

Chapter 3

Off-Grid Charging Solutions

Aside from electricity, there are two other types of technology used to charge mobile handsets in off-grid regions: solar and mechanical / kinetic. Micro-wind or micro-hydro solutions are in development, but currently, no tangible solutions are available. Below is a summary of the local solutions available to mobile subscribers.



Technology & Devices

Solar Handsets

Solar handsets have been available for many years but it is only recently that these models have gained any traction. Due to improved battery life, solar panel efficiency and the ability to charge under different sunlight conditions (indoor, cloudy etc), solar handsets are becoming a more attracting value proposition for end users living in rural areas with good sunlight conditions.

The energy conversion rate has been improved to reach 20 minutes of talk time for each hour of charge²³; with good sunlight conditions, the handset battery is fully charged in 4 to 5 hours. Intivation, a chipset provider based in the Netherlands, is behind the technology available in most handsets on the market today. The Intivation technology allows a bigger more effective surface area, avoiding the problem of partial shading impairing the charging process.

Retailing for an Average Selling Price (ASP) of US\$35, the Return on Investment (ROI) can be fast for the adoption of solar handsets.²⁴ If the charging expenditures are above US\$3 per month, users could have a ROI before 6 months of use. However, this factor has to be put in perspective with the average income of people living at the Bottom of the Pyramid (BoP) in rural regions – and the additional upfront cost is a barrier to take up (in this case, the price of a solar handset might be equivalent to a month’s salary).

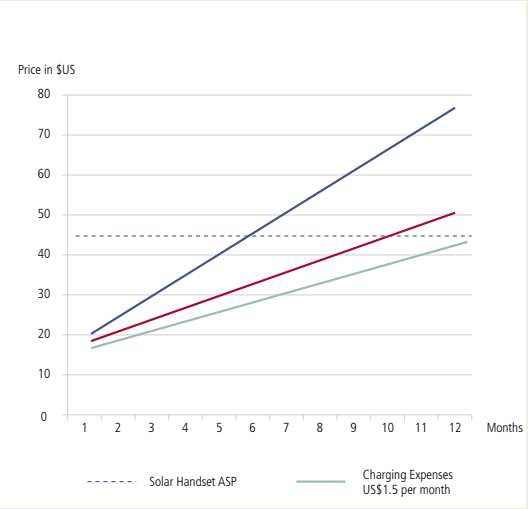
Other parameters have to be taken into account when comparing the operating costs of handsets. The usability of the solar handset can be viewed as a constraint for users, needing to put their phone on charge for several hours while they work. Efficiency of the solar panel can also deteriorate after several months of use in rural and harsh environments.

Figure 8: Solar Handset Model and Economics



Source: Intivation/ZTE

Figure 8: Estimated ROI from Solar Handset Use



Source GSMA²⁵

Indeed, the ergonomics of the solar handset itself could be a barrier to its adoption by the end users. In most cases, mobile users have to put their phone under sunlight for several hours to fully recharge its battery. In developing countries where theft rate remains high, users are not confident about leaving their phone outside without surveillance.

Considering that in sub-Saharan countries mobile money penetration is rapidly increasing and viewed as an attractive value proposition, the mobile phone is assimilated to a bank account and contains critical information. Users are very careful about their handset and value the security that the owner of a charging shop is guaranteeing. Increasingly, only the battery is given to charge while the handset is kept with them at all times.

Table 3: Solar Handset Vendors and Mobile Operators Partners

Vendors	ZTE, Sharp, Umeox, Samsung, Intivation (chipset+solar panel)
Mobile Operators (providing solar handsets)	UTL, Digicel, Vodacom, Econet, Vodafone, Safaricom

External Solar Chargers

Small personal solar chargers are increasingly appealing to the poorest consumers who are unable to afford charging shops, providing them with a cheap reliable source of electricity for lighting and communications needs. The price point of such devices varies between US\$10 to US\$80, depending on the power output. Several models available today are aligned with this US\$10 limit, which represents an acceptable expense for the low income users.

Solar external chargers are usually a combination of a solar panel on a flexible or rigid substrate, and a battery storing the energy. Lights or bulbs can also be bundled to offer end users a full solution to their off-grid needs. The advantage of external chargers is their agnosticism to devices; they can provide energy to a wide range of low power devices (torches, radio, mobile phones).

Figure 9: External Solar Charger Models



Source: Suntrica



Source: Toughstuff

Efficiency has been improved in recent years and today most of the models can provide at least 20 minutes of talk time after 1 hour of solar charging. Several African mobile operators have already provided their rural subscribers with external chargers, so they can benefit from charging solutions.

Feedback from end users is usually very good, as they feel empowered. Such devices also appear to be highly useful in disaster relief situations where the solution to access energy when all power systems are shut down is highly appreciated.

Table 4: External Handset Vendors and Mobile Operators Partners

Vendors	Renewit, Suntrica, Toughstuff, Solarc, Starfire, Solio, Fenix International, Voltaics System, Bullitt Group
Mobile Operators (providing solar external chargers)	MTN, UTL, Bharti Airtel, Digicel, Vodacom, Econet, Vodafone, Safaricom, Orange

Lamp with Handset Charging Features

The most abundant use of electricity in rural households is for lighting²⁶. The ability to access light after dark is key to the social and economic development of off-grid areas. Without affordable lighting, children cannot study at night, businesses cannot operate after sundown, women have difficulty cooking as well as other basic tasks.

It is estimated that over US\$10 billion is spent annually on lighting using non-renewable energy sources alone, by the African BoP, and this figure is set to rise to US\$12 billion by 2015²⁷. Many initiatives are currently targeting this problem: Lighting Africa, Light up the World, Sustainable Lighting Project and TERI.

Companies such as DLight and Barefoot Power are now providing lamp models based on the LED technology (10-20 W bulb equivalent), bundled with a small solar panel (1-2 W) and embedding handset charging feature.

Hundreds of thousands of these models have already been sold worldwide and the traction is forecasted to continue as the convergence of lighting and charging appears an attractive value proposition.

23. ZTE/Intivation – For a charge under full sunlight conditions

24. Handset replacement time is estimated to 36 months in rural areas of developing countries

25. Based on field studies and vendor information this calculation does not take into account expenses from travel to charging shops

26. The Welfare Impact of Rural Electrification 2008

27. Lighting Africa – Overview of Off Grid Solar Portable lighting – May 2010

Figure 10: The Lighting Experience (from Kerosene to Solar Lighting)

Expensive kerosene lighting is widely used in off grid households.



Source: Barefoot Power

New solutions are emerging, embedding a solar panel and handset charging features.



Hand Crank Charger

Hand crank chargers have been in use for many years as a small, cheap (US\$5-10) solution for low power device charging. They are usually able to provide around 1 to 2 minutes of talk time for a 10 minutes winding. However, if easy to use, this solution is seen as laborious and tiresome for such low efficiency. These devices have been distributed in disaster relief situations providing an immediate access to energy; this is unlikely to be suitable for providing a more permanent charging solution.

Figure 11: Hand Crank Charger Model Integrating Torch and Radio Features



Source: Eton

Kinetic Charger for Bicycles

Kinetic charging is widely used in developing countries as a cheap and easy solution for charging mobile phones. In East Africa, where the number of bicycles is high, it is easy to set up a dynamo system to charge a small battery. The time needed to charge a phone battery fully depend on the cycling speed and phone model, but on average, 10 minutes of cycling at roughly 10 km/h would provide enough power to produce around 28 minutes of talk time for a low end phone²⁸. The bikes are usually connected to a larger battery (car battery or smaller), so that power can subsequently be distributed to several phones at the same time.

Figure 12: Nokia Kinetic Charger model



Source: Nokia

However, this solution can be seen as cumbersome and takes a lot of work to deliver a small amount of energy. On the field in Uganda, an owner of a small household battery paid people to pedal their bicycle to charge his battery for him. In 2010, Nokia released a pedal powered mobile phone charger kit targeting developing nations where the power supply is limited (retail price has been stated at US\$18).

Initiatives & Models

Combined with an approach to provide solutions to handset charging, NGOs and private companies also provide tools and products to empower the local communities and become local entrepreneurs. The current initiatives presented below involve different models providing energy access to rural populations.

The Jokko Initiative²⁹

In 2009, in partnership with UNICEF, Tostan³⁰ added the **Jokko Initiative**³¹ to its core education programme to teach users the practical uses of standard mobile phone functions as well as to use SMS texting as a post-literacy practice tool. Tostan has built on the successor of the Jokko Initiative to enhance the reach of mobile technology, e.g. solar-powered social enterprise model. The project, developed in partnership with the Rural Energy Foundation³², is based on solar powered suitcases which acts as telecentres where customers can charge their mobile phones or purchase small amounts of credit through a phone-to-phone transfer system known as Seddo (from Orange) or Izi (from Tigo).

Figure 13: Solar Powered Suitcases from the Jokko Initiative



Source: Tostan

Women-Centred Distribution System³³

Solar Sister³⁴ is a social enterprise that empowers women through economic opportunity. Using a women-centred distribution system for micro-solar energy products such as solar lamps and cell-phone chargers, the company aims to bring clean energy access to BoP consumers in rural Africa. To date, Solar Sister has empowered over 100 entrepreneurs in three East African countries: Uganda, Rwanda and South Sudan. In the first year of operation, Solar Sister Entrepreneurs have given over 4000 rural customer's access to solar powered products.

Figure 14: Solar Lamps Provided by the Solar Sister Social Enterprise



Source: Solar Sister

28. Nokia

29. See Appendix 5 for more detailed information on the Jokko Initiative – contacts for this initiative: jokkoinitiative@tostan.org or sengal@ruralenergy.nl

30. Tostan is a US NGO working on the empowerment of African Communities www.tostan.org

31. The Tostan initiative covered 15,000 oarticipants from 2008 to 2011 from approximately 400 communities across Senegal and Mauritania

32. Rural Energy Foundation is a NGO based in the Netherlands http://www.ruralenergy.nl

33. See Appendix 6 for more detailed information on Solar Sister

34. www.solarsister.org

The Battery Solution

Fenix International, a San Francisco based renewable energy company, is providing a battery solution coupled with solar, kinetic and grid / mains charging to allow developing country entrepreneurs to set up phone charging shops. Off-grid communities around the world are heavily reliant on car batteries to power electronic devices. These batteries deteriorate quickly – in as little as six months – due to deep discharging and over-charging.

Figure 15: Fenix International Charging Kit



The ReadySet solution consists of a rugged battery and integrated charge controller, with 12-volt car adapter ports and USB ports for charging phones and devices. It charges from solar, bicycle, and grid / mains power, and provides a battery lifetime of two to three years.

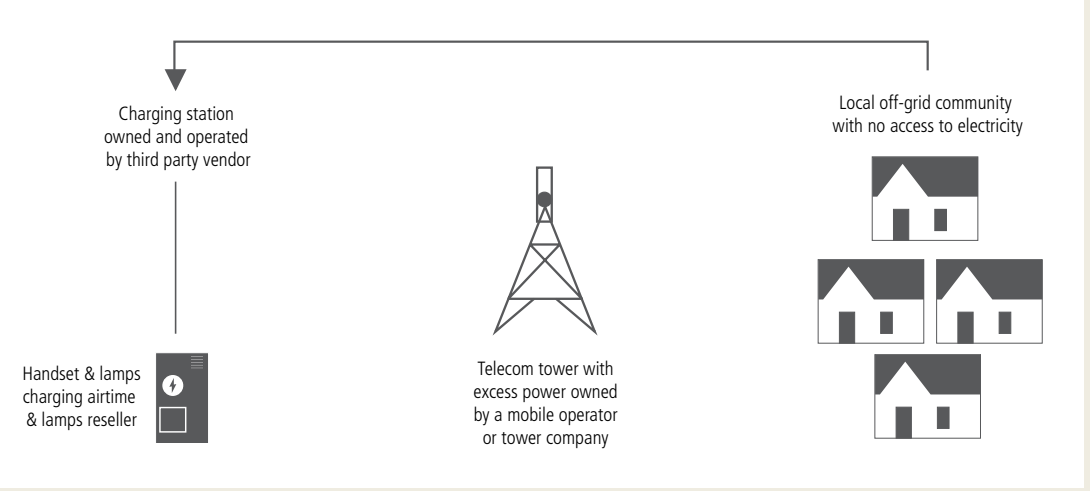
Available to mobile operators for between US\$100 and US\$200, the product is targeted at local entrepreneurs, who purchase the product with cash or a loan from a microfinance institution. The ReadySet was designed for rapid payback for both the end-user – who can earn \$50-75 a month through phone charging services – and the mobile operator, which earns as much as \$200-300 annually per device in incremental voice, mobile money and pay phone revenues. Today, the product is being trialed by mobile operators in several African countries.

Source: Fenix International

Community Power from Mobile (CPM) Model

The GPM programme, over the last two years, has developed the Community Power from Mobile (CPM) concept³⁵. Typically with more than 5 kilowatts (kW) of excess power each, the off-grid base stations are able to charge a range of devices such as mobile handsets, lanterns and household batteries. Base stations are often physically close to villages which means that communities will no longer have to waste time travelling long distances to charge devices. The CPM model is based on the operation of local charging stations by an agent from the nearby community. Pilots are currently being launched in several East African countries.

Figure 16: Community Power from Mobile Diagram



Source: GSMA

Purchasing Versus Leasing Charging Solutions

The income of most households in off-grid regions remains very low and the high price of charging devices is a major barrier to ownership. A price point of US\$10 is critical to be affordable, however their efficiency in charging multiple devices from the same battery will remain limited compared with more expensive models.

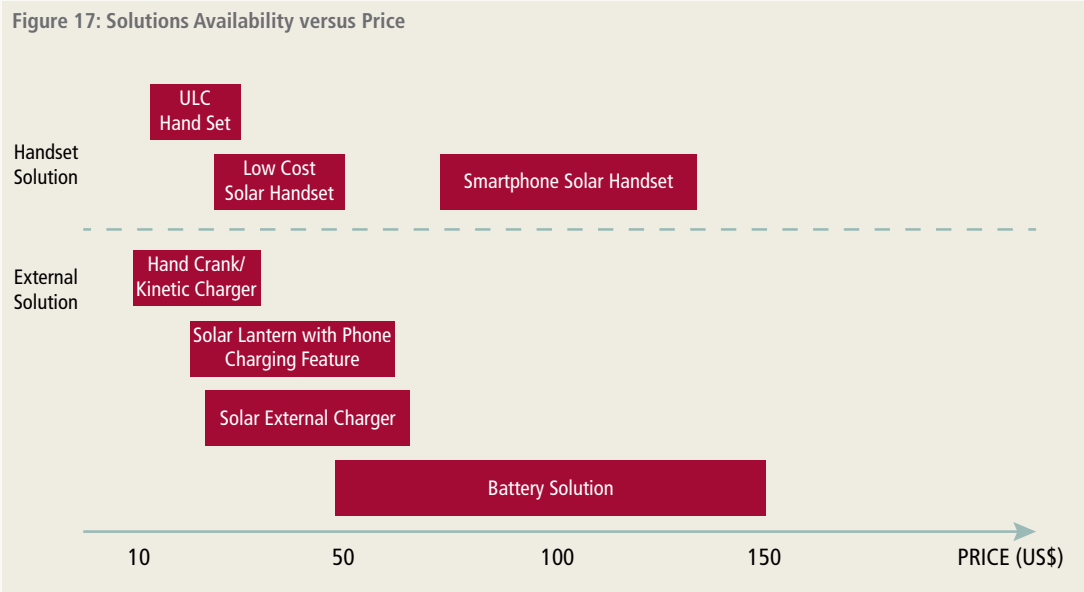
BoP customers are eager to have access to well-designed, efficient and long-lasting devices. Even though they are willing to pay a higher price to acquire such devices, they cannot afford the purchase nor do they sometimes have the ability to contract a microfinance institution to

get a loan. To reduce these issues, some companies providing higher end charging models are trialling leasing models, based on the ‘fee for service’ concept. In these models, local community groups act as retailers and leasing agents for these devices. End users willing to rent the device can sign a contract directly with the agent, ensuring their commitment to pay for the device. An option for purchase might also be included so that users have access to preferential tariffs to own the device.

35. For more information on Community Power from Mobile
http://www.gsmworld.com/our-work/mobile_planet/green_power_for_mobile/community_power_from_mobile.htm

Charging Solutions Overview

Several solutions coexist today to provide off-grid subscribers with a local and sustainable solution. Vendors have also been targeting this segment, providing thoughtful design and improved efficiency to achieve faster charging periods. In terms of volume, the GSMA estimates that up to 1 million charging devices³⁶ were shipped in 2009, with a projection of up to 5 million devices shipped in 2011 (a growth rate >150% per year³⁷). Although better affordability and reliability of devices should ensure sustainable sales, mobile operators can further increase this dynamic by distributing to their off-grid customers.



Source: GSMA

The Barriers to Charging Solution Adoption

- **Cost:** The cost of ownership of solar handsets and external charging is one of the main barriers to mass adoption. As for mobile handsets, the average price for newer solar handset models such as the ZTE VF 247 provided by Vodafone India and Vodacom (RSA) at the end of 2010, oscillated between US\$32 to US\$42. As a comparison, Ultra Low Cost (ULC) handset models retail today for US\$15. On the grey handset market, mobile subscribers can find even cheaper models. So from the prices of ULC to solar handsets, there is almost a ratio of 1 to 3. In off-grid environments, people tend to prefer ULC handsets, even if they have to go to charging shops to recharge their battery. Some external charger models are available at a lower price point, starting at US\$10, but going up above >US\$50. As price varies, efficiency also varies; therefore each model has to be tailored to customer needs.
- **Reliability:** The lack of traction of such devices can be partly explained by the poor quality of the products available on the mass market. Retailing at low prices, these charging devices achieve low efficiency and are often unreliable. When purchasing a solar handset, users want to be sure that they will get access to a faster and more convenient way of charging their mobile phone in their local environment. Vendors have been improving the design and technology behind their charging products in recent years, working directly with end users to enhance the overall user experience.

- **Distribution:** The availability of these devices is another critical barrier. Solutions are available but the difficulty in reaching consumers in remote off-grid regions prevent vendors from achieving the economies of scale and mass distribution required. Partnerships with mobile operators would give vendors access to their extensive distribution network and have a wider impact on communities.
- **Security:** Users are eager to get access to charging solutions, but they also want a reliable, cheaper and easy to use solutions compared to what is currently available. Charging should be a seamless experience, where the impact on daily life is negligible. The use of solar and other charging solutions may be stressful in some environments where theft rate is high. In these locations, people will be unwilling to leave their devices to charge outside without any attendance. Security of devices being charged is a high priority, and the community charging remains a good solution to this problem.

36. Including solar handsets, external charger, lamp with charging feature

37. GSMA based on sales figures communicated by vendors & operators