	0 to 43°C
Type of refrigerant	R134a
Battery	Yes
Size	1280 x 780 x 900 mm 1270 x 790 x 910 mm
Weight	115 kg 121 kg

Price “as of”

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

Fully WHO immunization standard

Links

http://dev.phaesun.com/components/product-range/product-detail/loads/refrigerator-and-freezer-boxes/dometic-tcw-series/vaccine-refrigerator-dometic-tcw2000-dc-bl53-pos.html?tx_felogin_pi1%5Bforgot%5D=1

FS48 Refrigerator Dulas solar VC series (battery driven)

Dulas Internationa,
Unit 1 Dyfi Eco Park, Machynlleth,
Powys, Wales, SY20 8AX, UK

Product Description

The Dulas VC are stand-alone, battery driven solar refrigerators and combined refrigerators with freezers for vaccines and blood for use in health centres. The Dulas solar is available with cooling volume of 65 l, 150 l and 200 l. Additional features include:

- → Flexible, reliable vaccine storage solutions
- → Ice pack freezing
- → Robust, high quality materials
- → Rapid, even cooling
- → LED display for fridge and freezer temperature
- → Low maintenance, CFC free
- → Supplied with: Locking door, external temperature indicator, air circulation basket, instruction manuals

Target Group

Basic freezing applications (particularly vaccine cooling)

Product Specification VC 150-2

Type of product	Vaccine freezer
Cooling volume	Vaccine storage capacity: 86 l Gross volume: 111.2 l
AC- or DC coupled	DC, 12 V
Energy consumption	@ 43°C: 680 Wh/24 h
Ambient temperature (Climate class)	T (43°C)
Autonomous days/ stand by	@ 43°C: 3 h 22 min
Type of refrigerant	CFC free
Size	92.9 x 128.5 x 78.1 cm

Price "as of"

(individually to be confirmed with retailer/supplier)

VC65-2	3,550.00 €
VC150-2	4,600.00 €
VC200-1	3,350.00 €

*(including solar panels, excl. shipping, taxes and installation work)

Technology and Market Development

- WHO/UNICEF certified
- Appliance can be supplied as a complete kit including solar panels, batteries, charge controller and accessories
- Dulas offers on-site training for installation and maintenance to ensure the ongoing success of the cold chain program and technical support via email and telephone – See more at: *http://www.dulas.org.uk/pns/international-solar-solutions/solar-refrigeration-training*

Links

http://www.nccvmtc.org/PDF2/2_028.pdf
http://www.nccvmtc.org/PDF2/2_029.pdf
http://www.dulas.org.uk/products/vc150-solar-medical-refrigerator.cfm
http://www.dulas.org.uk/pns/international-solar-solutions/solar-refrigeration

FS49 Refrigerator – Dulas VC200SDD Solar Direct Drive

Dulas Internationa,
Unit 1 Dyfi Eco Park, Machynlleth,
Powys, Wales, SY20 8AX, UK

Product Description

Solar Direct Drive (SDD) is Dulas' latest innovation in solar refrigeration. This technology uses a ground breaking phase change energy storage solution instead of traditional batteries. The solar direct drive is as robust, easy to use and as reliable as the battery driven solar refrigerators. Additional features include:

- Freeze-free technology
- Widest range of solar operating conditions
- Designed for challenging environments
- Exceptional energy efficiency & reliability
- Supplied with: Locking door, external temperature indicator, air circulation basket, instruction manuals

Target Group

Basic freezing applications (particularly vaccine cooling)

Product Specification VC200SDD

Type of product	Vaccine freezer
Cooling volume	158.1 L refrigerator; 42.9 l freezer Net vaccine storage capacity: 102 l
Freezing capacity	@ 32°C. 2.4 kg; @43°C 2.04 kg
Nominal power	40 W
AC- or DC coupled	DC, 12 V
Ambient temperature (Climate class)	T (43°C) Min. rated ambient temperature: 5°C
Capacity of PV modules required	> 600 W 60 cell module, Vpmax > 24 V DC; Voc < 45 V CD
Autonomous days/ stand by	@ 43°C: 77.95 h @ 32°C: 118.85 h
Type of refrigerant	CFC free – R600a
Battery	Direct drive (PCM), no battery
Size	73.5 x 128.3 x 99.2
Weight	170.4 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

VC150SDD	6,700.00 €
VC200SDD	4,600.00 €

*(including solar panels, excl. shipping, taxes and installation work)

Technology and Market Development

- → WHO/UNICEF certified; exceeds WHO PQS standards.
- → Appliance can be supplied as a complete kit including solar panels, batteries, charge controller and accessories.
- → Dulas offers on-site training for installation and maintenance to ensure the ongoing success of the cold chain program and technical support via email and telephone – See more at: *http://www.dulas.org.uk/pns/international-solar-solutions/solar-refrigeration-training*

Links

http://www.dulas.org.uk/pns/international-solar-solutions/solar-refrigeration

FS50 Refrigerator ONCool

ONergy, Punam Energy Pvt. Ltd. 1A, D. L. Khan Road Jaju Bhawan, Kolkata – 700027, Phone: +8420104760, info@onergy.in

Product Description

Standalone solar DC refrigerator for milk, vegetables, vaccines etc. available in sizes of 50 and 165 l. Applicable in urban and rural areas. Additional features include:

- → Energy efficient brushless DC-compressor
- → Low maintenance
- → Fast cooling, temperature controller
- → Portable

Target Group

Basic freezing applications

Product Specification

Type of product	Refrigerator
Cooling volume	50 l & 165 l
Nominal power	45 W to 80 W
AC- or DC coupled	DC, 12 V / 24 V
Energy consumption	Very low
Ambient temperature (Climate class)	–10 to 40°C
Capacity of PV modules required	80 Wp – 200 Wp
Autonomous days/ stand by	3 d
Type of refrigerant	R-134a
Product life time	10 y
Size	68 x 77x 60 cm 100 x 75 x 100 cm
Weight	34 kg, 51 kg, 59 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

- → Low maintenance requirements
- → Low voltage application

Links

http://onergy.in

FS51 Refrigerator Phocos FR50R/FR165R/FR225R

Phocos AG,
Magirus-Deutz Str. 12, 89077 Ulm, Germany

Product Description

The refrigeration system is equipped with a maintenance-free, brushless DC compressor. The patented low-frost system reduces the formation of condensation water and ice. Additional features include:

- → 11 cm thick insulation layer made of polyurethane ensures minimal thermal losses
- → Featuring shutoff at low voltage to protect battery from deep discharge
- → Scratch-proof steel-panel housing
- → Easy-to-clean aluminium lining
- → Lockable lid (except for the model FR 50 R), interior lighting
- → Adjustable interior temperature

Target Group

Basic freezing applications

Product Specification FR165R

Type of product	Refrigerator
Cooling volume	165 l
Cooling temperatures	2 to 5°C
Nominal power	40 W
AC- or DC coupled	DC, 12 V or 24 V
Energy consumption	@ 21°C: 96 Wh/24 h @ 32°C: 168 Wh/24 h
Ambient temperature (Climate class)	ST; (<38°C)
Type of refrigerant	R-134a
Size	98 x 76 x 98 cm
Weight	51 kg

Price “as of”

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

Delivery: 54 units/20 ft container (50 l), 30 units/20 ft container (165 l), 26 units/20 ft container (225 l)

Links

http://www.phocos.com/products/fr-50-165-225l
http://www.phocos.com/sites/default/files/document/Phocos_datasheet_FR_e_web_0.pdf

FS52 Refrigerator – Solar Chill

SolarChill (Project Coordinator),
5106 Walden Street, Vancouver, B.C., Canada, V5W 2V7

Product Description

A stand-alone refrigerator with DC compressor that runs the refrigerant cycle. An ice bank maintains the required temperature in the cabinet. Additional features include:

- Uses public domain technology – patent free
- Battery is substituted for an ice bank
- Instead of fluorocarbons, hydrocarbons are used as refrigerant

Target Group

Basic freezing applications

Product Specification FR165R

Type of product	Refrigerator
Cooling volume	50 l
Cooling temperatures	2 to 8°C
AC- or DC coupled	DC
Energy consumption	Ca. 500 Wh/d 15 V
Capacity of PV modules required	Min. 180 Wp (e.g. 3 x 60 Wp)
Autonomous days/ stand by	5 (depending on insulation)
Type of refrigerant	Hydrocarbon creates an ice bank as thermal energy storage
Battery	No

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price	1,500 – 2,000 $*	≈ 1,300 – 1,800 €

(*price including solar panels)

Technology and Market Development

- Solar Chill A is commercialized and implemented as vaccine cooler at health centres.
- ~1000 Solar Chills are installed world wide
- Manufacturer: Vestfrost (Denmark), Palfridge (Swaziland), Haier (China), True Energy (UK)
- Currently not many manufacturers use hydrocarbons as refrigerant, therefore a commercial production is difficult
- No freezer available

Links

http://www.solarchill.org/wp-content/uploads/2014/02/SolarChill-Technology-Brief.pdf
http://www.greenpeace.org/canada/Global/canada/report/2011/12/SolarChill%20Backgrounder%20Canada%2011_2011.pdf

FS53 Refrigerator Steca PF 166/240

Steca Elektronik GmbH,
Mammostraße 1, 87700 Memmingen,
Germany

Product Description

The Steca PF is available with a cooling volume of 166 l or 240 l. It can be used as refrigerator or freezer, its function is adjustable and the temperature is fully programmable.
Additional features:

- Automatic detection of voltage
- Suitable for all DC applications
- Low maintenance, easy to clean, lock with two keys
- Also suitable for mobile use
- Auto-dimming for reduction of own consumption
- Reverse polarity protection
- Deep discharge protection
- Power breakdown display
- Temperature alarm

Target Group

Basic cooling applications

Product Specification

Type of product	Freezer
Cooling volume	166 l
Freezer temperatures	-20 to -10°C
Nominal power	40 – 100 W
Energy efficiency class	A++
AC- or DC coupled	DC 10, 24 V
Energy consumption	166 l; Inside temperature: 8°C: 72 Wh/d @ 25°C 109 Wh/d @ 30°C 216 Wh/d @ 40°C
Ambient Temperature (Climate class)	10 to 43°C
Capacity of PV modules required	70 W
Type of refrigerant	190 g R134a
Battery	Not included
Size	917 x 872 x 709 mm 1,288 x 919 x 760 mm
Weight	47 kg, 62 kg

Price “as of”

(individually to be confirmed with retailer/supplier)

Steca PF 166	900 €
STECA PF 240	1,440 €

Technology and Market Development

→ Compliant with European Standards (CE)
→ No ozone destroying materials according EC 1005/2009 (CFC-free)
→ Manufactured according to ISO 9001 and ISO 14001

Links

http://www.steca.com

FS54 Refrigerator SunDanzer DCR

SunDanzer,
11135 Dyer Suite C, El Paso, Texas 79934 USA

Product Description

The SunDanzer DCR is available with a cooling volume of 165 l, 225 l, 390 l or as commercial reefers in 10', 20' or 40'-containers. The SunDanzer is applicable for remote areas, off-grid and intermittent grid. The low energy consumption requires smaller PV system.

- → Thick insulation and optimized refrigeration system
- → Rugged scratch resistant galvanized steel exterior, easy to clean aluminium interior
- → With lockable lid and interior light
- → Low cost refrigerator or freezer for rural areas
- → Patented low-frost system, automatic control with adjustable thermostat

Target Group

N/A

Product Specification (DCR165)

Type of product	Refrigerator
Cooling volume household units	165 l
Energy consumption	@ 32°C: 168 Wh/24h
Capacity of PV modules required	75 W
Type of refrigerant	Using R-134a (halo alkane refrigerant) as refrigerant
Size	102 x 76 x 94 cm
Weight	54.4 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price	700 $	≈ 615 €

Technology and Market Development

High technological standard, high energy efficiency.

Links

http://www.sundanzer.com

FS55 Refrigerator Sure Chill GVR

The Sure Chill Company Ltd,
Enterprise Park, Tywyn, Gwynedd, Wales, LL36 9LW, UK
Godrej & Boyce Manufacturing Company Ltd,
Pirojshanagar, Vikhroli, Mumbai – 400 079,
India

Product Description

Sure Chill solar refrigerators are available in two sizes: 46.5 l and 99 l.
They are direct driven and battery free. Water surrounds a Sure Chill refrigeration compartment. Using electric power the water forms an ice bank above the compartment, leaving only water at four degrees cooling the contents. When power is switched off, the 4°C water does the cooling until the ice compartment is melted. Additional features include:

- → Surechill cooling technology doesn't rely on constant power
- → Part-time running (Silent running during office hours, or switch it off at night)
- → Digital LED display
- → Self-sealing twin door gaskets and high levels of insulations
- → Front opening for easy stock management
- → Environmentally friendly – CFC, HFC and HCFC free
- → Corrosion resistant: Outer cabinet is made of galvanized steel

Target Group

Basic cooling applications

Product Specification

Type of product	Refrigerator
Cooling volume	46.5 l, 99 l
Cooling temperatures	4°C
AC- or DC coupled	DC, 24 V
Energy consumption	Stable running: 0.56 kWh/ 24 h, 0.75 kWh/ 24 h Cool down test: 0.64 kWh/ 24 h, 1.90 kWh/ 24 h
Energy efficiency class	N/A
Ambient temperature (Climate class)	T, 10 to 43°C
Capacity of PV modules required	470 Wp, 24V
Autonomous days/ stand by	+5 (GVR50DC)/+11 (GVR100DC)
Type of refrigerant	R900a
Battery	No
Size	1220 x 790 x 750 mm 1820 x 795 x 750 mm
Weight	125 kg, 160 kg

Price “as of”

(individually to be confirmed with retailer/supplier)

GVR50DC	4,040.00 $	≈ 3,550 €
GVR100DC	5,450.00 $	≈ 4800 €

*(including solar array, mounting kit and cables, excl. shipping, taxes and installation work)

Technology and Market Development

- WHO standard, Quality standard ISO 9001:2008
- Sure Chill technology is available worldwide and is in use as vaccine refrigerators in more than 38 countries
- Currently tests and further development for food, beverages and domestic markets are conducted
- Experiences from the field are integrated into product development
- Designed for easy maintenance and repair
- Sure Chill medical refrigerators are available directly from The Sure Chill Company. Contact +44 (0) 1654 712 713 or at hello@surechill.com for further information

Links

http://www.surechill.com
http://www.godrejappliances.com

FS56 On-farm milk cooling system

University of Hohenheim,
Institute of Agriculture Engineering,
Tropical & Subtropical Group,
Garbenstr. 9, 70599 Stuttgart, Germany
Steca Elektronik GmbH,
Mammostraße 1, 87700 Memmingen, Germany
Phaesun GmbH,
Brühlweg 9. 87700 Memmingen, Germany

Product Description

Small-scale solar milk cooling system based on the use of DC-refrigerators and conventional milk cans. Additional features include:

- → Use of 2 refrigerators for ice production and milk cooling
- → Ice is used as cooling medium for fast milk cooling
- → Adapted 20L milk cans assure milk quality for over 24 h
- → The use of ice as energy storage reduces the need of batteries and increase system profitability

Target Group

Basic cooling applications (particularly dairy farmers)

Product Specification

Type of product	Dairy refrigerator
Cooling volume	Up to 45 l milk / day
Cooling temperatures	4°C
Nominal power	40-200 W
AC- or DC coupled	DC
Energy consumption	@20°C: 1000 Wh, @30°C: 1500 Wh, @40°C: 2000 Wh
Energy efficiency class	A++
Ambient temperature (Climate class)	T
Capacity of PV modules required	1000 Wp
Autonomous days/ stand by	3
Type of refrigerant	R134a
Battery	Gel, 300Ah
Size	917 x 872 x 709 mm (freezer) 1,288 x 919 x 760 mm (chiller)
Weight	47 kg(freezer), 62 kg(chiller)

Price “as of”

(individually to be confirmed with retailer/supplier)

Retail Price	3,500 €

Technology and Market Development

- Developed by Steca (domestic refrigerators) and the University of Hohenheim (additional components)
- Distributed by Phaesun (whole system)
- R&D Phase until 2017; In-field testing 2015 – 2017 in Tunisia

Links

https://www.uni-hohenheim.de/project/field-testing-of-an-innovative-solar-powered-milk-cooling-solution-for-the-higher-efficiency-of-the-dairy-subsector-in-tunisia

FS57 Small scale decentralized Milk Cooling

Simply Solar,
G.v.Werdenbergstr.6, D-89344 Aislingen,
info@simply-solar.de
Universität Kassel, Fachgebiet Agrartechnik,
Nordbachnhofstr.1a, D-37213 Witzenhausen,
agrartechnik@uni-kassel.de

Product Description

A standard cooling device – the solar freezer STECA PF240 – is converted into a milk chiller that can handle ~ 38 ltr of milk per day (19 litres in the morning, 19 litres in the evening). The milk is cooled down to 4°C in 2.4 hours and remains at this required temperature until it is transported, thereby ensuring a fast cool down as per dairy industry standards. This is a battery-less system that stores energy in the form of ice. The ice storage allows cooling 24 h and boosts the cooling power of the freezer so that the milk can be chilled in the targeted time. Excess energy can be converted to hot water and adds benefits for the users (e.g. for the hygiene of the milk vessels).

A control unit manages three crucial functions: it prevents the milk from freezing, it provides the high starting current for the compressor without the use of batteries, and it manages excess energy by using it to heat water. Hot water is produced and stored in an insulated tank. The milk containers and the ice cartridge are designed for easy cleaning. The ice packs do not come in contact with the milk directly, thus cleaning requirements are minimized. The design of the ice packs allows local reproduction with simple means, even by the end users themselves.

Target Group

Dairy farmers, milk collection centres, milk bars

Product Specification

Type of product	Dairy refrigerator
Cooling volume	2 x 19 l/d
Cooling Temperatures	4°C
Nominal power	40 W – 100 W
AC- or DC coupled	DC
Energy consumption (Wh/24 h) (@25°C, 30°C, 40°C)	125Wh, 185Wh,351Wh (Steca Datasheet for original freezer) keeping cool only, 1000Wh including 16kg ice formation
Energy efficiency class	A+++
Ambient temperature (Climate class)	T
Capacity of PV modules required	400 W (2 modules of 200W each)
Autonomous days/ stand by time	Keeping milk cool at 4°C: 4 days With cooling down milk from milking temperature: 1 day
Type of refrigerant	R134a
Battery	No battery (starting current is covered by capacitors)
Size	240 l Steca freezer: 1288 x 760 x 919 mm (LxWxH) PV module: 1580 x 800 x 35 mm each 6 l thermos vessel for hot water
Weight	70 kg plus 30kg PV-Panels

Price and costs

Investment (including solar panels)	3,850 € (for single device)

Technology and Market Development

→ Developed in the framework of the RELOAD project
→ Field tests in Kenya underway since 2015

Links

http://www.simply-solar.de/index.php/projects/batteryless-milk-cooling
http://reload-globe.net

Walk-in cold rooms

FS58 Walk-in cold room FarmFresh

Smallholder Foundation,
1 Umuagwko Umuoba Road, Off MCC Uratte Road,
P.O. Box 3508, Owerri, Imo State, Nigeria,
+23 48060292346, info@smallholdersfoundation.org

Product Description

- A solar-powered walk-in cold room using the "CoolBot" technology to cool fruits and vegetables for women small famers in rural communities. Additional features include: applicable for farms, at home, at the market or at social institutions (schools)
- Cooling unit: solar powered air conditioner (1 – 2 hp), controlled by Cool Bot
- Construction: 20 ft insulated Container equipped with shelves and crates for vegetables and fruits
- Social and environmental benefits: reduces fruits and vegetable losses and improves quality; increases household income; reduces daily labour
- 7.5 KWA Inverter

Target Group

Medium-scale cooling applications

Product Specification

Type of product	Cold room
AC- or DC coupled	DC, 12 V
Capacity of PV modules required	5 x 200 W solar panels, Solar Charge Controller, 7.5 kVA Inverter, 10 x 12 V Batteries,

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price	5,481,300 Nigerian Naira (NGN)	≈ 24,000 €

Technology and Market Development

CoolBot technology is applying for patent

Risks and barriers

Long cool down period

- Not applicable for regular door opening as system recovers slower
- Poor functionality below 2°C – no freezer

Links

http://storeitcold.com

FS59 Cooling Container ILK

ILK Dresden – Institute for Air Handling and Refrigeration,
Bertolt-Brecht-Allee 20,
1309 Dresden, Germany

Product Description

A stand-alone solar reefer (20 ft) with 23 m² cold storage room to cool e.g. medicine or food. The Solar Cooling Container is designed as a shelter with steel-made outer walls, and an inner double skin thermal insulation system with a low over-all heat transfer coefficient. Additional features include:

- Stand alone, optional grid interface
- Thermal energy storage for 3 days of autonomy, small battery
- Mobile by lorry, ship or helicopter
- Can be adapted for use as solar power supply and cooling of supplied devices as well
- Uncomplicated commissioning and operating, low level of maintenance
- Automatically operating system designed for high ambient temperatures up to 52°C and for rough operation conditions in full-year operation
- PV-inverter 230 V/50 Hz
- Type of charge controller: MPP

Target Group

Medium-scale cooling applications

Product Specification

Type of product	Cold room
Cooling volume	23 m²
Cooling Temperatures	0 to 10°C (adjustable, fan controlled)
Nominal power	5.1 kW
AC- or DC coupled	DC/AC
Ambient temperature (Climate class)	up to 52°C
Capacity of PV modules required	40 modules, 3.4 kWp
Autonomous days/ stand by time	3
Battery	Gel
Product life time	< 10 y
Size	20 ft
Weight	5 t

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

→ ILK is a research and development enterprise in Germany, developing innovative prototype solutions
→ Adapted technologies according to special requirements and conditions can be developed (including cooling for telecom towers, small fishing communities, mobile for disaster relief, etc)

Links

http://www.ilkdresden.de/en/service/research-and-development-rd/applied-materials-engineering/detail/solar-cooling-container

FS60 Cooling Container ILK Milk Collection Center

ILK Dresden –
Institute for Air Handling and Refrigeration,
Bertolt-Brecht-Allee 20, 1309 Dresden,
Germany

Product Description

System for cooling and storage of milk with a refrigeration capacity of 1000l targeting cooperatives. Additional features include:

- Stand alone, optional grid interface
- 20ft container with milk storage
- a large ice storage with 70 kWh
- PV-inverter 230 V/50 Hz
- type of charge controller: MPP

Target Group

Liquid cooling applications (specifically dairy farmers, milk collection and distribution centres)

Product Specification

Type of product	Liquid cooling
Cooling volume	1000 l
Cooling Temperatures	4°C
AC- or DC coupled	DC/AC
Ambient temperature (Climate class)	Up to 52°C
Capacity of PV modules required	40 modules, 3.4 kWp
Autonomous days/ stand by time	3
Battery	Gel
Product life time	< 10 y
Size	20 ft

Price “as of”

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

- ILK is a research and development enterprise in Germany, developing innovative prototype solutions
- Adapted technologies according to special requirements and conditions can be developed

Links

http://www.ilkdresden.de/en/service/consulting-expert-opinions/detail/solar-cooling
http://www.ilkdresden.de/fileadmin/user_upload/img_projekte/03_Angewandte_neue_Techologien/PV_allgemein/PV_cooling.pdf

FS61 Container ILK Solar Ice Maker

ILK Dresden –
Institute for Air Handling and Refrigeration,
Bertolt-Brecht-Allee 20, 1309 Dresden,
Germany

Product Description

Specially developed ice machine with high efficiency for fisheries or butcheries as stand-alone, or with optional grid interface. Additional features include:

- → Variable ice maker with small battery
- → PV-inverter 3 ph/230 V/50 Hz
- → 250 kg crushed ice per day
- → Water tank
- → UV water disinfection
- → Ice storage size for two daily outputs
- → type of charge controller: MPP

Target Group

Medium-scale ice-making applications (specifically for fisheries and livestock butcheries)

Product Specification

Type of product	Ice maker
Nominal power	5.9 kW (-10/ 45°C)
AC- or DC coupled	DC/AC
Ambient temperature (Climate class)	Up to 52°C
Capacity of PV modules required	e.g. 60 modules, 5.1 kWp
Autonomous days/ stand by time	1
Battery	Gel
Product life time	< 10 y
Size	20 ft

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

- → ILK is a research and development enterprise in Germany, developing innovative prototype solutions
- → Adapted technologies according to special requirements and conditions can be developed

Links

http://www.ilkdresden.de/en/service/consulting-expert-opinions/detail/solar-cooling
http://www.ilkdresden.de/fileadmin/user_upload/img_projekte/03_Angewandte_neue_Techologien/PV_allgemein/PV_cooling.pdf

FS62 Walk-in Cold Storage Room

ONergy,
Punam Energy Pvt. Ltd. 1A,
D. L. Khan Road Jaju Bhawan,
Kolkata – 700027, India

Product Description

A grid connected partially solar powered cold storage room for extending produce shelf life.

Target Group

Medium-scale cooling applications

Product Specification

Type of product	Cold room
Cooling volume	9 t
Cooling temperature	30 to 260°C
Nominal power	2 kW
AC- or DC coupled	AC
Ambient temperature (Climate class)	50 to 450°C
Capacity of PV modules required	3.4 kWp
Autonomous days/ stand by	2
Battery	Solar Tubular Lead Acid 4500 charging cycles
Product life time	10 y

Price “as of”

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

→ Hybrid Solar PCU with High Surge Capacity
→ Low Cost Solution compare to conventional system

Links

http://onergy.in

FS63 Large Scale Refrigeration – SunDanzer

SunDanzer,
11135 Dyer Suite C,
El Paso, Texas 79934 USA

Product Description

SunDanzer's large scale cooling solution is available as commercial reefers in 10', 20' or 40'-containers The SunDanzer is suitable for remote areas, off-grid and intermittent grid. The low energy consumption requires smaller PV system. The containers can be stand alone (all necessary hardware packaged with container) or sold in groups for added functionality.

Target Group

Large-scale cooling applications

Product Specification (DCR165)

Type of product	Cool room
Cooling volume household units	~ 23 m^2
Size	10, 20 or 40 ft

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

High technological standard, high energy efficiency.

Links

http:// www.sundanzer.com
http://www.sundanzer.com/product/midway-island

3.5

3.5 Food for Sale

Description

This section presents DC-appliances for food preparation in a catering business or a cottage industry selling food to the community.

Powered by a PV system these appliances can be used for in-house food preparation for sale on markets, food preparation for restaurants or bars and entertainment or celebration venues or special events (weddings, performances, or funerals). At various occasions the sale of meals, snacks, soups, and hot drinks can generate additional income.

Technology Status and Development over the past years

Many of these DC appliances originate from the recreational vehicle or trucker (long-haul transport) industry, aiming at providing as much comforts as possible for people on the road. As the market for these appliances is relatively small, many of the more established and well known manufacturers of household appliances have not yet developed an extensive range of DC appliances.

Nevertheless this area offers possibilities for adapted technologies that are highlighted in this catalogue. The locally developed butter maker is an excellent example for successful technological development. It enables especially women to generate additional income by preparing butter that can be sold on local markets.

Type of equipment presented in the catalogue

Only a small selection of DC coupled appliance for food preparation is included in this catalogue to serve as indication of the type of products available.

FS64 Butter maker

Product Description

The solar butter maker is an adapted technology which reduces time and workload traditionally carried out by women.

It enables women to produce butter and by-products like whey or curd for sale.

Target Group

Cottage industry

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price	39 €

Technology and Market Development

Project supported by GLS Bank "Zukunftsstiftung Entwicklung"

Links

http://www.entwicklungshilfe3.de/spenderinnen/projekte/weltweit/afghanistan/energiestationen

FS65 Solar DC Kettle SE520

Ningbo Jiming Electric Appliance Co., Ltd.,
No.546 Qiye Road, Zhouxiang Town, Cixi,
Zhejiang, China

Product Description

DC –powered plastic kettle with 0.8 litre capacity. Additional features include:

- → Stainless steel heating element
- → ON/OFF light indicator
- → Easy open cover button
- → Colour: variable colour printing options
- → With water level indicator
- → Automatic switch off
- → With locking safety lid

Target Group

Catering and Cottage industry

Product Specification)

Type of product	Kettle
Load	400 W
AC or DC coupled	DC, 12 / 24 V

Price “as of”

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Links

http://www.solardcappliance.com/solar-dc-kettle/solar-dc-kettle.html

FS66Biosun Water Purification Systems

Phaesun GmbH,
Brühlweg 9, 87700 Memmingen, Germany

Product Description

BIO-SUN ensures the microbiological safety of the drinking water and enables the elimination of waterborne diseases. The Water to be disinfected only has to be filled in the tank, where it is subjected to fine filtration and disinfected using ultraviolet light (UV-C). In a few seconds the water is safe to be consumed for vital needs. Please note, that the water used must not be heavily polluted by large quantities of sludge nor must it contain high levels of pesticide-type residues or high concentrations of other contaminants such as heavy metals and/or organic matter.

Target Group

Households, particularly in peri-urban areas (townships,etc.)

Product Specification

Type of product	Water Purification System
Load (W) UV lamp	14 W
AC or DC coupled	DC
Number of hours of production per day	4 hours
Flow	500 l/h
Operating range	3 days
Volume of the tank	20 l
Type of supply	Two versions available: • pressure network (1.5 bar) • manual supply or network <1 bar
Power and voltage of panel	85W/12 V
Battery	70 Ah (C100), 60 Ah (C20), 12V

Price “as of”

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

→ Phaesun maintains close and long-lasting relationships with local distributing partners in several African countries.
→ Experiences from the field used for product optimization and leading to tailor-made system solutions.
→ Local business partners are provided with service and maintenance structure as well as spare parts and technological optimization for the end user.

Links

http://www.phaesun.com

FS67 Solar Kettle Stainless Steel 12V SE510

Ningbo Jiming Electric Appliance Co., Ltd.,
No.546 Qiye Road, Zhouxiang Town, Cixi,
Zhejiang, China

Product Description

A DC-powered kettle with 1.2 litre capacity.
Additional features include:

- → Stainless steel heating element
- → ON/OFF light indicator
- → Easy open cover button
- → Colour: variable colour printing options
- → With water level indicator
- → Automatic switch off
- → Keep warm for more durable for a long time
- → With locking safety lid

Target Group

Catering and cottage industry, recreational industry

Product Specification

Type of product	Kettle
Load	350 W
AC or DC coupled	DC, 12 / 24 V

Price “as of”

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Links

http://www.solardcappliance.com/solar-dc-kettle/dc-solar-kettle.html

FS68 Solar DC Kettle SE500

Ningbo Jiming Electric Appliance Co., Ltd.,
No.546 Qiye Road, Zhouxiang Town, Cixi,
Zhejiang, China

Product Description

A DC-powered kettle with 1.2 litre capacity.
Additional features include:

- Stainless steel heating element
- ON/OFF light indicator
- Easy open cover button
- Colour: variable colour printing options
- With water level indicator
- Automatic switch off
- Keep warm for more durable for a long time
- With locking safety lid

Target Group

Catering and cottage industry, recreational industry

Product Specification)

Type of product	Kettle
Load	350 W
AC or DC coupled	DC, 12 / 24 V

Price “as of”

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Links

http://www.solardcappliance.com/solar-dc-kettle/dc-kettle.html

FS69 DC Microwave WaveBox

Power Hunt,
12655 SW Center St, Suite 275
Beaverton OR 97005, USA

Product Description

DC-powered microwave oven. Additional features include:

- Large inside dimensions (25.4 x 17.8 x 15.3 cm)
- Permanent mount or portable use
- New space age interior improves performance by more than 10 % and provides even heating without the need of a turntable

Target Group

Catering and cottage industry, recreational industry

Product Specification

Type of product	Microwave oven
Load	660 W
AC or DC coupled	DC, 12 V

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price	330 $	≈ 290 €

Technology and Market Development

- Main markets: North and South America, Australia and New Zealand
- Includes FREE CoolBag Storage for food storage
- Requires PNP power outlet (sold separately)

Links

http://www.power-hunt.com/12-volt-products.php

FS70 AC/DC Microwave WaveBox

Power Hunt,
12655 SW Center St, Suite 275
Beaverton OR 97005, USA

Product Description

DC-powered microwave oven. Additional features include:

- Large inside dimensions (25.4 x 17.8 x 15.3 cm)
- Permanent mount or portable use
- New space age interior improves performance by more than 10 % and provides even heating without the need for a turntable
- Included 120V AC power cord enables operation through any standard household power outlet

Target Group

Catering and cottage industry, recreational industry

Product Specification)

Type of product	Microwave
Load	660 W
AC or DC coupled	Optional DC, 12 V or AC, 110V

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

- Main markets: North and South America, Australia and New Zealand
- Includes FREE CoolBag Storage for food storage
- Requires PNP power outlet for DC operation(sold separately)

Links

http://www.power-hunt.com/12-volt-products.php

FS71 Kettle RoadPro 12-Volt 20oz Hot Pot

RoadPro,
724 Lawn Road, Palmyra,
PA 17078, USA

Product Description

DC-powered kettle with 600 ml capacity and standard plug for cigarette lighter socket. Additional features include:

- → See-through window for assessing water level
- → Outer lid can be used as a cup
- → Safety circuit protection
- → CE certified

Target Group

Catering and cottage industry, recreational industry

Product Specification

Type of product	Kettle
Load	85 Watts/ 7 Amps
AC or DC coupled	DC, 12 V

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price	17 $	≈ 15 €

Links

http://www.roadproonthego.com/products/portable-electronics/12-volt-products/sp/12volt-20oz-hot-pot

FS72 Coffee Maker RoadPro 12-Volt with 16oz. Metal Carafe

RoadPro,
724 Lawn Road, Palmyra,
PA 17078, USA

Product Description

DC-powered coffee percolator. Additional features include:

- Brews 450 grams of coffee in under 15 minutes
- Brews directly into the stainless steel travel mug
- Easy to clean reusable filter
- Illuminated On/Off switch
- Includes mounting bracket for installation into a vehicle
- Fused 15 Amp 12-Volt Plug
- Water level indicator
- Stop-Drip Interrupt and Auto Shut Off features
- 18 cm electric cord length
- 13 Amps/156 W current draw

Target Group

Catering and cottage industry, recreational industry

Product Specification

Type of product	Coffee machine
Load	156 W
AC or DC coupled	DC, 12 V

Price “as of”

(individually to be confirmed with retailer/supplier)

Retail Price	30 $	≈ 26 €

Links

http://www.roadproonthego.com/products/portable-electronics/12-volt-products/sp/12volt-coffee-maker-with-16oz-metal-carafe

3.6

3.6 Tailoring

Description

There are three main types of sewing machines used in the tailoring sector, depending on size and type of commercial tailoring units: Straight stich sewing machines, industrial sewing machines, and fashion stich sewing machines.

Straight stich sewing machines

In small commercial tailoring units the regular manual pedalled sewing machines is still commonly used. With manual pedalling only about 300 stitches per minute can be achieved (an industrial sewing machine stitches at 1000 stitches per minute). To increase productivity, pedal sewing machines are often equipped with an additional motor, mostly conventional AC motors. Although this modification increases the productivity of the tailor compared to simple pedalling, fulltime working hours rarely can be achieved due to restricted power supply.

Through a case study in India undertaken by SELCO, it was discovered, that a sewing machine equipped with a high efficient DC motor coupled with a PV system for constant electricity supply, allows the tailor to increase productivity and double his income[10]. Furthermore, the reliable electricity supply from the solar system allows for longer working hours, particularly when room lighting is added. Both factors, constant electricity and a motorized sewing machine, increased the productivity of the tailor.

Industrial sewing machines

Industrial sewing machines are used in industrial production spaces and are bigger in size and have a sturdier base than the traditional sewing machines. They achieve a speed of 1000 stiches per minute and have various needle variations to allow for stitching textiles of different texture.

Industrial sewing machines can also be equipped with energy efficient DC motors. Combined with solar power, the modification can lead to an increase in productivity through constant power supply.

Industrial sewing machines have a high starting current, which can be countered with a three-phase DC motor with VFD (variable frequency drive) controller.

To equip an industrial sewing centre with PV-powered sewing machines high investment costs apply, but the advantages become significant when compared to a diesel generator powering the machines.

Faison stich sewing machines

Faison stitch sewing machines usually are energy efficient multi-function machines with various stitching patterns and spacing options, which are very useful for fashionable stitching and design tailoring.

[10] SELCO, 2015

Technology Status and Development over the past years

The technological development of AC sewing machines has accelerated significantly. High energy efficient multifunction machines are produced by worldwide known manufacturers. At the same time, especially in rural areas, small-scale manufacturers use manual pedal sewing machines that sometimes are equipped with an additional motor.

Currently, only a few DC sewing machines are available on the market, primarily produced by SELCO in India. While quantities may still be small, these machines are undergoing field tests and are continuously improved.

Type of equipment presented in the catalogue

This catalogue presents sewing machines that can be connected to AC or DC power systems as well as a weaving loom.

Further information

To power a sewing machine with PV it is extremely important that the machine is energy efficient. As cost structure and profit margins in the textile business are very narrow, only a high efficient appliance allows for a cost efficient investment into a PV-system.

FS73 Sewing Machine CERAD

CERAD,
UET, Lahore, Pakistan

Product Description

A solar powered sewing machine by CERAD with the use of an efficient DC motor, saving up to 80 % of power. Suitable for operating on small solar systems.

Target Group

Basic tailoring and clothes production industry

Product Specification

Type of product	Sewing machine
Load	40 W
AC or DC coupled	DC
Voltage	24 V
Capacity of solar panel (kWp) required	70 – 100 W

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price	12,550 Rs	≈ 170 €

Technology and Market Development

Developed by Center for Energy Research and Development (CERAD), which aims to evolve efficient, innovative and cost effective solutions in Punjab province, Pakistan.

Links

http://cerad.uet.edu.pk/solutions/products_detail/3

FS74 Weaving Loom Solar-powered charkha, MIGRI

Mahatma Gandhi Institute for Rural Industrialization (MGIRI),
Maganwadi, Wardha,
Maharashtra – 442 001, India

Product Description

Application of solar energy in rural garment manufacturing. MIGRI has developed an 8 spindled solar-powered spinning wheel (charkha) with the aim of reducing the spinners' physical effort and increasing the quantity of cloth output. Additional features include:

→ Integration of DC motor increased the energy efficiency
→ Output of woven fabric can be doubled in comparison to a traditional handloom

Target Group

Basic tailoring and clothes production industry

Product Specification

Type of product	Spinning wheel
Load	30 – 40 W
AC or DC coupled	DC
Voltage	12 V

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

Textile entrepreneurs require a 24 spindled charkha, which still is to be prototyped by MIGRI.

Links

www.mgiri.org

FS75 Sewing Machine ONSewing

SwitchON/ONergy,
1A, D. L. Khan Road,
Kolkata – 70002, India

Product Description

Sewing Machine, which can variably be connected to AC or DC.

Target Group

Basic tailoring and clothes production industry

Product Specification

Type of product	Sewing machine
Load	30 W
AC or DC coupled	AC or DC
Voltage	12 V
Capacity of solar panel (kWp) required	75 Wp
Product life time	3 y

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Links

http://www.onergy.in

FS76 Sewing Machine retrofitted with DC motor – SELCO

Selco Solar Light Pvt.ltd.,
690, Ground Floor, 15th Cross, 2nd Phase,
J P Nagar, Bangalore – 560078, India

Product Description

A regular manual pedalled sewing machine equipped with a high efficient DC motor. Additional features include:

- About 25 % increase in energy efficiency
- Brushless DC motors (BLDC) and permanent magnet DC motors (PMDC)

Target Group

- Basic tailoring and clothes production industry
- Karnataka, India

Product Specification

Type of product	Sewing machine
Load	60 W
AC or Dc coupled	DC
Voltage	12 V
Motor rated speed	3000 rpm
Typical machine speed	1000 stitches per minute
Stitch types	Straight stitch only
Speed control	PWM pedal control
Working time	8 h/d
Capacity of solar panel (kWp) required	60 Wp
Battery capacity	Lead acid flooded, 40 Ah, 12 V

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price	18,000 Rs*	≈ 245 €

(*Price for sewing machine and solar power system, Selco Foundation)

Technology and Market Development

- SELCO maintains close cooperation with its partners and customers to provide tailor-made system solutions
- The provided technologies range from high efficient AC machines with multiple design aspects, retrofitted DC machines to complete solar powered sewing systems
- Cooperation with financing institutions
- Local service support through 30 service centres in South India
  – Introduction of key maintenance measures to customers
- One year free service and maintenance support for solar sewing machines

Links

http://www.selco-india.com/contact_us.html
https://www.youtube.com/watch?v=HGTO2Nm5lng

FS77 Industrial Sewing Machine – SELCO

Selco Solar Light Pvt.ltd.,
690, Ground Floor, 15th Cross, 2nd Phase,
J P Nagar, Bangalore – 560078, India

Product Description

Industrial sewing machines allow a variation of stitches at a high speed. They are mainly used in larger sewing centres or training centres. Industrial sewing machines can be equipped with a more efficient DC motor or with a complete PV system to power the whole setup. Additional features include:

- VFD (Variable frequency drive) controller with a 250 W 3 phase induction motor of 3 Phase (230 V, 50 Hz)
- High starting current suppressed by VFD
- Solar PCU with MPPT (800 VA, 24 V)

Target Group

- Basic tailoring and clothes production industry
- Karnataka, India

Product Specification

Type of product	Sewing machine (industrial)
Load	230 W
AC or DC coupled	AC induction motor (3 phase)
Voltage	230 V, 50 Hz single phase
Motor rated speed	1440 rpm
Typical machine speed	2500 stitches per minute
Stitch types	Straight stitch only
Speed control	VFD speed control
Working time	8 h/d
Capacity of solar panel (kWp) required	230 Wp
Battery	Lead acid flooded, 40 Ah, 12 V

Price “as of”

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

- → SELCO maintains close cooperation with its partners and customers to provide tailor-made system solutions
- → The provided technologies range from high efficient AC machines with multiple design aspects, retrofitted DC machines to complete solar powered sewing systems
- → Cooperation with financing institutions
- → Local service support through 30 service centres in South India
  – Introduction of key maintenance measures to customers
- → One year free service and maintenance support for solar sewing machines

Links

http://www.selco-india.com/contact_us.html
https://www.youtube.com/watch?v=HGTO2Nm5lng

FS78 Faison Stitch Sewing Machine – SELCO

Selco Solar Light Pvt.ltd.,
690, Ground Floor, 15th Cross, 2nd Phase,
J P Nagar, Bangalore – 560078, India

Product Description

Modern Faison stitch sewing machines are generally modern high efficient electric machines. They offer a variation of stitches, as embroidery design, zig-zag stitching, button hole, etc.

Target Group

→ Basic tailoring and clothes production industry
→ Karnataka, India

Product Specification

Type of product	Sewing machine
Load	100 W
AC or Dc coupled	AC
Voltage	230 V, 50 Hz single phase
Motor rated speed	N/A
Typical machine speed	1000 stitches per minute
Stitch types	Straight stitch, zig zag, embroidery
Speed control	N/A
Working time	8 h/d
Capacity of solar panel (kWp) required	150 Wp
Battery	Lead acid flooded, 40 Ah, 12 V

Price “as of”

(individually to be confirmed with retailer/supplier)

Price for sewing machine	6,000- 8,000 Rs	≈ 80 – 110 €
Price for PV-equipment	35,000 – 40,000Rs	≈ 470 – 540 €

Technology and Market Development

- → SELCO maintains close cooperation with its partners and customers to provide tailor-made system solutions
- → The provided technologies range from high efficient AC machines with multiple design aspects, retrofitted DC machines to complete solar powered sewing systems.
- → Cooperation with financing institutions
- → Local service support through 30 service centres in South India
  – Introduction of key maintenance measures to customers
- → One year free service and maintenance support for solar sewing machines

Links

http://www.selco-india.com/contact_us.html
https://www.youtube.com/watch?v=HGTO2Nm5lng

3.7

3.7 Workshop Tools

Description

"The future of power tools is cordless" is a conclusion by the magazine popularmechanics.com after testing 20V drills. In fact an extensive range of powerful cordless tools encompasses multi tools, combi hammer drills, saws, grinder, multi cutter, palm sander and many more are readily available today. Many are as powerful as their AC counterparts.

Technology Status and Development over the past years

Cordless power tools are broadly available on the market, not only for do-it-yourself home maintenance, but also for professionals. Prices vary and mostly increase according to quality and performance. When making a buying decision the user should focus on equipment with a battery of high quality and durability.

Type of equipment presented in the catalogue

This catalogue presents only some examples to serve as an idea of the variety of products. Besides examples for different cordless power tools, two complete sets comprising five to six different tools are also presented. These sets contain the essential tools for a mobile workshop: a drill/driver, a circular saw and a reciprocating saw, and others.

Further information

Some criteria are important, when opting for a cordless power tool:

The current:

- Cordless power tools are available with 12, 14.4, 18 or 20 V which has no effect on their working quality. These respective voltages should be considered if the tools are to be powered by a PV-system.

The battery:

- High quality battery with a low rate of self-discharge.
- Full charging is mostly achieved within one hour. A second battery allows for long working times.

Impact drills:

- The choice of appliance depends mainly on the material to be drilled. For wood an impact drill can be used, for metal and concrete a hammer drill would be the right choice.
- Two-mode drive allows users to switch between tightening screws and drilling. Some appliances have adjustable torque (which adjusts the start-up current). For wide drill diameters or hard materials the first gear is used for better drilling.

Rotary hammers:

- Mostly rotary hammers are equipped with industrial SDS plus chucks, requiring SDS drill bits.
- Some special drill chucks require fitting drill bits, what may result in an expensive and hard to find accessory.
- Some models have a hammer-only mode that allows chipping off hardened concrete or cracking through a rock.
- High torque drills have an intense reaction, if the driller tilts. A second handle and a stable footing avoid injuries.

FS79 Rotary Hammer – Bosch RHS181

Bosch,
Robert-Bosch-Platz 1,
70839 Gerlingen-Schillerhöhe,
Germany

Product Description

Light and well balanced one-handed tool featuring compact portability for drilling small diameter holes in overhead or tight spaces. Additional features include:

- Variable speed trigger enables speed regulation,
- Two-mode drive allows users to switch between drilling with hammer action and drilling only
- LED light illuminates dark work spaces
- Drills over 100 ¼" x 2" – ½" holes per battery charge

Target Group

Mobile workshop, carpentry, etc.

Product Specification

Type of product	Hand drill
AC or DC coupled	DC
Voltage	18 V
Battery	Optional
Li-Ion	3000 rpm
Weight	2 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

	Tool only	Tool including one battery
Retail Price	200 €	295 €

Technology and Market Development

Today Bosch has a worldwide production and retailer network.

- Best ranked rotary hammer in 2013
- Sometimes the battery is not included

Links

http://www.boschtools.com

FS80 Drill – CIMCO 2 Gear Accumulator Impact Drill

Cimco Werkzeugfabrik,
Hohenhagener Str. 1-5,
42855 Remscheid, Germany

Product Description

This impact drill comes with a second accumulator pack. Additional features include:

- → Two modes drive
- → QuiXS quick-action chuck 13mm diameter
- → Quick charger CSL 30LI: only 15 minutes charging time
- → Protection cap

Target Group

Mobile workshop, carpentry, etc.

Product Specification

Type of product	Hand drill
AC or DC coupled	DC
Voltage	14.4 V
Battery	Li-Ion
Weight	1.6 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

Today Bosch has a worldwide production and retailer network.

- → Best ranked rotary hammer in 2013
- → Sometimes the battery is not included

Links

http://pdf.cimco.de/Kapitel_2015/Handwerkzeuge/Bohrer,Lochsaegen,Diamantwerkzeuge.pdf

FS81 Rotary Hammer – Hilti TE 4-A18

Hilti Deutschland AG,
Hiltistraße 2,
86916 Kaufering
Germany

Product Description

- Easy handling through ergonomic design
- Drilling and hammer drill for concrete and stonework

Target Group

Mobile workshop, carpentry, etc.

Product Specification

Type of product	Hand drill
AC or DC coupled	DC
Voltage	21.6 V
Battery	Optional
Li-Ion	3000 rpm
Size	324 x 94 x 201 mm (LxWxH)
Weight	3.3 kg

Price “as of”

(individually to be confirmed with retailer/supplier)

	Tool only	Tool including one battery
Retail Price	320 €	680 €

Technology and Market Development

Battery is not always included

Links

https://www.hilti.de/akku-bohr--und-kombih%C3%A4mmer/akku-bohrh%C3%A4mmer/r4717

FS82 Chain Saw Makita 18V x2 LXT

Makita,
Germany

Product Description

The Makita 18 V x 2 is a cordless electric chain saw with two 18 V batteries in series. It is designed for brushing and slashing, cutting up trees and branches under 6 inches in diameter.

- → Lower noise level at only 89 dB for improved user comfort
- → 12” guide bar for increased capacity
- → “Tool-less” chain adjustments for convenient operation and maintenance
- → Front hand guard engineered to actuate chain brake when engaged
- → Compact and ergonomic design at only 24-5/8” long
- → Convenient top handle design with ergonomic grip is engineered for the user to more easily apply even pressure when cutting
- → 3-year limited warranty on tool, battery and charger

Target Group

Mobile workshop, carpentry, etc.

Product Specification

Type of product	Chainsaw
AC or DC coupled	DC
Voltage	36 V
Battery	Optional
LXT Li-Ion (2 x 18V in series)	3000 rpm
Weight	5 kg

Price “as of”

(individually to be confirmed with retailer/supplier)

	Tool only	Tool including one battery
Retail Price	360 €	650 €

Links

http://www.makitatools.com/en-us/Modules/Tools/ToolDetails.aspx?Name=HCU02ZX2

FS83 Oscillating multi tool- Bosch PS50

Bosch,
Robert-Bosch-Platz 1,
70839 Gerlingen-Schillerhöhe,
Germany

Product Description

Oscillating tools are multifunction tools. They cut, grind, sand, with low vibrations and easy handling. A wide range of accessories is available. Additional features include:

- → Oscillations per minute: 5,000 – 20,000
- → Soft start feature
- → Universal adapter plate, fitting for accessories of other manufacturers

Target Group

Mobile workshop, carpentry, etc.

Product Specification

Type of product	Rotary tool
AC or DC coupled	DC
Voltage	12 V
Battery	Optional
Li-Ion	3000 rpm
Weight	2.2 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

	Tool only	Tool including one battery
Retail Price	160 €	N/A

Technology and Market Development

Since 1886 Bosch is an expert in for high quality home appliances. Today Bosch has a worldwide production and retailer network.

Battery is not always included.

Links

http://www.boschmultix.com/ps50.html

FS84 Bosch 18V Lithium Ion 4-Tool Combo Kit (CLPK414-181)

Bosch,
Robert-Bosch-Platz 1,
70839 Gerlingen-Schillerhöhe,
Germany

Product Description

Four tools in one bag. This kit includes the 4.0 Ah battery pack option. Bosch's Combo kits are available at 12 or 18 V and vary between 2 and 8 tools. Additional features include:

- → Brute Tough Hammer Drill Driver
- → EC Brushless 1/4 In. and 1/2 In. Socket-Ready Impact Driver
- → 1-1/8" Reciprocating Saw
- → Flashlight

Target Group

Carpenter, mobile workshop, facility management, etc.

Product Specification

Type of product	Power tool set
AC or DC coupled	Lithium-Ion Battery 4.0 Ah Fat Pack Batteries
Weight	~ 1.5 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price	500 €

Technology and Market Development

Today Bosch has a worldwide production and retailer network.

Links

http://www.boschtools.com

FS85 DeWalt 18V Max Lithium Ion 6-Tool Kit (DCK691M3)

DEWALT Industrial Tool Co.,
701 E. Joppa Road, Baltimore,
MD 21286, USA

Product Description

DeWalt's 18V Max Lithium-Ion kit.
Features include:

- DCD785 Compact Hammer Drill (350 W)
- DCF885 Impact Driver
- DCS391 Circular Saw (460 W)
- DCG412 Grinder (405 W)
- DCS331 Jigsaw (400 W)
- DCL040 LED Pivot Light
- 3 x 4.0 Ah Slide Pack Batteries
- Multi-voltage charger
- 2 x DS300 Tough System Kit Box

Target Group

Carpenter, mobile workshop, facility management, etc.

Product Specification

Type of product	Power tool set
Load	350 – 460 W (depending on tool)
AC or DC coupled	Max. DC 18 V
Type of battery	XR Li-Ion
Weight	13.5 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price	1000 €

Technology and Market Development

- 3 Year Limited Warranty
- 1 Year Free Service Contract
- 90 Day Money Back Guarantee

Links

http://products.dewalt.co.uk/powertools/productdetails/catno/DCK691M3

3.8

3.8 Media and Entertainment

Description

This section encompasses information and communication technology that is energy efficient and can be powered by a PV-system. Products include computers, communication devices, office equipment, televisions and radio.

This equipment can support an existing enterprise through improved administrative structures, but also offers opportunity to create other business activities, such as a rural multimedia theatre, a sports bar showing soccer games, a computer and video gaming centre, a solar kiosk offering secretarial services like printing and copying, or a mobile printing and editing studio, printing high quality photographs or marketing pamphlets and brochures.

Technology Status and Development during the last years

The technological development of IT, multimedia and communication equipment has globally accelerated over the last years at a tremendous rate. The target group for these appliances has shifted from a very specialized group of professionals towards normal citizens situated all over the world in different settings. Indeed, some form of IT and entertainment equipment can be found in even the most remote locations.

Criteria like energy efficiency, mobility, robustness and user-friendliness are firmly established, in a bid to reach consumers in remote areas worldwide.

Energy efficiency labels like the Energy Star or the European Energy Label have set efficiency targets and quality criteria. Special market segments are developing and most of these appliances are highly compatible with the DC power market.

Types of equipment presented in this catalogue

Appliances presented in this catalogue are mainly characterized by their low energy consumption and their robust and dependable design.

- **IT**
- **Secretarial Services**
- **Cinema, Television, Radio**

Further information

Many electronic devices like laptops or mobile phones work inherently on DC and are connected to the grid through an AC-adapter.

They can easily be charged by a DC power source which provides the voltage required by the appliance.

Portable Printer: High functionality in miniature

The development of DC printers is advancing and different types of printers with special characteristics exist. This catalogue presents a small overview of the variety of printers available.

Compact printers offer almost a complete range of functionality: black and white or coloured print, scans and copies. Their main advantage to AC printers is their small size and light weight. Their mobility targets especially sales representatives, field staff and professions that require lots of travelling. The printer is usually equipped with a battery power option that allows for mobility and printing on-the-go without immediate concerns about a ready power source.

Some compact printers use special paper, which may not be available in local stores, which poses a supply barrier and may result in higher printing costs. To avoid this, a printer taking standard letter-size copy paper should be selected.

Most printers can be connected via USB cable. If wireless printing is included, it is important that the printer can be connected to a mobile service device.

Disadvantages of DC printers

DC printers generally have a smaller printing capacity than professional AC printers.

Different printers

Inkjet, laser and thermal printers have different functionalities and performances. The performance of each printer is briefly described below.

Thermal Printers

Thermal printers are robust, reliable in harsh climate and require only minimal maintenance. Since no ink is used to print there are no moving parts or consumable like cartridges and ribbons, which makes them insensitive to physical shocks. Thermal printers can be extremely small and portable, the lightest models weighs less than 500g and size only 25 x 5 x 5 cm. Prints are normally done in black and white only and printing quality is secondary[11] to the convenience of printing almost anywhere. Thermal printers use a special paper though, which is coated with chemicals to make the paper change colour when heated. This special paper may be more expensive than normal copy paper.

[11] TopTenReviews (2013)

Some small-scale photo printers also use a zero ink, special thermal technology and allow for the printing of photos of good quality. These photo printers are pocket sized and create small sized photo prints (maximum 3 x 4”). As special paper is required, costs per print are relatively high. DNP offers a high quality thermal-dye photo printer for professional photo booths for weddings or corporate events, with minimal printing costs but investment costs ranging at around €1,500. Due to the high investment or high printing costs, thermal-dye photo printers are not included in this catalogue.

Laser Printers

Laser printers use the basic concept of static electricity to print efficient and high quality black and white prints. This type of printer is the right choice if a robust and reliable appliance is needed and documents should be of good printing quality.

Inkjet Printers

In case coloured printing or even photo printing is required, a mobile inkjet printer should be selected. It achieves high quality coloured prints at relatively low costs. Some contain up to five different ink cartridges and therefore offer high resolution and colour detail photo prints.

An inkjet printer should have at least a print resolution of 1200 x 600 dots per inch (dpi). This gives clear, sharp-looking documents. Furthermore it should print at least eight black-and-white pages per minute. In case the printer is used by several people at once , print speed should be reconsidered.

As inkjet printers are bigger in size, some manufacturers offer special printer cases for transportation.

IT

FS86 PC Aleutia T1 Fanless Eco PC

Aleutia Computers Ltd,
1st Floor London Heliport,
Lombard Road, London

Product Description

A silent, fan less, solid state Mini PC with low power consumption and the reliability of 'no moving parts'. Intel® Bay Trail technology with 4GB RAM, a Quad Core 2.0 GHz Celeron™ processor, a powerful integrated graphics allows you to watch full HD content and with a high speed SSD (30GB to 1TB).

Target Group

Households, schools, secretarial service

Product Specification

Type of product	Personal computer
AC or DC coupled	DC
Voltage	8 – 20 V

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

- The T1 is designed for solar and runs on DC directly, taking any voltage from 8 – 20 V and does not require a regulator
- AC adapter included
- The T1 has both a VGA and HDMI port and can power two independent displays (2560 x 1440 resolution each)

Links

http://www.aleutia.com

FS87 PC Asus EEE Box EB1007P

ASUSTeK COMPUTER INC.,
15, Li-Te Rd., Taipei 112, Taiwann

Product Description

1L-sized energy efficient commercial PC with Windows 7 Professional installed. This PC is designed for moderately harsh environments.

Target Group

Small business, offices, rural health clinics.

Product Specification

Type of product	Personal computer
Load	16 W (27 W with monitor)
Weight	0.7 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

→ The PC can be connected to two independent displays at the same time
→ Worldwide distribution network
→ Not suited for processor-intensive applications (CAD/CAM, video editing, etc.)

Links

http://www.asus.com/de/EeeBox_PCs/EeeBox_PC_EB1033

FS88 Computer station ONergy Solar Computer

SwitchON/ONergy,
1A, D. L. Khan Road, Kolkata – 70002, India

Product Description

Solar powered lean computer station acting as server for 6 computer terminals each equipped with LED Monitor.

Target Group

Schools, rural computer training centres, offices, banks, internet café, etc.

Product Specification

Type of product	Computer server
Load	300 W
AC or DC coupled	AC
Voltage	12 V
Capacity of solar panel (kWp) required	500 Wp
Battery	Solar Tubular Lead Acid
Product life time	5 y +

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Links

www.onergy.in

FS89 Router – EdgeRouter POE

Ubiquiti Networks,
2580 Orchard Parkway,
San Jose, CA 95131, USA

Product Description

5-Port router with power over Ethernet. EdgeRouters combine carrier-class reliability with enterprise-level features in a compact and affordable unit.

Target Group

Office, schools, health clinics

Product Specification

Type of product	Network router
AC or DC coupled	DC
Voltage	24/ 48 V

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

Distribution via Simplifi Networks with offices in Nairobi, Kenya and Kampala, Uganda

Links

https://www.ubnt.com/products/#all/routing
www.simplifinetworks.com

Secretarial Services

FS90 Fan 50 fosera

fosera,
Beim Mühlbach 3,
89171 Illerkirchberg,
Germany

Product Description

The Fan 50 has a diameter of 42 cm, a very low energy consumption and a speed of 290 rpm.

Target Group

Domestic use, media entertainment for restaurants, bars, multimedia theatres

Product Specification

Type of product	Ventilator
Load	4 W
AC or DC coupled	DC, 12- 14 V
Voltage	13 V
Capacity of solar panel (kWp) required	0.01 kWp
Size	21 x 9.5 x 9 cm
Weight	0.41 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price	19.20 €

Technology and Market Development

→ Development and market entry: 2015
→ Spare parts are supplied by fosera and are available from retailers

Links

http://www.fosera.com/products/power-line/applications.html

FS91 Fan ONergy BOX FAN

SwitchON/ONergy,
1A, D. L. Khan Road,
Kolkata – 70002, India

Product Description

A 10" five-bladed DC FAN with 3 modes of speed control.

Target Group

Households

Product Specification

Type of product	Ventilator
Load	6 – 8 W
AC or DC coupled	DC
Capacity of solar panel (kWp) required	10 W, 12 V
Product life time	3 y
Size	10 inch diameter

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Links

www.onergy.in

FS92 Fan ONergy PEDESTAL FAN

SwitchON/ONergy,
1A, D. L. Khan Road,
Kolkata – 70002, India

Product Description

A 16" AC / DC FAN with three blades and 3 modes of speed control for high speed and high air delivery.

Target Group

Small rooms, individual work spaces

Product Specification

Type of product	Ventilator
Load	15 W
AC or DC coupled	AC and DC coupling possible
Voltage	12 V DC or 100 – 240 V AC
Capacity of solar panel (kWp) required	20 W, 12 V
Size	16 inch diameter
Weight	5.5 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Links

www.onergy.in

FS93 DC Table Fan Fast Breeze FT-30AD

Phaesun GmbH,
Brühlweg 9,
87700 Memmingen, Germany

Product Description

The table fan with an automatic swivelling drive including three speed levels allows due to an highly efficient electronically commuted motor for very low energy consumption and high fan efficiency.

Target Group

Offices, living rooms, production halls, travellers

Product Specification

Type of product	Ventilator
Load	2,7 W/5,3 W/10,4 W
AC or DC coupled	DC
Voltage	12 V DC (10...15)
Size	410 x 355 x 190 mm
Weight	2.1 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

- → Phaesun maintains close and long-lasting relationships with local distributing partners in several African countries.
- → Experiences from the field used for product optimization and leading to tailor-made system solutions.
- → Local business partners are provided with service and maintenance structure as well as spare parts and technological optimization for the end user.

Links

http://order.phaesun.com/index.php/dc-table-fan-fast-breeze-ft-30ad.html

FS94 Ceiling Fan Cool Breeze RC 12

Phaesun GmbH,
Brühlweg 9,
87700 Memmingen, Germany

Product Description

The DC ceiling fan has three metal blades with a white finish and six modes of speed control.

Target Group

Offices, living rooms, production halls, restaurants, hotels, hostels

Product Specification

Type of product	Ceiling Fan
Load	1,8/2.48/3.67/5.74/8.88/14.16 W
AC or DC coupled	DC
Voltage	12 V
Diameter	1,32 mm
Weight	7 kg
Speed	50/85/119/152/191/239 rpm

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

- → Phaesun maintains close and long-lasting relationships with local distributing partners in several African countries.
- → Experiences from the field used for product optimization and leading to tailor-made system solutions.
- → Local business partners are provided with service and maintenance structure as well as spare parts and technological optimization for the end user.

Links

http://order.phaesun.com/index.php/dc-ceiling-fan-cool-breeze-12.html

FS95 Solar Air Conditioner GenPro DC48VFT-12 DC

GenPro Energy Solutions,
13261 Timberline Plaza, Suite B,
Piedmont SD 57769, USA

Product Description

Designed as efficient cooling choice for 48 V DC (or -48 V DC) as part of a telecom or off-grid solar application. DC48 air conditioners can substantially reduce power supply/generation costs and battery requirements. An all-DC system means advantages of extreme high efficiency without the need for inverters.

Target Group

Households, offices, shops

Product Specification

Type of product	Air conditioner
Weight	4.65 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Links

http://www.genproenergy.com

FS96 Inkjet photo printer Canon Pixma iP110

Canon Deutschland GmbH,
Europark Fichtenhain A10,
47807 Krefeld, Germany

Product Description

The Canon PIXMA iP110 is an extra compact inkjet printer with wireless capabilities. It is one of the smallest compact printers, lightweight and easy to use. Everywhere you travel it creates top-quality photo prints with excellent colour resolution. Settings are controlled via phone app or the included software. (Apps: for Apple: AirPrint; for Android: Google Cloud Print app or the Canon PIXMA). Additional features include:

- Print, scan and copy function
- Uses standard copy paper in a variety of sizes (A4, B5, A5, ID card, photo, envelopes, etc.)
- Manual duplexing (no automatic)
- Supports USB, IrDA, optional Bluetooth®-Adapter BU-30
- SD card slot

Target Group

Offices, field staff, sales representatives, professionals on the go

Product Specification

Type of product	Multifunction printer
Load	10 W operational 1.8 – 2.2 W 0.2 W off
AC or DC coupled	100 – 240 V AC
Type of battery	Lithium-Ion
Printing speed	10 x 15 photo in 53 sec.
Print resolution	Colour: 9600 x 2400 dpi Black/white: 600 x 600 dpi
Paper feeder capacity	50 pages
Size	6.3 x 19 x 32 cm
Weight	2.0 kg

FS97 Inkjet photo printer Epson PictureMate Charm PM 225

Epson America, Inc.,
MS: 3-13, 3840 Kilroy Airport Way,
Long Beach, CA 90806-2469, USA

Product Description

The Epson PictureMate Charm PM 225 is a pure photo printer with its main feature in portability and quality. As a photo printer that looks more like a small cooler. Additional features include:

- Simple and straightforward in use
- Uses PictureMate photo paper
- Connections: USB connection between printer and PC, PictBridge and USB Direct Print-enabled digital cameras.
- Battery has to be purchased separately

Target Group

Offices, field staff, sales representatives, professionals on the go

Product Specification

Type of product	Printer
Load (W)	Operational mode: 11.5 W Sleep mode: 3.0 W
AC or DC coupled	120 V AC
Type of battery	Optional lithium-ion battery
Printing speed	4 x 6 photo: around 40 to 60 sec
Print resolution	5760 x 1440 dpi
Paper feeder capacity	20 sheets of photo paper
Size	17 x 23 x 14.5 cm
Weight	3.5 kg

Price “as of”

(individually to be confirmed with retailer/supplier)

	Printer only	Battery
Retail Price	145 €	~ 45

Technology and Market Development

- ENERGY STAR® qualified
- Epson customer service offers email and phone support user manual and FAQs section
- Standard one-year warranty

Links

http://printers.toptenreviews.com/photo-only/epson/epson-picturemate-charm-pm-225-review.html
http://www.mypicturemate.com

FS98 Inkjet photo printer HP Office jet Mobile 150

Hewlett-Packard GmbH,
Herrenberger Str. 140,
71034 Böblingen, Germany

Product Description

The HP Office jet 150 Mobile is a compact printer that prints at a high quality and has all-in-one functionality. It's small and light, and incorporates wireless print technology. Additional features include:

- Print, scan and copy function
- Inkjet technology printing in colour or black and white
- Uses standard copy paper
- Supports manual duplexing (no automatic)
- Navigation via small LCD touchscreen
- Battery is rated for 500 printed pages of use which gives ample time of usage without charging
- Supports USB, SD card slot, Bluetooth connectivity
- Does not have Wi-Fi, (Apple users can't send it print jobs from iPhones or iPads)

Target Group

Offices, field staff, sales representatives, business travellers

Product Specification

Type of product	Multifunction printer
Load	22 W (active) 3.2 W (sleep) 6.4 W (standby) 0.4 W (manual-Off)
AC or DC coupled	AC, 90 – 132 V
Type of battery	Lithium-ion battery
Printing speed	5 b/w pages per minute 3.5 coloured pages per minute
Print resolution	4800 x 1200 dots per inch
Paper feeder capacity	50 pages
Printing capacity	500 pages per month
Size	9 x 18 x 36 cm
Weight	2.9 kg (3.1 kg with battery)

Price “as of”

(individually to be confirmed with retailer/supplier)

Retail Price	440 €

Technology and Market Development

- For its exceptional functionality and smart design, the HP Office jet 150 Mobile is the Top Ten Reviews Gold Award winner
- HP does offer phone, email and social media support. It ships the Office jet Mobile 150 with a one-year warranty
- ENERGY STAR® qualified

Links

http://printers.toptenreviews.com/compact/hewlett-packard/hp-officejet-mobile-review.html

FS99 Laser printer: Sharp AL-1035

Sharp,
22-22 Nagaike-cho, Abeno-ku,
Osaka 545-8522, Japan

Product Description

Sharp's AL-1035 is a multi-function product (MFPs) for small bureaus and home offices. From scanning, integration in a network or saving scans on a USB stick, Sharp's home and small office solutions leave nothing to be desired. The portable AL-1035 provides its users with mobility and its extremely simple operation. Additional features include:

- → Black and white prints and copies, colour scans
- → Flexible use during customer meetings, at events or on business trips
- → Ideal for mobile use at different workplaces
- → Practical carrying handle and low weight make it easy to transport
- → Excels for occasional use on the store counter in small shops
- → Easy to be stored away nearly anywhere when it's not being used
- → ID card scanner allows scanning all cards in credit card format in colour from both sides and printing them out on a page in a single step
- → Two USB 2.0 ports and 'scan to USB' function make it possible to save scanned documents or images directly onto a connected USB stick

Target Group

Small shops, mobile workplaces, home offices

Product Specification

Type of product	Multifunction printer
Load	660 W
AC or DC coupled	AC 220 – 240 V
Type of battery	No battery
Printing speed	10 b/w pages per minute
Print resolution	600 dpi
Paper capacity	40
Printing feeder capacity	800 pages/month
Size	422 x 291 x 130 cm
Weight	7 kg

Price “as of”

(individually to be confirmed with retailer/supplier)

Retail Price	270 €

Technology and Market Development

- → The toner saving mode lowers toner density during the copying process, thus saving money by reducing toner consumption
- → Automatic power cut-off and preheating mode in order to reduce energy consumption
- → The Sharp AL models have been awarded the ‘Energy Star’ environmental label
- → 24 month warranty

Links

http://printers.toptenreviews.com/compact

FS100 Thermal printer Brother PocketJet6

Brother International Corporation,
100 Somerset Corporate Boulvard,
Bridgewater, NJ 08807-0911, USA

Product Description

The PocketJet 6 series is a black, bar-shaped printer with a USB port and little else. It has a rechargeable battery that gives you 70 pages per charge. Additional features include:

- Prints: black and white prints at a resolution of 203 x 200 dots per inch, which is sufficient for professional-looking black-and-white documents
- Connections: USB , IrDA and Bluetooth (PJ662)
- Paper has to be introduced manually
- Easy to handle

Target Group

Professional vehicles, sales representatives, service engineers, mobile offices, travelling professionals

Product Specification

Type of product	Printer
AC or DC coupled	AC-adapter is optional
Type of battery	Ni-MH 14.4 V or Li-Ion 11.1V
Printing speed	6 pages per minute
Print resolution	300 dpi
Paper feeder capacity	manual paper feeding only
Size	25.5 x 3 5.5 cm
Weight	473 g

Price “as of”

(individually to be confirmed with retailer/supplier)

Retail Price	500 €

Technology and Market Development

- Special paper is needed (costs per print around 0.14 €)
- 3 years warranty

Links

http://printers.toptenreviews.com/compact
http://www.testberichte.de/p/brother-tests/pj-622-testbericht.html

FS101 Thermal printer: Possio Greta

Possio AB,
P.O. Box 1236,
SE-164 28 Kista, Sweden

Product Description

GRETA is designed to turn any computer into a small mobile office. Printing is available by simply connecting GRETA via an USB cable to the computer and supports other typical all-in-one functions scanning, faxing and copying. GRETA is includes a phone. Additional features include:

- Printer, Fax, Scanner, SMS-printer and Copier
- USB Connection
- Telephone, via SIM card reader
- Cellular interface: Quad band Cinterion, MC55i and/ or Triple band Siemens, MC56 (for US market)
- Comes with mounting kit and carrying case
- Adjustable print and scan density

Target Group

Professional vehicles, sales representatives, service engineers, mobile offices, travelling professionals

Product Specification

Type of product	Multifunction printer
AC or DC coupled	DC 12/24 V AC/DC adapter is included
Type of battery	Internal NIMH-battery (1300mA)
Paper feeder capacity	15 meter / 50 ft. roll (Appr. 50 A4 pages)
Size	29 x 15 x 5 cm
Weight	1,087 g
Size	25.5 x 3 5.5 cm
Weight	473 g

Price “as of”

(individually to be confirmed with retailer/supplier)

Retail Price	600 €

Technology and Market Development

User Manual available

Links

http://printers.toptenreviews.com/compact

Cinema, Television and Radio

FS102 TV Alphatronics

Alphatronics GmbH,
Breitengraserstraße,
90482 Nürnberg

Product Description

Low energy consumption television with Integrated media features (DVD, Bluetooth, USB, DVB-T) and several sizes available

Target Group

Households, multimedia theatre, bars, etc.

Product Specification

Type of product	TV
Load	Starting with 10 W
AC or DC coupled	DC
Voltage	12 V
Screen diagonal	15 – 24", Widescreen
Size	15 inch screen diagonal

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

Reliable, state of the art multimedia technology

Links

http://www.alphatronics.de

FS103 TV fosera DC 15.6" 12 V

fosera,
Beim Mühlbach 3,
89171 Illerkirchberg,
Germany

Product Description

The fosera DC television for high quality home entertainment consumes only 5.5 W and offers a number of inputs for modern entertainment. With high energy-efficiency it is designed to work with the fosera POWER LINE LSHS and all other 12V solar systems.
Ports:

- HDMI 1.3
- USB 2.0
- SCART
- AV interfaces

Target Group

Media entertainment for restaurants, bars, multimedia theatres

Product Specification

Type of product	TV
Load	5.5 W
AC or DC coupled	DC, 13 V
Voltage	13V
Capacity of solar panel (kWp) required	0.02 Wp
Size	15.6"
Weight	2.2 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price	135 €

Technology and Market Development

- Winner of the Global Leap Award 2014, emerging technology – small TV
- Spare parts are supplied by fosera and are available from retailers

Links

http://www.fosera.com/products/power-line/tv.html

FS104 Satellite Receiver fosera DVB-S2

fosera,
Beim Mühlbach 3,
89171 Illerkirchberg,
Germany

Product Description

The Satellite Receiver DVB-S2 needs to be connected to a Satellite in order to successfully operate.

Target Group

Media entertainment for restaurants, bars, multimedia theatres

Product Specification

Type of product	TV receiver
Load	8.8 W
AC or DC coupled	DC, 13 V
Voltage	13 V
Capacity of solar panel (kWp) required	0.02 kWp
Size	20.5 x 6 x 21.5 cm
Weight	0.9 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price	45 €

Technology and Market Development

- Before purchase it is required to know how program signals can be received in the residential area, whether by antenna or satellite
- Spare parts are supplied by fosera and are available from retailers

Links

http://www.fosera.com/products/power-line/tv.html

FS105 Terrestrial Receiver fosera DVB-T2

fosera,
Beim Mühlbach 3,
89171 Illerkirchberg,
Germany

Product Description

The Terrestrial Receiver enables to enjoy programs received by antenna, which means that no satellite is necessary to successfully receive program signals.

Target Group

Media entertainment for restaurants, bars, multimedia theatres

Product Specification

Type of product	TV receiver
Load	3.1 W
AC or DC coupled	DC, 13 V
Voltage	13 V
Capacity of solar panel (kWp) required	0.02 kWp
Size	18.5 x 17.5 x 5.5 cm
Weight	0.7 kg

Price “as of”

(individually to be confirmed with retailer/supplier)

Retail Price	35 €

Technology and Market Development

Spare parts are supplied by fosera and are available from retailers

Links

http://www.fosera.com/products/power-line/tv.html

FS106 Radio fosera

fosera,
Beim Mühlbach 3,
89171 Illerkirchberg,
Germany

Product Description

The fosera radio includes, additional to FM, AM, SW, MW receiver also an AUX-IN-Outlet that allows connection to any cell phones or mp3 players to play own music. The radio can be powered with the fosera PSHS, LSHS, all fosera lanterns or over USB.

Target Group

Media entertainment for restaurants, bars, multimedia theatres

Product Specification

Type of product	Radio
Load	20 – 100 mA (depending on sound volume)
AC or DC coupled	DC, 12- 14 V
Voltage	3.25 V & 13 V
Capacity of solar panel (kWp) required	0.01 kWp
Size	19.5 x 14.2 x 9 cm
Weight	0.52 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price	10 €

Technology and Market Development

→ To use the radio with the LSHS, a USB to 2.1 mm DC jack cable is required
→ Spare parts are supplied by fosera and are available from retailers

Links

http://www.fosera.com/products/blue-line/applications.html

FS107 LED TV Niwa 15,6”

Niwa,
15/F, Neich Tower, 128 Gloucester Road,
Wan Chai, Hong Kong

Product Description

The Niwa 15.6” TV consist of integrated digital and analogue tuner combined with DVB-T, DVB-T2, HDMI, HDTV MPEG4, PC VGA and Video-In allows a very universal use for entertainment, education and presentation.

Target Group

Households, schools, restaurants, bars

Product Specification

Type of product	TV
Load	8 W
AC or DC coupled	DC, 12 V
Voltage	12 V
Size	375 x 130 x 288 mm
Weight	1.5 kg

Price “as of”

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Links

http://niwasolar.com/Modular-Solar-Systems-MSS
http://order.phaesun.com/index.php/solar-eled-tv-niwa-15-6.html?___store=german&___from_store=default

FS108 COLOR TV ONergy

SwitchON/ONergy,
1A, D. L. Khan Road,
Kolkata – 70002, India

Product Description

ONergy's coloured LED TV is available in two sizes: TV 16 has a screen diameter of 15.6 inches and consumes 40 W, whereas the TV 22 has a 21.5 inches screen diameter and consumes 75 W.

Target Group

Households, bars, kiosk, etc.

Product Specification TV 16

Type of product	TV
Load	20 W
AC or DC coupled	Optional AC and DC coupled
Voltage	12 V
Capacity of solar panel (kWp) required	40 W, 12 V
Battery	Solar Tubular Lead Acid
Size	16"

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Links

www.onergy.in

FS109 TV-Kit BOSS Kit Pro Fit

Phaesun,
Brühlweg 9, 87700 Memmingen, Germany

Product Description

A complete TV-Audio kit for off-grid entertainment. It can be used for video shows, live broadcast of sports events or karaoke shows in restaurants and bars. Additional features include:

- A DC television of Alphatronics R-24eWDSB
- 24" LED screen
- full HD
- DVD player
- USB connection
- independent Bluetooth sound system and
- DVB-T Antenna

Target Group

Households

Product Specification

Type of product	TV kit
Load	20 – 24 W
AC or DC coupled	DC
Voltage	12 V
Capacity of solar panel (kWp) required	85 W, 12 V
Battery	65 Ah
Working hours per day	6 h/d

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

- Phaesun maintains close and long-lasting relationships with local distributing partners in several African countries
- Experiences from the field used for product optimization and leading to tailor-made system solutions
- Local business partners are provided with service and maintenance structure as well as spare parts and technological optimization for the end user.

Links

http://order.phaesun.com/index.php/kits-40892/bosskits-40949/phaesunbosskitsprofit-41296.html

FS110 BOSS Kit Pro Jector

Phaesun GmbH,
Brühlweg 9,
87700 Memmingen, Germany

Product Description

This portable plug and play solar projector system allows for the presentation of movies, sports matches, educational videos, Power-Point presentations etc. to a big audience. The kit includes a LED projector, a foldable robust solar module, an AGM battery and electronics and cabling. Due to the low energy consumption of the LED projector, the presentation time with a fully charged battery exceeds 3 hours. The projector has an integrated file viewer, which enables to show videos etc. directly from a USB memory stick. Alternatively a laptop can be connected. The battery serves the projector via a DC/DC converter. The system can be extended by a sound system.

Target Group

Bars, restaurants, open-air cinemas, schools and training center

Product Specification TV 16

Type of product	Projector, 1000 lm
Load	80 W
AC or DC coupled	DC
Voltage	19 V
Capacity of solar panel (kWp) required	105 W, 12 V
Battery	35 Ah, 12 V
Inverter	DC/DC, 90 W, in 12 V, out 19 V
Weight	22 kg

Price “as of”

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

- → Phaesun maintains close and long-lasting relationships with local distributing partners in several African countries.
- → Experiences from the field used for product optimization and leading to tailor-made system solutions.
- → Local business partners are provided with service and maintenance structure as well as spare parts and technological optimization for the end user.

Links

http://order.phaesun.com/index.php/phaesun-boss-kit-pro-jector.html

3.9

3.9 Energy services – Charging, Metering and Measuring

Description

In the context of this catalogue energy services refer mainly to charging of batteries, lamps, mobile phones and other electronic devices. The use of electronic devices is extraordinarily wide spread, regardless of access to an electricity grid. Therefore charging of such devices is a frequently requested service in remote, off-grid areas and is often offered by small businesses. Charging services can either be provided in shops or as a mobile solution.

In remote off-grid areas villagers use rechargeable batteries to power lights, radio and other services. Usually they have to carry these batteries a fair distance to the nearest grid access point for recharging. At a weight of almost 18kg for an average car battery, this can be a strenuous task. Charging stations at central points in rural areas have the potential to considerably reducing time, effort and indirect expenses (transport, loss of income while away) for recharging batteries and this is an attractive market for convenient and clean (e.g. PV powered) battery-charging systems.

Furthermore, central battery charging stations have lower initial investment costs for households compared to individual PV solutions. A charging station can be further developed into an energy shop, providing energy services and additional other services such as selling basic commodities, snacks, offering secretarial services like printing, copying or provide entertainment like watching soccer games on TV.

Technology Status and Development over the past years

The technological advancement in charging systems as well as metering and measuring devices has been significant over the last years. It is driven by improvements made in storage technologies and by expert solar companies that have specialized in the provision of energy services in remote areas. Therefore the companies often do not only offer products but also a service and maintenance structure.

In addition the accelerated deployment of PV systems is driven by falling prices for PV modules and storage systems.

Type of equipment presented in the catalogue

In this section the catalogue present a selection of small stationary charging stations. In addition DC/DC converters are included, as they allow electricity supply at required current level, and DC metering and measuring equipment.

Further information

Apart from clear benefits, charging stations still face some challenges, as listed below:

- → Relatively high running and maintenance costs e.g. for blown fuses, chargers, inverters and batteries → only high quality equipment should be purchased and the operator should be trained in handling it appropriately
- → On cloudy days the system may not provide enough energy to respond to the demand → Therefore, appropriate sizing of the system components is required (size of battery, number of power outlets and DC ports)
- → Environmentally friendly disposal of used batteries is highly important

FS111 Charging ECOBOXX Qube 50/ 90/ 160

EcoBoxx/ Sungrid Group (PTY) LTD South Africa,
Unit D06B Collingwood Building, Black River Park Observatory, Cape Town 7925, PO Box 3231, Somerset West 7129, Republic of South Africa

Product Description

A solar powered package capable of providing up to 50 hours of power. It can be used for lighting, cell phone charging and the charging of other small electrical appliances (such as fans, radios and small TVs). Additional features include:

- Different sizes for different needs (50, 90, 160)
- 2 x 3 W super bright LED lights with independent switches
- 75 W modified sine wave inverter

Target Group

Rural offices, Village community

Product Specification

Type of product	Charging station
AC or DC coupled	DC, optional with AC converter
Capacity of battery @C10	4 – 14 Ah
Type of battery	Lead Crystal
Capacity of solar panel (kWp) required	5 – 20 Wp
Days of autonomy	1 – 4 days
Possible loads (appliances)	LED lights, mobile phones, DC fans, tablet
Maximum number of loads that can be charged at a time	1 – 2 USB ports
Size	170 x 75 x 65 cm
Weight	95 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price	1500 – 3000 ZAR	≈ 100 – 200 €

Technology and Market Development

- Made in South Africa
- Retailer in South Africa, Lesotho, Swaziland
- Distributed via energcare

Links

http://www.ecoboxx.co.za/pages/products.php?prod_id=1
http://energcare.co.za

FS112 Charging Ready Set Solar Charger

Fenix,
30 Cleveland Street, San Francisco,
CA 94103, USA
Plot 12 Makindu Lane,
Kampala, Uganda

Product Description

Ready Set is a smart battery system engineered to thrive in harsh conditions. Its microcontroller works in concert with patented firmware to protect itself from high-temperature, overloads, and short circuits. Intelligent electronics prevent deep discharge and preserve battery life. Ready Set includes a solar panel and is expandable up to 75 watts as your needs grow.

Target Group

Rural Areas

Product Specification

Type of product	Charging station
AC or DC coupled	DC: 16 – 19 V
Capacity of battery @C10	9 Ah
Type of battery	Valve-Regulated Lead-Acid
Capacity of solar panel (kWp) required	5 – 75 W
Possible loads (appliances)	lights, mobile phones, tablets, LCD TVs
Maximum number of loads that can be charged at a time	Up to 4 devices with a 15 W solar panel

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

- Smart, rugged and user-friendly design that makes it easy for anyone to use and maintain
- Due the characteristics of the battery, the charge rate is limited to a max charge power of 30W regardless of available solar power. If energy is being drawn from the power ports while charging, the Ready Set can convert up to an additional 30W of solar energy and provide it directly to the outputs (bypassing the battery) for a total of 60W of solar energy conversion
- CLA and USB output
- Rental schemes available for Uganda and Tanzania
- 6 month limited warranty

Links

http://www.fenixintl.com/products

FS113 Charging Boss Kit Pro Fee

Phaesun GmbH,
Brühlweg 9,
87700 Memmingen,
Germany

Product Description

The Pro Fee Phone Charging Station enables shop owners to recharge mobile phones for a fee in areas without grid power. Additional features include:

- Cell phones are charged via USB
- Optionally an inverter can be integrated to supply an AC plug. This can even be extended with a multi plug socket to charge older phones via AC plug
- PV-modules recharge a conventional system-battery to make business independent from weather or daytime
- Plugs, electronics and battery are integrated into one enclosure
- The system is mobile

Target Group

Mobile phone charging stations, kiosk, small shop

Product Specification

Type of product	Charging station
AC or DC coupled	DC, 5 V
Type of battery	Integrated
Capacity of solar panel (kWp) required	55 W (85 W for AC plug)
Possible loads (appliances)	Mobile phones
Maximum number of loads that can be charged at a time	18

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

- Phaesun maintains close and long-lasting relationships with local distributing partners in several African countries
- Experiences from the field used for product optimization and leading to tailor-made system solutions
- Local business partners are provided with service and maintenance structure as well as spare parts and technological optimization for the end user

Links

http://order.phaesun.com/index.php/boss-kit-pro-fee-basic.html

FS114 Charging Sundaya Charging station

Sundaya,
Indonesia, Sweden, China
Sundaya Nordic, Flöjelbergsgatan 12,
431 37 Mölndal, Sweden

Product Description

The Sundaya Ulitium and T-lite lamps are high efficient LED-lamps with integrated Li-Ion batteries. They can light entire rooms and are completely independent lighting solutions for off-grid households. The Sundaya Charging Station can charge 30 – 120 Ulitium or T-lite lamps at the same time.

Target Group

Households, small enterprises, schools, workshops

Product Specification Ulitium

Type of product	Rechargeable lantern
Output of Lantern	LED
Light output	Adjustable 25, 120 or 240 lumen
AC or DC coupled	DC, 12 V
Capacity of battery @C10	4500 mAh
Type of battery	Integrated lithium cobalt battery

Product Specification T-lite

Type of product	Rechargeable lantern
Output of Lantern	LED
Light output	Adjustable 18 – 180 lumen
AC or DC coupled	DC, 12 V
Type of battery	Integrated lithium cobalt battery
Capacity of solar panel (kWp)	100 – 120 Wp
Working time	60h light
Possible loads (appliances)	T-Lite or Ulitium Lamps
Maximum number of loads that can be charged at a time	Plug-in for 30 – 120 T-lite or Ulitium Lamps

Price “as of”

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

Broadly distributed by Phaesun and Sundaya

Links

http://sundaya.com

FS115 Charging Kit Azad Power Pack

SwitchON/ONergy,
1A, D. L. Khan Road, Kolkata – 70002, India

Product Description

A plug and play – mini solar home electrification system with LED tube and charging capability for mobile phones

→ Azad Powerbox:
1.5 W LED bulb and mobile phone
→ Azad Powerpack:
2 x 3 W LED tube and mobile phones

Powerbox and Powerpack are consisting of solar panels, Micro Controller Based, PWM Charge Controllers, LED tube and charger.

Target Group

Urban and rural households, farmers, cooperatives, etc.

Product Specification

Type of product	Solar home system
Capacity of solar panel	5 W, 6 V (Powerbox) 10W, 12 V (Powerpack) 18 W
Electricity supply	4 h of light
Possible loads (appliances)	1 – 2 lamps + mobile phones
Capacity of battery @C10	4.5 – 7.2 Ah
Battery type	Gel
Autonomy days	2

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

→ Partnership with individuals, NGOs, farmers' clubs, cooperatives, who are trained by ONergy
→ ONergy supports business generation
→ Cooperation with MFIs is under development

Links

http://onergy.in/product.php

FS116 Solar Home System Griha On Shakti (75/100W)

SwitchON/ONergy,
1A, D. L. Khan Road,
Kolkata – 70002, India

Product Description

A 75 W/ 100 W home solar power system that can supply DC appliances like fans and TV and can be used for mobile charging. The system consists of solar panels, inverter, Micro Controller Based, PWM Charge Controllers. Furthermore it contains a number of LED bulbs and CFL lights.

Target Group

Urban and rural households

Product Specification

Type of product	Solar home system
Voltage of system	12 V
Capacity of solar panel	20 – 200 W
Electricity supply	4 h light
Possible loads (appliances)	N/A
Maximum number of loads that can be charged at a time	Varies with system capacity
Capacity of battery @C10	20 – 200
Battery type	Lead Acid
Autonomous days	3
Product life span	Battery: 8 y Solar Panels: 25 y

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

→ The system is robust and weather resistant
→ ONergy gives a 5 years warranty

Links

http://onergy.in/product.php

FS117 Inverter System Griha ON Shakti (200/400W)

SwitchON/ONergy,
1A, D. L. Khan Road,
Kolkata – 70002, India

Product Description

Solar Smart Charger 20/ 40A , with hybrid charging feature with priority being given to solar. This can be used to retrofit existing home inverters and is suitable for AC appliances and can be either grid connected and used as an off-grid system.

Target Group

Urban and rural households or offices

Product Specification

Type of product	Charging station
Capacity of solar panel	200 – 1000 W
Possible loads (appliances)	AC appliances (TV, Fans, etc.)
Maximum number of loads that can be charged at a time	Varies with system capacity
Battery type	Lead Acid
Product life span	Battery: 8 y Panels: 25 y

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

ONergy gives 1 year warranty

Links

http://onergy.in/product.php

FS118 Solar Charging Station ONergy

SwitchON/ONergy,
1A, D. L. Khan Road,
Kolkata – 70002, India

Product Description

A Lantern Charging Station for different types of solar lanterns and mobile phones

Target Group

Small enterprises, offices or urban and rural households

Product Specification

Type of product	Charging station
Voltage of system	48 V
Capacity of solar panel	2000 Wp
Possible loads (appliances)	Small Lights/ Lanterns/ mobile phones
Maximum number of loads that can be charged at a time	1500 W
Capacity of battery @C10	300 Ah
Battery type	Solar Tubular Lead Acid
Product life span	8 y

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Links

http://onergy.in/product.php

FS119 Portable charging station ECOBOXX 300

EcoBoxx/ Sungrid Group (PTY) LTD South Africa,
Unit D06B Collingwood Building, Black River Park Observatory, Cape Town 7925, PO Box 3231, Somerset West 7129, Republic of South Africa

Product Description

Portable solar charging equipment, ideal for heavier multiple charging, light and medium plus AC-power. Additional features include:

→ LED indicator for battery level.
→ Includes 1 x AC/DC wall charger for grid charging

Target Group

Small mobile charging business

Product Specification

Type of product	Charging station
AC or DC coupled	5 – 12 V DC/ 300W AC
Capacity of battery @C10	24 Ah
Type of battery	AGM
Capacity of solar panel (kWp) required	30 Wp (3 x 10 W foldable solar panel)
Possible loads (appliances)	Mobile phones, tablet, USB-fan, AC-fan, TV p to 130 W, router, radio, camping fridge,
Maximum number of loads that can be charged at a time	4 DC outlets, 2 AC outlets

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price	9,000 ZAR	≈ 600 €

Technology and Market Development

→ Made in South Africa
→ Retailers in South Africa, Namibia, Lesotho, Swaziland

Links

http://www.ecoboxx.co.za/pages/products.php?prod_id=7

FS120 Portable charging station ECOBOXX 600

EcoBoxx/ Sungrid Group (PTY) LTD South Africa,
Unit D06B Collingwood Building, Black River Park Observatory, Cape Town 7925, PO Box 3231, Somerset West 7129, Republic of South Africa

Product Description

The ultimate all-in-one power machine.
High charging and greater AC power capacity. Additional features include:

- → LED indicator for battery level
- → Travel trolley included
- → Includes 1 x AC/DC wall charger for grid charging

Target Group

Small mobile charging business

Product Specification

Type of product	Charging station
AC or DC coupled	5 – 12 V DC/ 600W AC
Capacity of battery @C10	42 Ah
Type of battery	AGM
Capacity of solar panel (kWp) required	40 Wp (4 x 10 W foldable solar panel)
Possible loads (appliances)	LED lights, mobile phones, tablet, USB-fan, AC-fan, TV p to 130 W, router, radio, camping fridge, 600 W tools, 800 W microwave
Maximum number of loads that can be charged at a time	4 DC outlets, 2 AC outlets

Price “as of”

(individually to be confirmed with retailer/supplier)

Retail Price	20,000 ZAR	≈ 850 €

Technology and Market Development

- → Made in South Africa
- → Retailers in South Africa, Namibia, Lesotho, Swaziland

Links

http://www.ecoboxx.co.za/pages/products.php?prod_id=7

FS121 Portable Charging Station ECOBOXX 1500

EcoBoxx/ Sungrid Group (PTY) LTD South Africa,
Unit D06B Collingwood Building, Black River Park Observatory, Cape Town 7925, PO Box 3231, Somerset West 7129, Republic of South Africa

Product Description

The ultimate all-in-one power machine.
High charging and greater AC power capacity.
Additional features include:

- → stand and carry bag
- → 1m cable from the junction box with MC4 connector
- → 4m Solar panel cable for multiple connections
- → 5 Amp / 16 V DC AC/DC adapter
- → Big LCD display to monitor and control the parameters

Target Group

Small mobile charging business

Product Specification

Type of product	Charging station
AC or DC coupled	5 – 12 V DC/ 1500W AC
Capacity of battery @C10	100 Ah
Type of battery	EcoTank
Capacity of solar panel (kWp) required	130 Wp (2 x 65 W foldable solar panel)
Days of autonomy	N/A
Possible loads (appliances)	LED lights, mobile phones, tablet, USB-fan, AC-fan, TV p to 130 W, router, radio, camping fridge, 600 W tools, 800 W microwave
Maximum number of loads that can be charged at a time	3 x 5 V DC USB charging ports 2 x 5.5mm DC jacks – 12 V DC output 1 x 12 V DC cigarette light 4 DC outlets, 2 x 230 V AC sockets

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price	20,000 ZAR	≈ 1,350 €

Technology and Market Development

- → Made in South Africa
- → Retailers in South Africa, Namibia, Lesotho, Swaziland

Links

http://www.ecoboxx.co.za/pages/products.php?prod_id=7

FS122 Portable charging station BOSS Kit Port Able

Phaesun GmbH,
Brühlweg 9,
87700 Memmingen,
Germany

Product Description

This system is the link between a portable Pico PV-System and a fixed installation. Constructed on a hand wagon or bicycle trailer on 20" wheels. Additional features include:

- → Includes panel, charger, battery, inverter
- → Maintenance free, high quality components
- → Storage space inside

Target Group

Small mobile charging business or village communal system

Product Specification

Type of product	Charging station
AC or DC coupled	DC, optional with AC converter
Capacity of battery @C10	138 Ah
Type of battery	Integrated
Capacity of solar panel (kWp) required	130 Wp
Possible loads (appliances)	Mobile phones
Maximum number of loads that can be charged at a time	18
Size	170 x 75 x 65 cm
Weight	95 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price	2665 €

Technology and Market Development

- → Loads can be adapted to individual needs
- → Examples for 24 h/d use:
  - 3 cell phones, 2 laptops and 5 LED lamps
  - 1 refrigeration box, 1 TV and 5 LED lamps
  - 1 broadcast station with 1 PC, 5 lamps, charging station for radio equipment
  - 1 Surface water pump

Links

http://order.phaesun.com/index.php/boss-kit-port-able-basic.html

FS123 DC/DC Converters Studer MDCI and MDC Series

Studer Innotec SA,
Rue des Casernes 57,
1950 Sion, Switzerland

Product Description

The DC/DC converters type MDCI and MDC are used, depending on the model either to step up or to step down a DC voltage. The MDCI range converters are electrically isolated. The inverters are protected against short-circuit, over-heating over-voltage and reverse polarity. Great stability of the output voltage for a more reliable system.

Target Group

Rural areas

Article	Dimensions [l x w x h]	Weight	Article No.
DC/DC Converter MDCI 100 100 W | input: 9 – 18 VDC or 20 – 35 VDC or 30 – 60 VDC or 60 – 120 VDC | output 12,5 VDC/8 A or 24 VDC/4 A	49 x 88 x 152 mm	0,5 kg	104118
DC/DC Converter MDCI 200 200 W | input: 9 – 18 VDC or 20 – 35 VDC or 30 – 60 VDC or 60 – 120 VDC | output 12,5 VDC/16 A or 24 VDC/8 A	49 x 88 x 182 mm	0,6 kg	104119
DC/DC Converter MDCI 360 360 W | input: 9 – 18 VDC or 20-35 VDC or 30 – 60 VDC or 60 – 120 VDC | output 12,5 VDC/30 A or 24 VDC/15 A	64 x 163 x 160 mm	1,4 kg	104120
DC/DC Converter MDCI 360 charger 330 W | input: 9 – 18 VDC | output 27,6 VDC/12 A	64 x 163 x 160 mm	1,4 kg	321209
DC/DC Converter MDC 1224-7 170 W | input: 9 – 18 VDC | output 24 VDC/7 A	49 x 88 x 98 mm	0,3 kg	104121
DC/DC Converter MDC 2412-5 65 W | input: 18 – 35 VDC | output 13,2 VDC/5,5 A	49 x 88 x 68 mm	0,2 kg	104122
DC/DC Converter MDC 2412-8 105 W | input: 18 – 35 VDC | output 13,2 VDC/8 A	49 x 98 x 88 mm	0,3 kg	104123
DC/DC Converter MDC 2412-12 160 W | input: 18 – 35 VDC | output 13,2 VDC/12 A	49 x 98 x 88 mm	0,3 kg	104124
DC/DC Converter MDC 2412-20 275 W | input: 18 – 35 VDC | output 13,8 VDC/20 A	49 x 88 x 126 mm	0,5 kg	104125

Product Specification

Price “as of”

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

Distributed via Phaesun

Links

http://www.phaesun.com
http://www.studer-innotec.com

FS124 DC/DC Converter Solaric Solar Optimizer

Solaric,
House# 03, Road # 08, Baridhara,
Dhaka 1212, Bangladesh

Product Description

Solar Optimizer is a highly efficient DC/DC converter that produces high voltage DC (125 V DC) from low voltage battery input (12 V DC). The very low conversion losses make it possible to implement it in the low power off-grid SOLAR applications such as Solar Home System (SHS). Additional features include:

- Reduced cable diameter allows standard wiring
- Transmission losses are reduced
- Costs are reduced
- The distance from battery to load can be extended
- Enables user to use LED tubes, mobile phone charger, lantern charger etc. from low voltage DC battery
- The integrated Solar Charge Controller provides the necessary functions and protections to charge the battery from PV panels
- The high voltage enables the consumer to use standard appliances such as laptop, fan, colour TV, standard LED lighting etc.

Target Group

Rural areas

Product Specification

Type of product	Converter
DC Input	12 V
DC output	125 V

Price “as of”

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

- Available in Bangladesh, India, Nepal and Tanzania
- Improved load capacity and lower end user cost are targeted

Links

http://solar-ic.com/solaricdev/major-innovations/solar-optimizer

FS125 DC/DC Converter Solaric Solar APS Micro

Solaric,
House# 03, Road # 08, Baridhara,
Dhaka 1212, Bangladesh

Product Description

The APS is an efficient multipurpose device: Solar Charge Controller and DC/DC Converter and LED Driver. The DC/DC converter produces high voltage DC from low voltage battery (12V) or PV input. Conversion losses are low so that it is possible to use it in low power off-grid solar applications as well as on grid establishments as secondary power source. Additional features include:

- Small static loss leads to reduced stand-by consumption
- The innovative Eco-Power mode can be used to dim the driverless LED Lamp and thereby saves energy and increases backup time significantly
- The solar APS allows the user to use any standard appliances such as SOLARIC driverless LED lamp, AC CFL Lamps, mobile phone charger, lantern charger etc. from low voltage DC battery
- The output voltage level is high enough to be within the universal voltage range (85-265 Volt) such that it can drive standard loads such as CFL, mobile charger, colour TV etc.

Target Group

Users with SHS in off grid and grid connected areas

Product Specification

Type of product	Converter
DC Input	12 V
DC output	85-265 V

Price “as of”

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Links

http://solar-ic.com/solaricdev/products/solar-ips

FS126 Digital DC Energy Meter

Solaric,
House# 03, Road # 08, Baridhara,
Dhaka 1212, Bangladesh

Product Description

The DC Pre-paid Energy Meter measures energy consumption and counts down balance in TAKA as per tariff setting. The tariff setting is adjustable after commissioning if required. The meter shuts down load on low balance. Additional features include:

- Information display: connected load, operation voltage, balance, cumulative energy usage after each recharge, any fault conditions
- Impressive electrical attributes: measurement accuracy > 99 %; very low static loss (3mA)
- The recharge code used is based on random numbers and is completely secure to user
- Overload and short circuit protection
- Secure recharge code

Target Group

Designed for solar grids where energy is expensive and has to be predictably distributed.

Product Specification

Type of product	Energy meter
Rated power	60 – 100 W
Measurement accuracy	> 99 %
Self-consumption	< 1 W

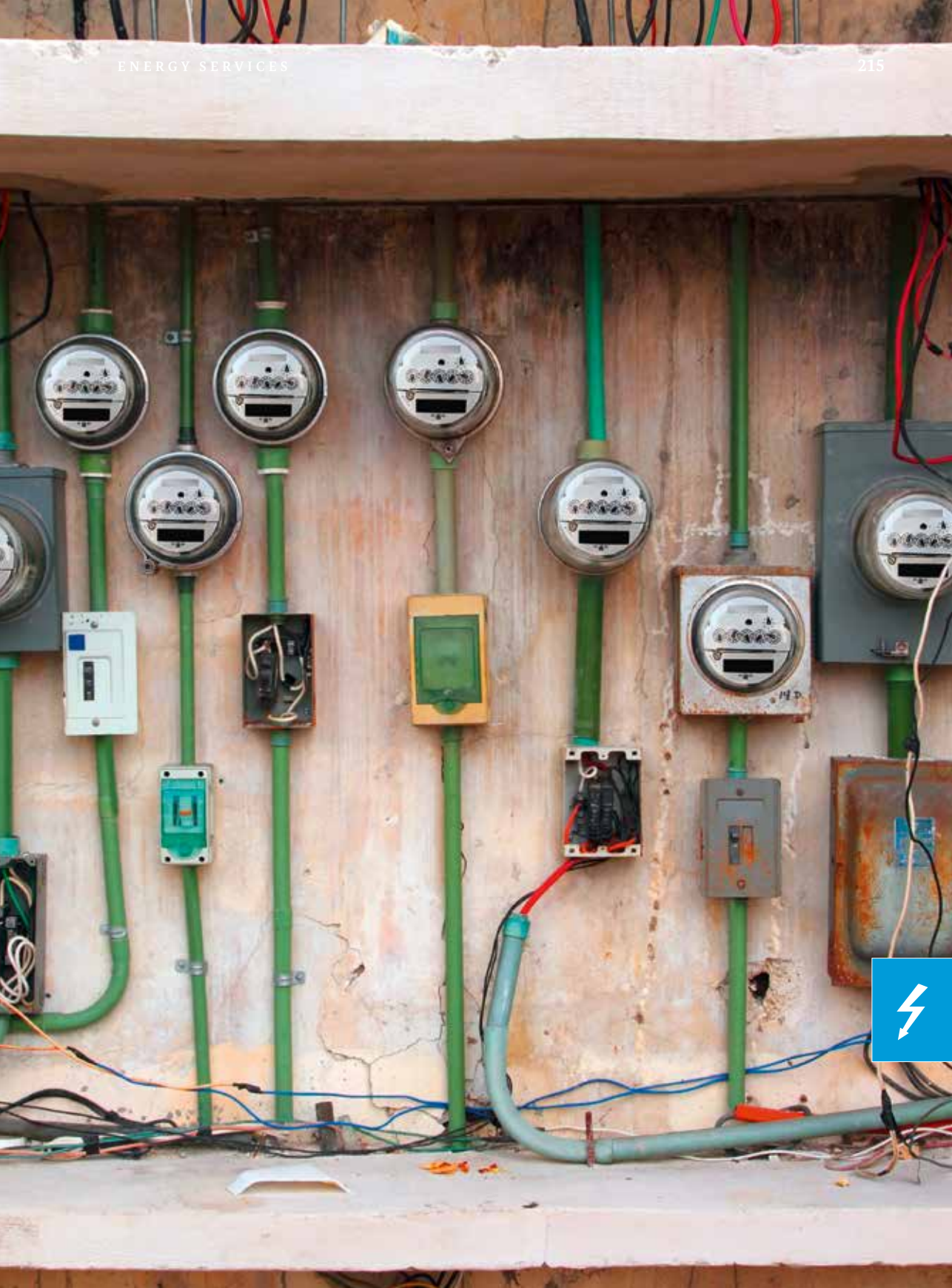
Price “as of”

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Links

https://www.ubnt.com/products/#all/routing



3.10

3.10 Haircutting & Other Services

Description
PV-powered appliances offer broad possibilities for income generation in the service sector. This section gives some examples of income generating services like housekeeping, laundry and haircutting.

Technology Status and Development over the past years
The technological diversity of DC-appliances for the service sector is developing steadily. Whereas the AC counterparts still dominate the market, and are generally highly developed, with high quality standards, DC appliances lag behind in regards to quality and choice.

Many appliances for the beauty industry use DC motors, as these are more efficient, lightweight and cordless. But they are then provided with an integrated adapter to be connected to an AC power system. For direct connection to a PV system the plugs of these appliances have to be changed to DC.

Type of equipment presented in the catalogue
This catalogue presents housekeeping appliances like washing machines, dryers and irons as well as appliances for barber shops and beauty salons.

Further information

Hair and beard trimmer
Hair trimmers are ideal appliances for short haircuts or to cultivate a beard. They are easy to use and require little energy. Several appliances have an integrated battery and are cordless. This makes handling easier and charging can be done via a PV system.

Several international brands offer hair trimmers in different sizes and with a variety of features. This catalogue does not present all appliances in this category, but rather provides a sample selection. All models allow for adjustment of hair length, some with integrated telescope systems others with easy slip on/off adapters. Length adjustment ranges normally from 4 to 25 mm, some even allow for 43 mm. Beard trimmer can be used for shaving, beard trimming and hair trimming. The quality of a product mainly relies on the cutting edge, which should be of stainless steel or ceramic. Cutting edges of carbon-titanium or diamante laminated provide best and most accurate cuts, but are costly.

Hairdryers, in contrast to trimmers, usually require lots of energy. Their power load normally ranges from 1000 – 2000 W. Two examples for DC hairdryers with only 500 W are included in this catalogue, being fully aware that drying long and thick hair with these appliances may take some time.

Other beauty appliances like shavers or hair straighteners, which can be connected to a battery via USB cable, are entering the market.

FS127 Washing Machine CERAD

CERAD,
UET, Lahore,
Pakistan

Product Description

A low mute design, single tube, full plastic cabinet, water proof, rust proof and energy efficient washing machine has been designed by CERAD, using a 12 V DC motor and saving up to 80 percent of power. It is made by modifying a conventional washing machine and is power failure independent during sunny days when attached to a PV system. Its electric power consumption is reduced 5 fold, has same washing capacity at equal speed and better working hours and has a potential payback period of only 18 months.

Target Group

Laundries, households

Product Specification

Type of product	Washing machine
Load	70 W
AC or DC coupled	DC
Voltage	12 V
Washing capacity	5 – 7 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Links

http://cerad.uet.edu.pk/index.php/solutions/products

FS128 Cloth Dryer CERAD

CERAD,
UET, Lahore,
Pakistan

Product Description

A single tube, full plastic cabinet, water proof, rust proof and energy efficient cloth dryer, designed by CERAD, saving up to 80 percent of energy, resulting in a payback period of about 16 months. The dryer machine is converted into an energy efficient device by modifying it with a DC motor.

Target Group

Laundries, households

Product Specification

Type of product	Cloth dryer
Load	40 – 50 W
AC or DC coupled	DC
Voltage	12 V

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Links

http://cerad.uet.edu.pk/index.php/solutions/products

FS129 Solar DC Power Iron Dry/ Spray style-12V SL100S

Ningbo Jiming Electric Appliance Co., Ltd.,
No.546 Qiye Road, Zhouxiang Town, Cixi,
Zhejiang, China

Product Description

Electric 12Volt iron for dry ironing or spraying. Additional features include:

- 3M 2 x 1.5 mm² Power wire with clamp, white and blue
- Max. current: 12.5 A
- Max. temperature: 150°C
- Automatic temperature control system
- Energy saving: 1 minute hot for 60°C; 2 minutes hot for 150°C
- Duration time: up to 7 hours on a 100 Ah battery
- Material: ABS body and aluminium baseplate
- With 3 meters copper cable and clamps
- Red power indicating light

Target Group

Laundries, household, recreational industry

Product Specification

Type of product	Cloth iron
Load	150 W
AC or DC coupled	12 V DC
Size	240 x 107 x 115 mm

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

2 year warranty

Links

http://www.solardcappliance.com/solar-dc-iron/solar-dc-power-iron.html

FS130 DC Electric Dry Iron SL-100D

Ningbo Jiming Electric Appliance Co., Ltd.,
No.546 Qiye Road, Zhouxiang Town, Cixi,
Zhejiang, China

Product Description

Electric 12Volt iron for dry ironing or spraying. Additional features include:

- Dry use only
- Max. temperature: 150°C
- Automatic temperature control system
- Energy saving: 1 minute hot for 60°C; 2 minutes hot for 150°C
- Duration time: up to 7 hours on a 100Ah battery
- Material: ABS body and aluminium baseplate
- With 3 meters copper cable and clamps
- Red power indicating light

Target Group

Laundries, household, recreational industry

Product Specification

Type of product	Cloth iron
Load	150 W
AC or DC coupled	12VDC
Size	240 x 107 x 115 mm

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

2 year warranty

Links

http://www.solardcappliance.com/solar-dc-iron/dc-solar-iron.html

FS131 21-Piece Haircut Kit Custom Cut® with Case (model: HC200GB)

Conair-Store.com,
20 Constitution Blvd. South,
Shelton, CT 06484, USA

Product Description

Powerful clipper with 5-detent taper control, nine comb attachments and a powerful DC motor for 50 % more cutting power to blade. Provides 50 precision height settings. Additional features include:

- For all lengths and hair styles
- Diamond-sharpened carbon steel blades
- Powerful clipper with 5-detent taper control
- 9 comb attachments: 1/8”, 1/4”, 3/8”, 1/2”, 5/8”, 3/4”, 7/8”, left and right ear
- Provides 50 precision height settings
- Barber cape, barber comb, styling comb, 2 styling clips
- Hard case
- Scissors, cleaning brush, oil, blade guard
- Spanish/English instruction booklet

Target Group

Barber shops

Product Specification

Type of product	Hair cutter
AC or DC coupled	AC

Price “as of”

(individually to be confirmed with retailer/supplier)

Retail Price	24 $	≈ 21 €

Technology and Market Development

- Limited 5 year warranty
- Available via online shop

Links

http://www.conair.com/custom-cut-21-piece-haircut-kit-with-case-p-682.html

FS132 Professional 20-Piece Haircutting Kit Fast Cut Pro, model: HC1000

Conair-Store.com,
20 Constitution Blvd. South,
Shelton, CT 06484, USA

Product Description

The Fast Cut Pro Professional Home Haircutting Kit has twice the cutting force, with a powerful DC motor and professional blade technology. Additional features include:

- High-quality, self-sharpening stainless steel blades
- High-performance DC motor
- Taper control for customization
- 10 guide combs: 1/8”, 1/4”, 3/8”, 1/2”, 5/8”, 3/4”, 7/8”, 1”, left and right ear
- Includes: barber scissors, comb and cape, deluxe storage case, cleaning brush and oil, 2 styling clips and blade cover

Target Group

Barber shops

Product Specification

Type of product	Hair cutter
AC or DC coupled	AC

Price “as of”

(individually to be confirmed with retailer/supplier)

Retail Price	50 $	≈ 44 €

Technology and Market Development

- Limited 5 year warranty
- Available via online shop

Links

http://www.conair.com/2-in-1-custom-styler-clipper-trimmer-p-612.html

FS133 Philips Hair Clipper Series 9000

Philips,
Lübeckertordamm 5,
20099 Hamburg, Germany

Product Description

Hair Clipper Series 9000 with digital swipe, motorized Combs, memory function and a high performance cutting element.

Ultimate precision and control
→ Digital Swipe interface
→ Easy to select and lock-in 400 length settings: 0.5 to 42mm
→ Adjustable hair combs for the best clipping results
Performance
→ Self-sharpening titanium blades for extra durability
→ Motorized Combs for easy length selection
→ Auto Turbo to boost cutting speed
→ Double-sharpened cutting element
Easy to use
→ Remembers 3 cutting length settings per comb
→ 120 minutes of cordless use after a 1-hour charge
→ Easy charging and storage

Target Group

Barber shops

Product Specification

Type of product	Hair cutter
AC or DC coupled	AC

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

2 year guarantee worldwide

Links

http://www.philips.de/c-p/QC5770_80/hairclipper-series-9000-haarschneider

FS134 Hair Clipper Series 7000

Philips,
Lübeckertordamm 5,
20099 Hamburg, Germany

Product Description

Hair Clipper Series 7000 offers precision and control through several features including:

→ Control buttons
→ Easy to select and lock-in 60 length settings: 0.5 to 42mm
→ Adjustable hair combs for the best clipping results

Performance

→ Self-sharpening steel blades for long-lasting sharpness
→ Motorized Combs for easy length selection
→ Auto Turbo to boost cutting speed
→ Double-sharpened cutting element
→ 2-year guarantee

Easy to use

→ Remembers the last used length setting
→ 120 minutes of cordless use after a 1-hour charge

Target Group

Barber shops

Product Specification

Type of product	Hair cutter
Size	24.5 x 14.0 x 7.0 cm
Weight	0.46 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Links

http://www.philips.de/c-p/QC5380_32/hairclipper-series-7000-haarschneider/

FS135 Hair Dryer Solar DC SE310

Ningbo Jiming Electric Appliance Co., Ltd.,
No.546 Qiye Road, Zhouxiang Town, Cixi,
Zhejiang, China

Product Description

A DC-powered foldable travel hair dryer with several features:

- → Can work with solar panel or battery
- → Material: ABS
- → Over Heating Protection Device
- → Function: 2 speed control (low-high)
- → Colour: variable colour printing options

Target Group

Barber shop, hair dresser

Product Specification

Type of product	Hair dryer
Load	400 W
AC or DC coupled	DC, 12

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Technology and Market Development

2 year warranty

Links

http://www.solardcappliance.com/solar-dc-hair-dryer/12v-solar-dc-hair-dryer.html

FS136 Hair Dryer Solar DC SE300B

Ningbo Jiming Electric Appliance Co., Ltd.,
No.546 Qiye Road, Zhouxiang Town, Cixi,
Zhejiang, China

Product Description

- A DC-powered foldable travel hair dryer with several features: Can work with solar panel or battery
- Material: ABS
- Over Heating Protection Device
- Function: 2 speed control (low-high)
- Colour: variable colour printing options

Target Group

Barber shop, hair dresser

Product Specification

Type of product	Hair dryer
Load	180 W
AC or DC coupled	DC, 12

Price "as of"

(individually to be confirmed with retailer/supplier)

No price information available at this point.

Links

http://www.solardcappliance.com/solar-dc-hair-dryer/solar-dc-hair-dryer.html

FS137 Hair Straightener Carmen Mini, Cordless, Rechargeable

Carmen Products,
Link House, Bute Street,
Stoke-on-Trent, ST4 3PR, UK

Product Description

A rechargeable DC hair straightener with additional features including:

- 3 Temperature Settings: 140° C / 160° C / 180° C
- Locking function
- 2.5 hours charging time
- 25 minutes continual use from 1 charge
- Rechargeable lithium battery

Target Group

Barber shop, hair dresser

Product Specification

Type of product	Hair straightener
AC or DC coupled	DC

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price	25 £	≈ 34 €

Links

http://www.carmen-products.co.uk/carmen-ranges/carmen-cherish-2028/cordless-rechargeable-mini-hair-straighteners.html

FS138 Shaver Carmen USB C82002

Carmen Products,
Link House, Bute Street,
Stoke-on-Trent, ST4 3PR, UK

Product Description

A compact design rechargeable shaver with several features:

- → Rechargeable by USB plug
- → Charge time: 8 hours
- → Run time: 40 minutes

Target Group

Barber shop, hair dresser

Product Specification

Type of product	Shaver
Size	2.3 x 6.2 x 10.7 cm
Weight	0.229 kg

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price	25 £	≈ 34 €

Links

http://www.carmen-products.co.uk/carmen-ranges/carmen-chrome/shaver-usb.html

FS139 Barber Kit Ecoboxx 160 DC Plus

EcoBoxx/ Sungrid Group (PTY) LTD South Africa,
Unit D06B Collingwood Building, Black River Park Observatory, Cape Town 7925, PO Box 3231, Somerset West 7129, Republic of South Africa

Product Description

Ecoboxx is a portable PV system. Whether for productive, recreational or emergency use, there are multiple Ecoboxx models available with varying power outputs. The barber kit consists of:

- 2 x 3 W super bright LED lights with independent switches
- USB fan + clipper
- AC/DC adaptor
- 2 x USB charging ports
- 1 x Multi point phone charging cable
- 75 W modified sine wave inverter

Target Group

Barber shop

Product Specification

Type of product	Hair cutter
AC or DC coupled	AC and DC
Voltage	12 V
Capacity of solar panel (kWp) required	2 x 10 W
Type of battery	14 Ah Lead Crystal battery
Product life time	Battery: 5 y Solar panels: 20 y

Price "as of"

(individually to be confirmed with retailer/supplier)

Retail Price	4,500 ZAR	≈ 300 €

Technology and Market Development

Retailers in South Africa, Namibia, Lesotho, Swaziland

Links

http://www.ecoboxx.co.za/pages/products.php?prod_id=9
http://energcare.co.za/solar-light-charger-combos

4

4. Business cases using PV appliances for PUE

Although investment costs are often higher than for conventional products, PV-powered appliances are cost competitive on a life-cycle basis. Nevertheless the key barrier they face is the relatively high capital-to-operational cost ratio compared to conventional appliances[12].

The economic situations prevailing in rural communities tends to push people towards technology choices and buying decisions based on short-term planning horizons and mainly focus on lowest investment costs. For a household that invests in a solar lamp to save money on kerosene or candles, an investment takes several months to pay off.

From a long term perspective, these choices are often not ideal, especially in isolated communities where traditional and diesel fuels are time-intensive or expensive resource that is difficult to obtain[13].

Identifying appropriate financing schemes, tailored to the consumers' income, cash flow and current expenditures on energy services (e.g. kerosene or candle lighting, mobile charging), assist greatly in overcoming these barriers[14].

Setting up of a viable business model

There are different approaches towards setting up a business model. The best suited model will depend on the respective product and may vary from community to community and the business approach should be adapted to the conditions of local market[15]. Typical types of business models include:

- → Direct sale (cash sale)
- → Microcredit
  - Dealer Credit (One-hand model)
  - End-user Credit (Two-hand model)
  - Lease / Hire purchase (either One-hand model or Two-hand model)
- → Fee-for-Service
- → Point-of-Sale
- → Dealer-based

Some of the key factors that should be taken into account when choosing a suitable financing scheme, are the product and framework conditions. Both are described below in more detail.

[12] IRENA, 2015
[13] Wiemann & Li, 2014
[14] IRENA, 2015
[15] Wiemann & Li, 2014

1. The product

The product is an essential factor for the choice of a business model as the required investment costs and involved persons may vary significantly (e.g. solar irrigation pump vs. solar charging station).

Each technology has to fit the local communities and, where necessary, needs to be adapted or modified. Below important points for product (or service) choice are listed:

→ **Local market conditions** that affect the cost-competitiveness of the product. Local markets may be very different and conditions such as costs for diesel or kerosene may vary significantly from region to region. In Africa, for example, cost for kerosene is much higher than in India. Furthermore diesel and kerosene are still subsidized in several countries.

→ **Training** needs should be assessed. Especially for:
- The solar entrepreneur, to run a solar business
- Technicians (or entrepreneur/ consumer) in service and maintenance
- Consumers, to handle and use the product correctly

Training should be customised to local conditions and requirements to ensure relevance.

2. Framework conditions for an appropriate business model

To establish a reliable business model the local framework conditions should be analysed. Important points are listed below:

→ **Regional and local financing structures**
- Who are the lending institutions in the country (banks, microcredit institutes, institutions that manage revolving funds, point-of-sale financing etc.).
- What are the existing repayment structures? (mobile banking, cash collection, pre-payment systems etc.)
- What are customers willing to pay for: product, service, energy, time?
- Repayment structure should be adapted to the financial capabilities of the consumers, taking into account seasonal income fluctuations, regular disposable cash incomes, poverty constraints, pension pay-outs and others.
- Consider ability to pay, willingness to pay in order to determine pay-back times.
- In case of close knit community structures, can or should the responsibility for repayment be shouldered by the entire community?

→ **Stakeholders involved**

- Entrepreneur: invests in technology to build a business
- Operator: operates the system, and has to be trained and receive payment
- Financier: facilitates investment into technology procurement by the entrepreneur
- Customer:
  - Number of customers and consumers and their financial capabilities
  - In case of small investments, a high number of consumers could encourage a greater investment and thereby attract the interest of financiers.
- If one of the actors is the community: how is it organized and structured?

→ **In the agricultural sector it has to be adapted to farming practices**

- When is the energy needed? (Over the course of the day or only in morning and evening hours, 2 – 4 hours per day, seasonal, etc.)

→ **The business model should include a service and maintenance mechanism:**

- To ensure regular production of the product or provision of service.
- To generate trust in the technology (among both customers and financiers).
- Encourage maintenance and service agreements with the supplies, along with after-sales service.
- Regularly inspect and maintain systems and put financial resources aside diligently. Insist on product guarantees and warranties to hold the supplier accountable should the system fail due to sloppy workmanship.

Successful operating business model lead to new ones

- **Functioning models grow trust in business and trust in technology.**
- **More entrepreneurs are willing to invest in PV technologies.**
- **New technologies can be introduced.**
- **New markets can be tapped**

(ONergy)

→ **Calculate your own business case**

The various appliances listed in the catalogue allow for numerous different business cases. In order to simulate the viability of a typical business idea, an excel-based tool was developed, as supplement to this catalogue. This tool comprises the essential business questions that an entrepreneur needs to consider and then summarises the results in terms of generalised business feasibility. You can freely access this tool via: *https://energypedia.info/wiki/File:PUE_Mini_Business_Plan_Calculator.xlsx*


1) Idea
2) Resources & assets
3) Input need
4) Market opportunities
5) Business plan

Examples for business cases

This section of the catalogue provides some examples for business opportunities, relating directly to some of the products listed in this catalogue.

Business opportunity: Cold Chain

a. PV powered services at a solar kiosk (Somaliland)

A solar kiosk can provide a variety of services: cooled drinks, mobile phone charging, battery charging or secretarial services.

In this example an entrepreneur bought a 160 litre solar-powered cooler and a solar-powered battery charging station so he could offer chilled drinks and charge mobile phones. He invested $2,500 but was able to increase sales by 40 %. Now he can sell 45 cold drinks per day at $0.60 cents each instead of the previous $0.45 cents for uncooled drinks. This makes an additional income of about $203 a month. Furthermore, he charges 15 mobile phones a day, earning an additional monthly income of $67. This means that the investment will pay for itself in less than a year. Meanwhile, the kiosk owner has invested more than $400 to upgrade his solar home system so that he can operate a ceiling fan[16].

Investment (for 160 litre refrigerator and upgrade of PV system)	2,500 $
Additional income per month	
Cooled drinks sold at 0.60$	203 $
Mobile phone charging	67 $
Breakeven point of the economic activity with this system is reached after 9.5 month	

[16] Zwirner, 2014

b. BOSS Kit Keep Fresh

The BOSS Kit Keep Fresh consists of the solar fridge Steca PF 166, solar modules and all equipment for charging as well as installation materials. The solar fridge can be used for cooling or freezing.

The scenarios assume a solar irradiation of 4 kWh/m²/d, which refers to the minimum irradiation in most African country. With a 120 W solar module, the system generates 480 Wh/d. Assuming an outside temperature of 35°C, the fridge / freezer can cool:

→ 70 x 0.33 l cans of soft drink, beer or water
→ Or freeze 4 kg of water per day

Scenario 1:
A solar kiosk can sell 60 cans (soft drinks, beer, water) a day to his customers. He can charge 0.10 $ extra for cooled drinks.

Investment	1,100 $
Additional income per week based on the assumption: • that cooled drinks can be sold with a surcharge of 0.10 $	36 $
Working time: 6 days/week	
Breakeven point of the economic activity is reached after 31 weeks.	

Scenario 2:
A grocery store uses the refrigeration kit to freeze meat, fish as well as fruit juices or water ice.

Investment	1,100 $
Additional income per week based on the following assumptions: • Frozen meat and fish can be sold at a surcharge of 3.00 $/kg • In average he sells 2 kg of fish or meat per day • Income from ice (new product): 0.15 $ / kg • It is estimated that 15 kg of ice are sold per day.	50 $
Working time: 6 days/week	
Breakeven point of the economic activity is reached after 30 weeks.	

c. BOSS Kit Keep Fresh compare to costs of a refrigerator powered by diesel

This scenario assumes, that in the absence of a solar system, the entrepreneur would use diesel power to provide electricity for his refrigerator.
At an outside temperature of 35°C, the Steca PF consumes 156 Wh per day or 1.1 kWh/week. A diesel generator set with an average efficiency generates 3 kWh from 1 litre of diesel. Diesel prices are assumed to be 1 $ per litre. Service and maintenance costs for the diesel generator are not included in the scenarios.

→ 70 x 0.33 l cans of soft drink, beer or water
→ Or freeze 4 kg of water per day

Scenario 1:
A solar kiosk can sell 60 cans (soft drinks, beer, water) a day to his customers. He can charge 0.10 $ extra for cooled drinks.

Investment (Conventional A++ refrigerator)	500 $
Operation cost per week	3 $
Additional income per week based on the assumption: • that cooled drinks can be sold with a surcharge of 0.10 $	36 $
Working time: 6 days/week	
Breakeven of the investment is reached after 15 weeks which is half of the time of the Solar Refrigerator. Nevertheless operation costs will continuously accrue and account for approximately 156 $ per year.	

Working time: 6 days/week

Scenario 2:
A grocery store uses the refrigeration kit to freeze meat, fish as well as fruit juices or water ice.

Investment	500 $
Operation cost per week	3 $
Additional income per week based on the following assumptions: • Frozen meat and fish can be sold at a surcharge of 3.00 $/kg • In average he sells 2 kg of fish or meat per day • Income from ice (new product): 0.15 $ / kg • It is estimated that 15 kg of ice are sold per day.	50 $
Working time: 6 days/week	
Breakeven of the system is reached after 10 weeks, third of the time of the solar Kit, but operation costs will continue to accrue.	

Business case: Electricity for Charging

a. Unintended business opportunities: mobile phone charging (Kenia)

A customer is investing in a solar panel, lamp, radio connector, mobile phone connector, and power pack. His investment should cover his personal energy needs, business is not intended.

The fully charged lamp can last up to 6 hours, allowing him and his family to enjoy bright lighting at night and his children are able to study without acceptable light intensity. In addition he can use his radio either using direct sunlight or through the power pack. This saves money he formerly spent on kerosene for the lamp and dry cell batteries for the radio.

As mobile phone charging becomes very easy during day time he is requested by friends and neighbours and starts to charge mobile phones for extra income at a charge of KES 20 per charge per phone.

Investment Is not considered, as system was purchased for private use only.	
Weekly costs saved	
Kerosene	140 KES
Batteries	30 KES
Additional income per week • He charges 20 KES per charge per phone and charges • 3 phones a day on 6 days a week.	360 KES (4.5 $)

(UNDP, Tough Stuff)

b. Battery charging on a fee-for-service basis

All systems are run on a fee-for-service basis, meaning that even public services pay an energy tariffs to the private operator.

Cross-financing

The income generated from battery charging and lantern rental covers the costs for maintenance of the charging stations themselves and the PV systems for the social institutions. It also allows for a reasonable profit by the private operator. The contribution from the public users (local government, schools) are so low that they can only cover replacement cost of batteries and are insufficient to ensure benefits for the private service provider.

Blocked bank account for battery replacement
The private service providers sign a contract with the mayor and ADER. The money allocated to battery replacement for the systems at the social institutions is regularly transferred into a blocked bank account. Access to the account by the private operators is monitored by ADER.

Tariffs
- → Social Infrastructure: € 5 / 100Wp per month (The tariff for the social infrastructure had to be based on the capacity of the system (kW) as the energy consumption (kWh) is not measured.)
- → Battery charging: € 3 / month battery rental plus € 0.50 per charge
- → Solar lamp rental: € 0.07 per night (compared to 10€cents for a candle)

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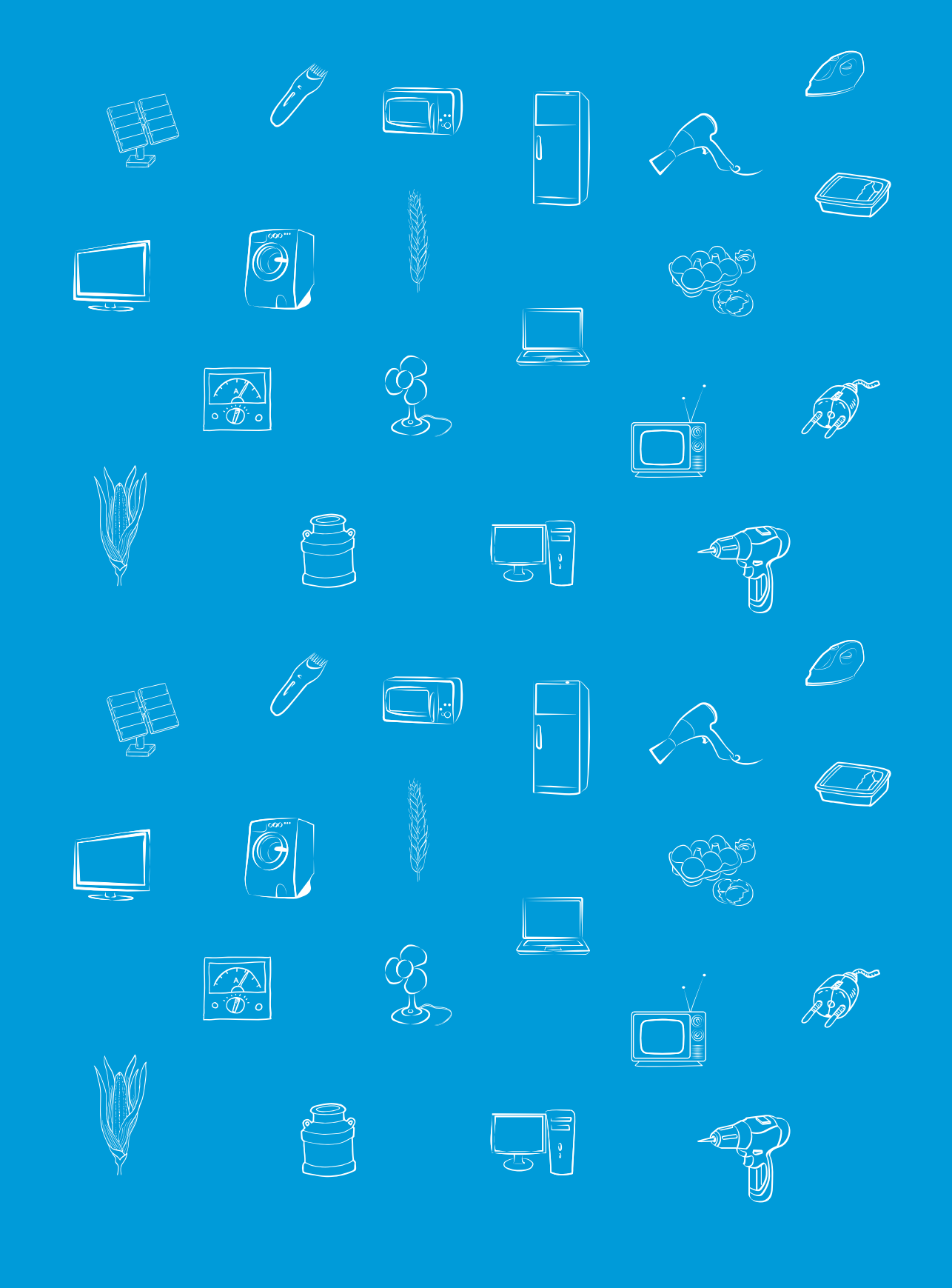

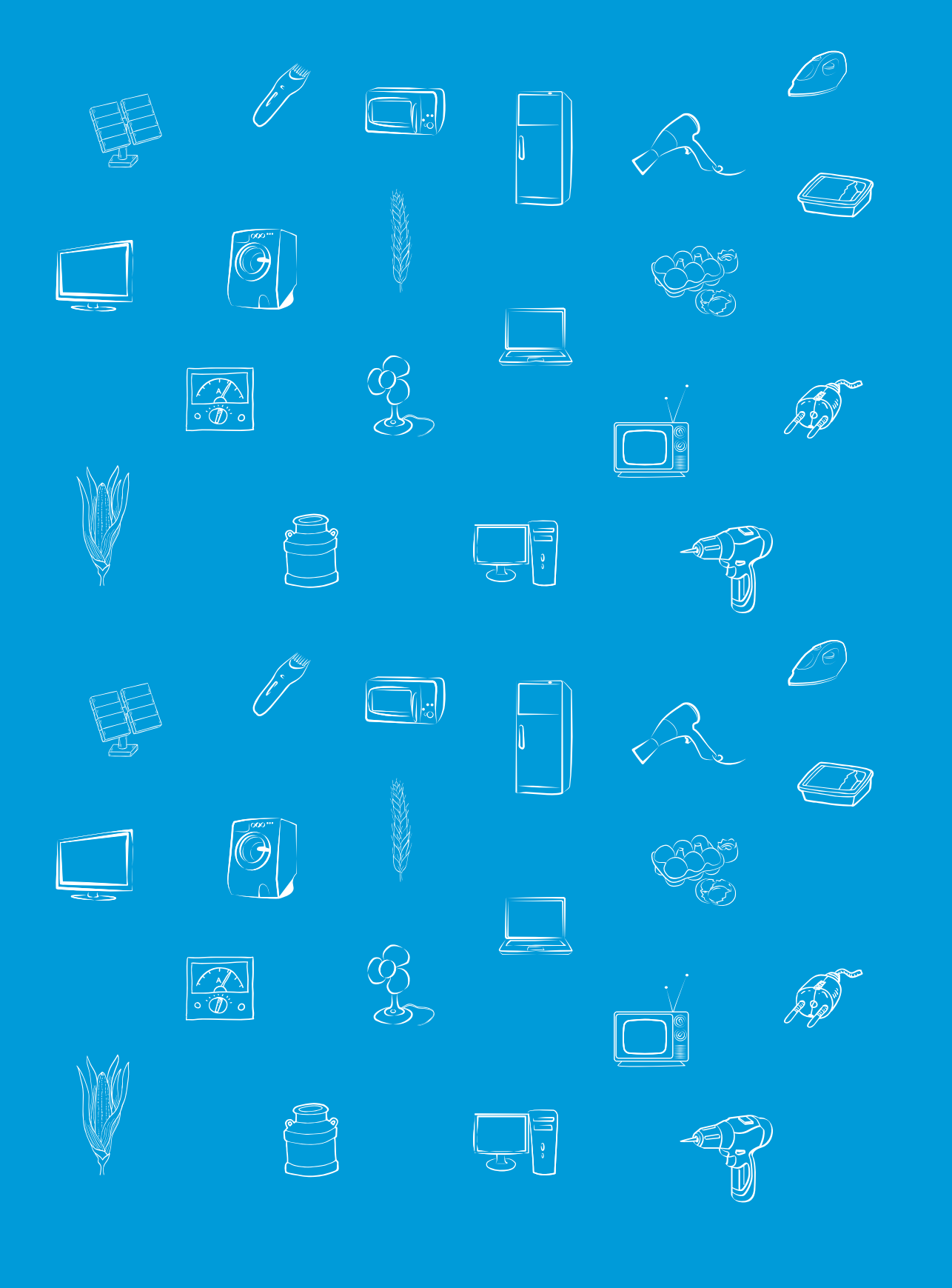

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