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# Green Power for Mobile Charging Choices 2011

Mobile Phone Charging Solutions in the Developing World











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# **Executive Summary**

As the rate of mobile subscriptions surges in developing countries, mobile phones are becoming a vital tool for empowering remote communities. However, several barriers remain which inhibits full adoption in rural regions. Coupled with the economic factor linked to the Total Cost of Ownership (TCO) of mobile handsets, the energy factor remains one of the top issues for mobile subscribers. A growing proportion of these subscribers (estimated to more than 500 million in 2010) live off-grid and the current solutions to charge their mobile phones are, overall, distant and costly. Since 2009, several solar models have been introduced in developing countries including India, Kenya and Uganda.

Over the last year, the Green Power for Mobile (GPM) Programme has been working with Mobile Network Operators (MNO) to address the off-grid charging issues. There is an increasing consideration from operators to add solar phones to their handset portfolio particularly in rural markets. Since 2009, several solar models have been introduced in developing countries including India, Kenya and Uganda. The Digicel Group has been distributing solar phones in various emerging markets after estimating a market of 700,000 customers across Central America, the Caribbean and the South Pacific in 2009.







Since 2009, several solar models have been introduced in developing countries including India, Kenya and Uganda. The Digicel Group has been distributing solar phones in various emerging markets after estimating a market of 700,000 customers across Central America, the Caribbean and the South Pacific in 2009. In terms of volume, the GSMA estimates that up to 1 million charging devices were shipped in 2009, with a projection of up to 5 million devices shipped in 2011 (a growth rate>150% per year.

In addition to solar handsets, there is also rapid innovation around other renewable charging technologies such as kinetic charging and external solar chargers. Solar external chargers in particular are a good alternative to solar handsets and are very appealing to the poorest consumers who are unable to afford or travel to charging shops on a regular basis. In an attempt not to stifle innovation, the GSMA promoted momentum around these different technologies to address the charging issue for users who do not have easy access to the grid. This applies not just to their mobile phones, but for other low power devices such as lights, radio and batteries, thus improving the quality of life for many rural communities. The various technologies available as well as the benefits and barriers for each, will be discussed at length in the body of this report.

To better understand the current challenges of the off-grid population accessing electricity, the GPM Programme conducted several field studies<sup>1</sup> to collect and analyse data about charging services, expenditures and end user behaviour. The countries studied for this project are listed below and detailed results can be found in the appendix of this report:

- Sub-Saharan Africa: Uganda, Kenya, Burundi
- South Asia: India, Bangladesh, Cambodia

Solutions for charging mobile phones vary according to the country's electrification rate. We found that different models of phone charging were required for the various African and Asian countries. In most African countries, off-grid mobile subscribers usually charge their phone on a pay per charge basis at a nearby "Phone Shop" owned by a local entrepreneur. In Asia, the handset charging shop model is not as dominant as it is in Africa and subscribers spend much lower on charging their handsets. For example, the primary issue in Indian rural electrification is grid reliability rather than grid availability. Batteries are widely available and allow users to power home devices such as televisions, lights and mobile phones.

Overall, mobile operators have a key role to play in bridging the energy gap by providing charging solutions for mobile phones and other low powered devices. This will first benefit their core business. Previously conducted trials have suggested that when off-grid subscribers acquire mobile charging solutions, usage and ARPU increases by 10% to 14%<sup>2</sup> Due to their strong position in emerging markets and direct relationship with off-grid customers, operators could also benefit from building a stronger relationship with vendors and rural communities to enhance the efficiency and affordability of energy access.



 Countries were selected according to availability of local workforce on site and electrification rate/GDP characteristics.

 Digicel - this ARPU increase can be explained by the transfer of expenses from travel and charging to spending on airtime.

# **Chapter 1** Mobile Access in Off-Grid Regions

## **Growing Mobile Penetration in Rural regions**

Today GSM is the most popular and widespread personal technology on the planet, with a forecasted 6 billion connections at the end of 2011. Over the last few years, the developing world has proven to be the engine for this growth and now accounts for almost 80% of the world's total mobile connections.<sup>3</sup>





3. Wireless Intelligence

Growth in the developing world is not uniform across market segments; rural regions have lagged significantly behind urban regions. Recent generators for off-grid cell tower sites as well as research from the GSMA estimates a 95% market penetration in urban regions but only 28% penetration in rural regions.<sup>4</sup> This rural gap, totalling 1.39 billion unconnected people, represents a major untapped market segment for mobile operators.

Figure 1: Urban/Rural Penetration by Region



Source: GSMA

The remote location of rural populations means that availability of mobile services is even more vital. A rural customer is likely to be unbanked, in the highest need of mobile money, will live the farthest from health centres or hospitals and therefore will benefit most from mobile health services. A high proportion of them will work as farmers, so would make good use of mAgri services (weather information, crop prices).

Mobile penetration remains the lowest in African and Asia Pacific. These two continents represent an untapped rural market of more than 1.21 billion people.<sup>5</sup> Indeed the urban-rural disparities are high in these regions where a large proportion of the population still lives in rural areas and is considered to be living under the poverty line. Due to economic factors, mobile phones are generally shared by a household and/or a community.

Although the rural segment represents a major underserved market for mobile operators in the developing world, major challenges remain to access this market. The business case for expanding network coverage into rural regions is challenged by the dispersion of villages and the

Average Revenue Per User (ARPU) being too low. The high energy costs of running diesel the high operational and maintenance costs due to the remoteness of these cell sites adds to the challenges and barriers operators face when targeting rural regions.

To expand further on these challenges, once the network is built and the coverage is provided, there are multiple issues which may make a person unwilling or unable to own a mobile phone. Income levels in rural areas are likely to be lower than for an urban dweller making handset costs and airtime expenditure a barrier to ownership. In addition, rural customers in the developing world typically live in either off-grid or unreliable grid regions therefore require 'charging shops' to power their handsets.

## Access to Electricity is Rare in Rural Regions

A study published in 2009 by Accenture<sup>6</sup> looked into the obstacles to mobile adoption in rural environments. Added to total cost of ownership and the lack of mobile infrastructure leading to poor reception, the inability to access electricity when required to charge handsets was viewed by the end consumers as one of the main barriers to mobile take up.

Today, electricity access in the sub-Saharan Africa and South Asian regions is still well below the world average<sup>7</sup> ( $\sim 65\%$ ), with less than 10% of the population having direct access to the electricity grid in many countries in Africa. The situation is not going to change in the short to mid-term due to the high investments required from governments and private players to electrify the isolated rural areas.

## Table 1: Population and Number of Mobile Subscribers without Access to Electricity

	Population without Access to Electricity <sup>7</sup> (in million)	Mobile Subscribers without Access to Electricity <sup>8</sup> (in million)
Sub-Saharan Africa	585	161
Middle East and North Africa	24	12
East Asia and Pacific	186	88
South Asia	612	260
Latin America	31	27

The total number of people living in homes not connected to the electricity grid is estimated at 1.6 billion.<sup>9</sup> The total number of mobile subscribers living in off grid areas is estimated to 548 million. This proportion will grow with time as mobile penetration is increasing quickly in emerging markets<sup>10</sup> (growth estimated to ~20%) per year in Africa and Asia Pacific) whereas the extension of the electricity grid is much slower (<5% per year). According to the International Finance Corporation (IFC), the number of African mobile users is expected to overtake the number of households connected to the electricity grid in 2011. This gap is expected to further increase in 2015, with around 30% of the population expecting to be connected to the electricity grid and mobile penetration reaching





Figure 2: Regional Segmentation of Off-grid Mobile Subscribers (in million subscribers)

85% of the population.<sup>11</sup>



Source: GSMA

Supply outages are common across Africa even when connected to the grid, as power outages are a daily occurrence across much of East Africa. Research conducted by Lighting Africa reveals that more than one-third of the connected population experience power loss at least once a week, lasting from anything between a couple of hours to days at a time.<sup>12</sup>

The divide is even more important when comparing urban and rural areas especially in the sub-Saharan and South Asian regions. Without direct access to electricity, rural mobile users rely on third party charging services and have a much higher expenditure on energy than people living in urban areas.

4. GSMA - Based on the calculation of mobile penetration in urban and rural areas from 112 developing countries mid-vear 2009

11—12

5. Based on the number of persons between 14 to 74 years old living in rural areas and who doesn't have a mobile subscription

- 6. New business model for profitable rural expansion – Accenture - 2009
- 7. IEA, World Energy Outlook 2009
- 8. GSMA 2010 Based on the ectrification level and marke penetration per regions in 2010



## Figure 3: Regional Urban Versus Rural Electrification Level

Source: IEA World Energy Outlook 2009

- 10. Wireless Intelligence 4Q2010
- 11. Source IFA & Wireless Intelligence
- 12. Lighting Africa Off Grid Lighting for the Base of the Pyramid 2010

<sup>9.</sup> UN – Energy Poverty Report - 2010

# Chapter 2 Results from the Field

To understand better the current challenges of the off-grid population accessing electricity, the GPM Programme conducted several field studies to collect and analyse data about charging services, expenditures and end user behaviours. Countries studied for the project have been<sup>13</sup>:

Sub-Saharan Africa: Uganda, Kenya, Burundi South Asia: India, Bangladesh, Cambodia





Countries were selected according to availability of local workforce on site and electrification level/GDP characteristics

Figure 4: Regional Handset Charging Field Studies Uganda, Kenya, Burundi, India, Bangladesh, Cambodia

The results from these field studies allow us to outline global trends in mobile phone charging and general access to charging services in developing countries. Overall, the consensus is that expenditure is very high for the off-grid population on handset charging services, sometimes up to 50% of their monthly mobile expenditures. The charging process is also time consuming, as a round trip often involves a full day's travel to the nearest urban area to access electricity. It is estimated that in most cases, phones are not in use for at least 1 day per week due to battery depletion. Most people interviewed in Uganda<sup>14</sup> say that they would spend more money on airtime if they could save money on charging services.

Solutions for charging mobile phones vary according to the country's electrification level. We found that as a result, different models of phone charging were required for the various African and Asian countries. The table below presents a short summary of our main findings.

In most African countries, off-grid mobile subscribers usually charge their phone on a pay per charge basis at a nearby "Phone Shop" owned by a local entrepreneur. In Uganda, mobile users are spending between 10% and 50% of their monthly mobile expenditure on the charging process, preventing them from buying airtime as much as they would like.

## Table 2: Off-grid Handset Charging Field Studies Summary

	India	Cambodia	Kenya	Bangladesh	Uganda	Burundi
Electrification Level 2009 (%) <sup>15</sup>	66	24	18	41	9	2
Mobile Penetration (%) <sup>16</sup>	55	44	58	39	40	16
GSM Population Coverage (%) <sup>17</sup>	73	86	95	89	97	59
ARPU (Q2 2010)1 (US\$)18	2.99	5	4.33	2.38	4.20	3.68
Charging Expenses per Month <sup>19</sup> (US\$)	0.5-3	0.5-2	1.5-6	0.5-2.5	1-7	1-5
Travel Expenses Impact	Low	Average	High	Average	High	High
Monthly Expenditure Spent on Charging Services (%)	10-20	~10	10-50	15-25	10-50	10-40

15. IEA – World Energy Outlook 2009 electrification level is defined as the % of population or households with electricity

Source: GSMA

14. Around 80% of the people interviewed in Uganda would rather spend money on airtime than charging service (based on a sample of 45 persons)

16. Wireless Intelligence 2010

17. GSMA - Based on GIS methodology

18. Wireless Intelligence 2010

19. Data gathered from GSMA field studies in respective countries does not include expenses on travel to charging shop

The cost of a single charge is relatively high for example in downtown Kampala charging a mobile phone costs three times the cost of a phone call ~ 500 Ugandan Shillings (US\$0.21).<sup>20</sup> In rural Africa, people living in remote areas travel sometimes up to 20 km to charge their phone. They may spend up to 50,000 Ugandan Schillings (US\$25) per month on transportation to the nearest village, mainly to charge their phones. If in luck, they may be able to give their phone to a driver (truck, car, bike) going to the city to get it charged for them, and then recover it again in the evening.

## Figure 5: Charging Shop in Kisoro (Uganda)

- 30 Handsets can be charged simultaneously. Handsets are securely locked in the cabinet below
- The charging services are provided by this hairdressing salon, connected to electricity



### Source: GSMA

In Uganda, the low electrification level of the country means that unfortunately mobile users have to travel several kilometres before reaching an area connected to the electricity grid. Local solutions such as solar panels are becoming more available but still rare due to the high capital expenditure (CAPEX) required; an owner of a charging shop in Uganda would purchase a solar system (50W solar plus battery) for at least US\$200.

In the table 2, ARPU is often lower than the amount spent on charging services. This is explained by the fact that mobile users may own several SIM cards, switching SIM cards to make use of the lowest tariffs when making a call. As a result, their mobile expenditure will be a sum of separate ARPUs. This behaviour is so widespread in emerging markets, that there are even dual and triple SIM handsets available on the market.



Results from the Field

Figure 6: Mobile Phone User Profile in Rural Uganda

Mobile User: Anna K. in Rural Uganda Occupation: Farmer Location: Uganda Kanoni Trading Centre – 600 inhabitants. Rural area with low population density

Anna lives 3 km away from Kanoni, in a house not connected to the electricity grid. The first city connected to the grid is 10 km away. She comes to Kanoni to charge her handset twice a week, using a boda boda (local motorbike taxi) costing her 10,000 UShs (US\$5) for a return trip.

Her total expenditure on charging services per month is estimated to be 4500 UShs (US\$2.5). The total expenditure on transport per month is up to 45,000 UShs (US\$25). She needs her mobile phone for its farming business: prices and weather information as well as to call friends and family. She would prefer to spend more money on airtime if she could reduce the charging expenditures.

Source: GSMA



In Asia, the handset charging shop model is not as dominant as it is in Africa and subscribers spend much lower on charging their handsets. For example, the primary issue in rural electrification in India is grid reliability rather than grid availability. Batteries are widely available and allow users to power home devices such as televisions, lights and mobile phones. In India, most people with access to some form of grid electricity rely on it to charge their phones. Wealthier households are able to install larger battery/inverter systems as backup solutions<sup>21</sup> whereas poorer households often only have smaller 12V batteries<sup>22</sup>, just enough to charge mobile phones. Household batteries can be charged at US\$0.20 to US\$1.1 per charge depending on the battery capacity. In Cambodia, nearly every household has a car battery for their home; the cost of charging a battery is between US\$0.37-0.50 for a 40-50 Ampere lead acid car battery. The monthly expenditure for battery charging is estimated to US\$4 per month.

Mobile phone charging can also be offered as a complimentary service:

- In Cambodia, free phone charging is often offered at the local airtime distributor shop when the users tops up on airtime for at least US\$0.7
- In India it is common for longer distance busses to offer mobile phone charging as a value added service





- 21. Richer households tend to install large battery + inverter systems which cost as much as INR 9000 (~US\$200)
- 22. Poorer households own 12V 15 or 25 Ah battery/inverter systems which cost INR 1500-2000 (~US\$35-45) which are used to charge mobile phones during outage

Figure 7: Charging Shops in Uttar Pradesh (India)

# 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

21—22

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 charge<sup>23</sup>; 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.<sup>24</sup> 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.



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

## Figure 8: Estimated ROI from Solar Handset Use



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	UTL, Digicel, Vodacom, Econet,
(providing solar handsets)	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: Touahstuff



The most abundant use of electricity in rural households is for lighting<sup>26</sup>. 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 2015<sup>27</sup>. 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.

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

Renewlt, 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

<sup>26.</sup> The Welfare Impact of Rural Electrification 2008

<sup>27.</sup> 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.



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



Source: Barefoot Powe

### 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 phone<sup>28</sup>. 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.





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 Initiative<sup>29</sup>

In 2009, in partnership with UNICEF, Tostan<sup>30</sup> added the Jokko Initiative<sup>31</sup> 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 Foundation<sup>32</sup>, 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

## **Social Enterprise**



Source: Solar Sister

28. Nokia



## Women-Centred Distribution System<sup>33</sup>

**Solar Sister**<sup>34</sup> is a social enterprise that empowers women through economic opportunity. Using a women-centred distribution system for microsolar 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



- 29. See Appendix 5 for more detailed information on the Jokko Initiativ contacts for this initiative: iokkoinitiative@tostan.org or sengal@ruralenergy.nl
- 30. Tostan is a US NGO working on the rment of African C empowerment of www.tostan.org
- 31. The Tostan initiative covered 15.000 oarticipants from 2008 to 2011 from approximately 400 communities across Senegal and Maurtania
- 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

## Off-Grid Charging Solutions

## **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



Source: Fenix International

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.

## Community Power from Mobile (CPM) Model

The GPM programme, over the last two years, has developed the Community Power from Mobile (CPM) concept<sup>35</sup>. 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.



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.

<sup>35.</sup> 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

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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 devices<sup>36</sup> were shipped in 2009, with a projection of up to 5 million devices shipped in 2011 (a growth rate >150% per year<sup>37</sup>). 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.

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

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

# Chapter 4 The Role of Mobile Operators

Due to their extensive distribution channels and strong links with the off-grid population, mobile operators have a key role to play in the accessibility of charging solutions for remote off-grid communities.







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## Revenue Benefits from Mobile Phone Charging

The GSMA estimates 548 million mobile subscribers live in off-grid areas today; these subscribers live mostly in two regions, South Asia and sub-Saharan Africa, where the percentage of rural populations remains high. The total market opportunity for mobile operators is estimated to be US\$3.37 billion globally<sup>38</sup>, the sub-Saharan Africa and South Asian regions having the highest potential to supply charging solutions.

Figure 18: Additional Yearly Revenues for Mobile Operators from Charging Solutions Availability (in million US\$)



Source: GSMA

This calculation is based on an estimate from the mobile operator Digicel. Trials in Haiti and Madagascar in 2009 suggested that when off-grid subscribers acquire mobile charging solutions, usage and ARPU increases by 10% to 14%<sup>39</sup>. This ARPU increase can be explained by the transfer of expenses from travel and charging to spending on airtime. Increased battery life also contributes to the increase in ARPU. Without an instant solution for phone charging, phones are

often left unused for days after the battery life has depleted. This consequently leads to reduced usage, whereas an instant charging solution would allow the user to use their phone as and when required. Incremental revenue opportunities range from US\$83 million per year in the MENA region, to US\$1.33 billion per year in sub-Saharan Africa; on a country level, India accounts for the majority of this with an estimated US\$866 million.

## Figure 19: Revenue Opportunity Segmentation by Regions



Source: GSMA

There are additional benefits to operators and the community:

## Table 5: Benefits to Mobile Operators and Community

Benefits to	
Operators	Local ARPU increase due to availability of charging solutions New mobile users within community Increased community support for the company brand (churn reduction)
Community	Time savings (reduced travel to charging shops) Cost savings (reduced charging expenditures) Ability to charge multiple devices (external chargers) Local Empowerment

## Mobile Operators' Current Approach to **Charging Solutions**

Mobile operators ensure their users have access to mobile connectivity by extending their network and increasing mobile coverage. On the user side, people have access to mobile phones and are finding ways to charge their handsets; going to charging shops or using local solar or kinetic external chargers. The difficulty is that, to date, charging of handsets has not been viewed as a major barrier for operators in terms of subscriber growth.

Operators are also testing external chargers in order to get feedback from users and assess the priority of distributing such devices. Mobile operators are more inclined to provide charging products to off-grid communities on a Corporate Social Responsibility basis. Low end solar chargers (such as the model retailing for US\$10) are sometimes distributed for free in off-grid regions. Higher end models (achieving higher efficiency at a higher price >US\$50) are being trialled by different operators in West and East Africa.

However these energy challenges are real and in recent years mobile operators have begun distributing solar handsets and external charging solutions. The additional upfront cost for customers of solar handsets has prevented operators deploying devices on a mass scale. The new generation of solar handsets and other external charging solutions may however bring new perception to these devices, achieving lower costs and faster charging rates.

<sup>38.</sup> GSMA-2010-Based on the average ARPU per country and a conservativ estimate of 10% ARPU increase from charging solutions

## Suggested Future Approach with Charging Solutions

Mobile operators have a key role to play in bridging the energy gap to charge mobile phones. Thanks to their strong position in emerging markets and their direct relationship with off-grid customers, they could benefit from building a stronger relationship with vendors and communities to enhance affordable energy access.



Source: GSMA

Several options can be considered to create a healthy charging ecosystem:

- Using operator's distribution channels: by providing the charging devices at local airtime shops, operator's ensure remote off-grid populations have access to appropriate solutions. Extra revenue could include a margin on the devices sold (from a price range of ~US\$10 to US\$150)
- **Bundling option:** for external chargers, solutions could be bundled with airtime or handsets, so that users within a community have access to a full package of mobile communication

• Leasing model: solutions could be leased to end users to reduce the primary cost of ownership and upfront capital

By partnering early with vendors, mobile operators can also trial the different charging solutions directly on the field and collect feedback from end users as well as the impact on these communities through indicated such as ARPU, minutes used per user and new subscriptions.

## Appendix

## 1. Field Study Uganda

A field study in Uganda was conducted in August 2010 with the support of MTN Uganda. MTN Uganda is involved in several off-grid charging projects. 12 sites were visited across the country, from East to West, in different environments: urban perimeter with unreliable access to grid, rural areas with access (unreliable) to grid and off-grid areas.

Figure 21: Charging Shops in Kanoni and Kisoro (Uganda)





Source: GSMA

in rural areas.

The cheapest handset available is ~US\$14. People are usually willing to pay more to have a more efficient and longer lasting product. Uganda Telecom (UTL) is the only solar phone distributor in Uganda for a cost close to US\$30.

There are major problems of theft in Uganda and customers value the charging shop experience as they know their handset is secure while charging. The price of a charge varies between 200 to 500 Ugandan Schillings (US\$0.10 – US\$0.25), with an average price of US\$0.20. The price seems to be dependent on the site's connection to the electricity grid the price is usually lower when the site is connected or close to a large city connected to the grid.

Average monthly expenditure is estimated at ~US\$2.25. This represents between 10 and 50% of subscribers mobile expenditure per month. Added to that is the cost of transport; people living in remote areas travel up to 20 km to charge their phone and can spend up to 50,000 Schillings (US\$25) per month on transport to the nearest village. Sometimes they are able to give their phone to a driver (truck, car, bike) going to the city to get it charged for them, and then recover it later in the evening. More than three out of four interviewed would spend more money on airtime if they could reduce their charging expenditure.

Whereas almost everyone owns a phone is urban areas, only 1 in 5 people owns a phone 2. Field Study India

35—36

A field study in India was conducted in September 2010 with the support of Bharti-Infratel and Idea Cellular. 10 sites were visited across Uttar Pradesh. This covered 9 villages with unreliable access to the grid.

Figure 22: Charging Shops in Uttar Pradesh (India)





Source: GSMA

The primary issue with rural electrification in India is grid reliability rather than grid availability. Even though in some states like Bihar, Meghalay and Jharkhand where grid availability is an issue, in most parts of the country, grid electricity, even if scarce, is available in some form within a short distance from most villages. In Uttar Pradesh where this research was conducted, villages closer to urban centres and highways had better grid connectivity than those further away. Long power outages are common, though restoration time varies from region to region. Most people with access to some form of grid electricity rely on it to charge their phones.

Uttar Pradesh (UP) is the most populous state in India but is also among the poorest states in India. As of 2005, only 19.8% of rural households were electrified, placing it among the bottom 5 states in terms of levels of rural electrification. Villages closer to urban centres have better grid reliability (8-10 hours a day) than those further away (4-5 hours a day). Week-long power outages, sometimes extending to 15 days, are common due to transformer failures.

ARPU is about INR 270 (~US\$6) in villages close to Muzaffarnagar and reduces significantly as one travels further out, reducing to INR150 (~US\$3.3) in a small remote hamlet. Richer households tend to install large battery + inverter systems which cost as much as INR 9000 (~US\$200). Poorer households own 12V 15 or 25 Ah battery/inverter systems which cost INR1500-2000 (~US\$35-45) which are used to charge mobile phones during outages. In small remote villages in the interior airtime shops double up as charging shops, which charge mobile phones at about US\$0.10 per charge and household batteries at U\$0.20 to US\$1.1 per charge depending on the battery capacity.

## 3. Field Study Cambodia

A field study in Cambodia was conducted in September 2010 with the support of Hello Axiata. Several sites were visited in rural Cambodia in off-grid and grid connected regions.

The electrification level in Cambodia is estimated to be 17%. Commercial power is rarely available and rural inhabitants have to travel several kilometres to access electricity. Around 96% of the Cambodian electricity is generated by diesel; however, Cambodia has a very big potential for renewable energies, especially solar, wind and hydropower.

Overall mobile coverage is good (86% of population), but mobile penetration in rural areas remains low (10-20%) – where families have to share their handset. ARPU levels in rural areas are estimated at US\$2-3 whereas ARPU in urban areas US\$6. At the time of this study, solar handsets were not available in Cambodia.

Handset charging is mostly done through car batteries, as nearly every household has one. The batteries run the TV as well as charging small devices via a DC charger. Batteries are perceived to be a very convenient source of power and relatively cheap. People usually travel to the local shop 1 or 2 times per week to charge their battery. The cost of charge a battery is between US\$0.37-0.50 for a 40-50 Ampere lead acid car battery. The GSMA estimates that the monthly charging expenditure for a household battery is up to US\$4 and therefore a very small cost as the power drawn to charge a handset battery is <5Watts.

Electrification level is low in Bangladesh, estimated to be 39%. Rural inhabitants have to travel several kilometres to access electricity and 80% of the total population live in rural areas.

## 4. Field Study Bangladesh

A field study in Bangladesh was conducted in September 2010. Several sites were visited in rural Bangladesh in off-grid and grid connected regions.

Mobile penetration in rural areas remains low  $(\sim 20\%)$ , with penetration being 40% on a national level. Overall mobile coverage is good (89% of population). Subscribers have access to local charging points (through neighbours or friends) as well as handset shops. Travelling to a charging point (handset shop) is not convenient especially in rainy and monsoon seasons. Mobile users also have access to solar panels and/or diesel generator to charge their devices locally. Most of the time charging shops are also airtime dealers. These airtime shops offer charging services to customers when topping up on airtime from that shop. The service is free of charge if the user tops up at least US\$0.7 of airtime. Similar patterns exist in most of other parts of the country.

People use their phones extensively and charge them at least 2-3 times a week. Many farmers in this region have to get their phone charged around the Hat days (which are the weekly shopping days, on Saturday and Wednesday of each week).

## The Role of Mobile Operators

## 5. Tostan – The Jokko Initiative

In 2009, in a partnership with UNICEF, Tostan added the Jokko Initiative to its core education programme which aims to teaches the practical uses of standard mobile phone functions including the use of SMS texting as a postliteracy practice tool.

Tostan found that many of its programme participants had limited access to mobile phones, and limited knowledge of the range of its uses. This observation was coupled with the realisation that writing and receiving SMS text messages was an attractive and inclusive way to practice basic literacy skills.

Tostan uses mobile phones primarily as a teaching tool to teach and reinforce literacy, organisation and management skills and secondly as a social mobilisation tool to help to build local development initiatives. The Tostan initiative covered 15,000 participants from 2008 to 2011 from approximately 400 communities across Senegal and Mauritania.

The project 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).

Implemented in partnership with the Rural Energy Foundation, a Dutch NGO, the Jokko Telecentre has three main aims:

- To provide a sustainable source of electricity to charge cell phone during and after the Tostan programme
- To act as a social enterprise for rural communities
- To provide a financial base for awareness raising activities organised by the Community Management Committees (CMC)

Each Telecentre consists of a locally assembled portable wooden suitcase, equipped with a solar panel and multiple outlets where phones and other small electrical appliances can be charged. CMC members can carry the suitcase around their villages and to surrounding communities, charging up to 15 phones per day. Weekly rural markets can be a particularly profitable location. Figure 23: Solar Powered Suitcase and Community involved in the Jokko Initiative





Source: Tostan

## Learnings from the pilot

The telecentres were piloted in 7 villages in the Velingara area of Southern Senegal. The pilot was launched with a four-day training workshop where participants learnt and practiced technical, social, and business management skills relevant to operating a Jokko Telecentre. CMC participants carried out a feasibility study, and developed a foundation in the basics of solar energy. The training culminated in an inauguration of the programme in Sare Dialo, one of the pilot villages, which served as a model for the 6 other villages which launched their own telecentres during the following week.

The monitoring process took place in two main sections. First, in the weeks following the training workshop, two Tostan supervisors visited each village to carry out support. The second phase of the monitoring process was a capitalisation seminar where the Jokko team, with support of staff members from the Tostan Kolda office, visited two villages and held a seminar, with a more qualitative discussion of the successes and

challenges of the telecentres. Some of the indicators covered in the questionnaires included:

- Price of recharging one phone by the CMC (usually XOF100, US\$0.20)
- Number of phones charged during the last week (usually up to 105)
- Number of days per week that the CMC operated the telecentres
- Number of different villages visited by the CMC per week
- Amount of money realised per week from charging phones
- An estimate of the number of people who visit the telecentre per day (including customers and visitors who are simply curious)
- Number of people requesting contact information for the local distributor

## Results

- Each CMC sets its own price, and the price of charging a phone ranged between 50 and 100CFA (US\$0.10 - 0.20)
- The average amount of money made per week from sales of telephone credit was 2200CFA, of which 360CFA is profit (US\$4.40, profit - US\$0.72)
- On average, CMCs charge 50 phones per week, incurring an average weekly income of 3750CFA. (US\$7.50)
- Most CMCs are open for business 7 days a week unless there is a lack of sunshine, or a preponderance of other household activities
- CMCs take the telecentres to between 3 and 5 surrounding villages. Some CMCs choose to remain stationary and instead, invite neighbouring villages to come and charge their phones
- About 15 different clients visit the telecentres each week (they do not necessarily all buy credit or charge phones)

By Katherine Lucey, Solar Sister CEO Solar Sister empowers women through economic opportunity. Using a women-centred distribution system for micro-solar energy products such as solar lamps and cell-phone chargers, Solar Sister brings clean energy access to BoP consumers in rural Africa.

In the past few years, great advances have been made in the technology and design of microsolar products so that they are both available and affordable. They have been designed with features that specifically address the needs of BoP consumers, including building in phone charging capability. However, the lack of distribution systems and a gender-based technology gap means that this potentially life-changing technology is not yet accessible to the people who need it the most.

In rural Africa, the gender-based technology gap is particularly wide, and has devastating consequences as women and girls miss out on education and opportunity due to lack of access. Solar Sister provides the women with a 'business in a bag', a start-up kit of inventory, training and marketing support. The women become their own boss and often, create sustainable businesses. The women use their natural networks of family, friends and neighbours to provide an effective distribution to the most rural and hard-to-reach customers. Because women are 'built-in' to the system, they provide a critical link to the women consumers who often get overlooked by traditional distribution channels.

Using a market-based social enterprise model, Solar Sister has empowered over 100 Solar Sister Entrepreneurs in three East African countries: Uganda, Rwanda and South Sudan. Solar Sister fills the distribution gap for clean energy technology including affordable solar powered lamps and mobile phone chargers. In the first year of operation, Solar Sister Entrepreneurs have been able to bring access to solar powered products to over 4,000 rural customers.

Solar Sister's goal is to build a network of 5,000 entrepreneurs across five countries in five years - benefiting over 1 million people with light, hope and opportunity.

## 6. Solar Sister Initiative

## 7. List of Companies Interviewed for this White Paper

Table 6: Companies Interviewed for the Charging Choices 2011 Report

	Company	Website
Operator	Orange MTN Uganda Digicel Group Telenor Grameenphone Telefonica Vodafone Group Econet Burundi Hello Axiata	www.orange.com/en_EN/responsibility/ www.mtn.co.ug/ www.digicelgroup.com/ http://www.telenor.com/en/corporate-responsibility/ http://www.grameenphone.com/about-us/corporate-information/ corporate-responsibility/cr-initiatives http://www.crandsustainability.telefonica.com/en/ http://www.vodafone.com/content/index/about/sustainability.html www.econetwireless.com/ www.hello.com.kh/
Handset Provider	Nokia ZTE	www.nokia.com/corporate-responsibility wwwen.zte.com.cn/en/about/corporate_information/
External Charger	Renewlt Solarc Toughstuff Suntrica Barefoot Power Solio Bullitt Group Voltaics System Fenix International DLight Design	www.renewit.com www.solarc.de www.toughstuffonline.com www.suntrica.com www.barefootpower.com www.solio.com/charger/ www.sullitt-group.com www.voltaicsystems.com/ www.voltaicsystems.com/ www.fenixintl.com www.dightdesign.com
Technology/Chipset	Intivation	www.intivation.nl
NGO/Social Enterprise	Tostan Solar Sister	www.tostan.org www.solarsister.org/

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Green Power for Mobile website: http://www.gsmworld.com/our-work/mobile\_planet/green\_power\_for\_mobile/index.htm

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