1. Project Concept

The Need: Research throughout the Millennium Villages has shown that the rural poor are paying as much as 5 USD ($) per month for kerosene, batteries, and other energy inputs that could be more efficiently and cheaply supplied by electricity from a centralized source. This 5 $/month of energy use is equivalent to about 1.5 kWh. The rural poor are paying in excess of 3 $/kWh, yet grid electricity prices in many of these countries can be an order of magnitude lower (< 0.30 $/kWh). Detailed analysis of grid connection costs have shown that extending the grid to reach these rural poor typically requires more than 1000 $/household in many cases, and still only connects the few who are nearby the existing infrastructure (roads) along which the grid would be extended. Furthermore, traditional post-pay metering is too expensive given the low energy use levels that theses populations can afford, and the variability of their use. Even individual home solar units, which might supply the right scale of energy (a few kWh per month) are expensive (>2 $/kWh when amortized over the life of the system), as shown in the comparison in Figure 1.

The unfortunate irony is that the poorest are paying the most for the worst quality energy, and the cost to connect them to better, more modern services does not present an appealing, profitable business model.

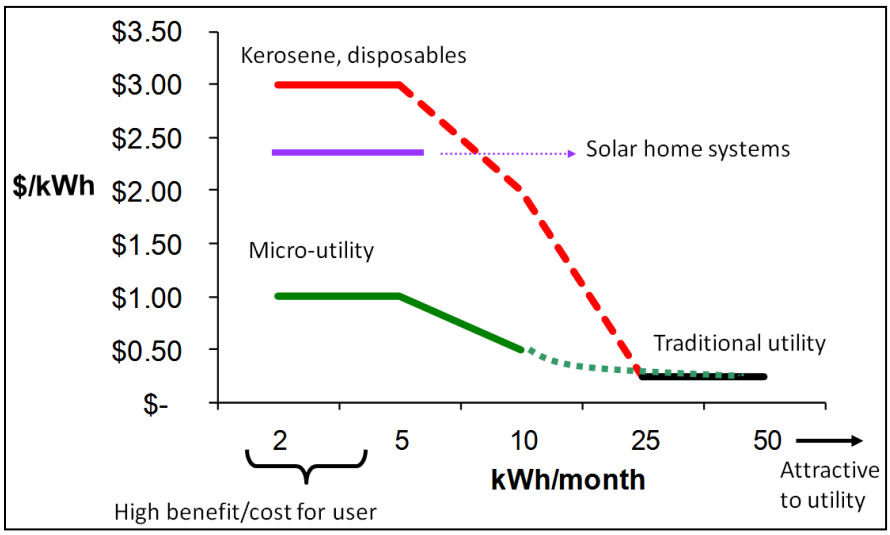

Figure 1: Energy Price Comparison

The Innovation: Prepaid metering (via manually keyed codes or RFID cards on the meter) is an existing technology that has been utilized in traditional macro-utility managed grid based systems in India, China, South Africa, and other areas. Similarly, aggregated sub-metering or Meter circuit metering has been utilized in a wide variety of applications from apartment complexes to server database centers throughout the world. Additionally, mobile telephony providers have developed a profitable prepaid business model throughout the developing world that supplies an analogous service (low amount of highly variable use). Furthermore, small (1 kW), stand-alone power technologies such a solar PV or even

diesel-solar hybrids are well understood and are highly flexible, due to their modular characteristics, and many times offer higher reliability than even local grid services.

The marriage and modification of these four mature technologies provides a compelling solution: small scale (1 kW) micro-grids with prepaid, aggregated metering and semi-automated management as shown in Figure 2.

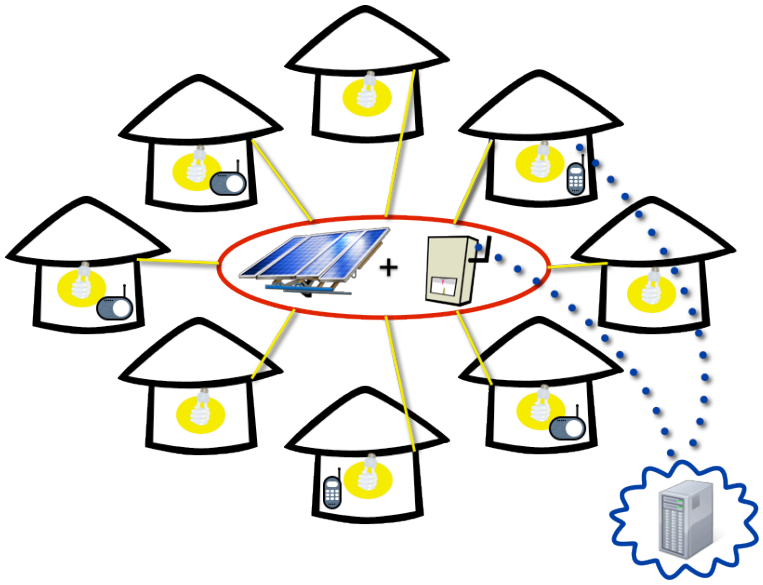

Figure 2: Micro-grid Star Topology and Remote Server (Payment Gateway) Communicating with Meter over Mobile Network

How it Works: Connected households buy scratch cards from local vendors, similar to prepaid airtime, and then SMS the revealed codes to credit their account (associated with a wire running to their home or business). The SMS message is sent to the payment gateway server. The payment gateway communicates, also via SMS and HTTP, with power meters connected to each of the households, to turn power on and off as needed. When the customers credit is exhausted, the meter shuts off the customer's circuit. We have designed the systems to be modular so that as demand for electricity increases, we can simply add solar generation capacity or deploy additional systems. An additional benefit of SMS meters is that maintenance costs can be lowered by automated reporting of system health.

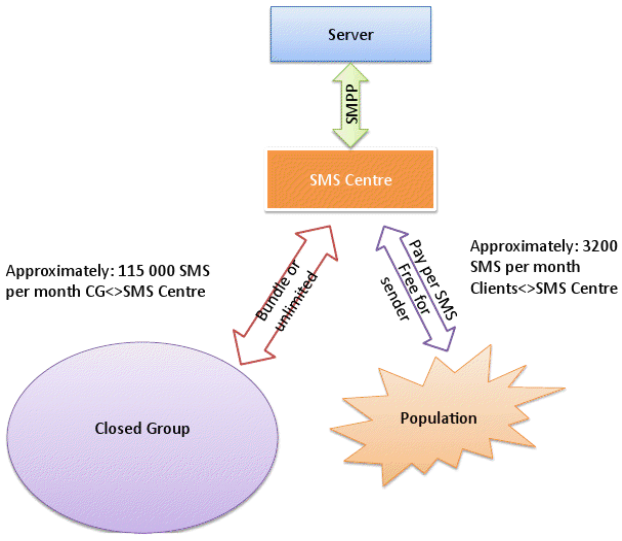

Figure 3: Information Flow Diagram

The Plan: Partners from Columbia University, UC Berkley, Scatec (Norway), and Millennium Promise have developed a modular micro-utility system called SharedSolar. SharedSolar systems utilize a network of micro-grids, each controlled with a unique prepaid metering system that leverages existing mobile telephony systems. Through remote management, the metering costs are significantly minimized and automated dispatch further drives down monitoring and maintenance costs. Whereas existing metering technologies assume a threshold of use beyond the economic capacity of the rural poor, these specially designed meters allow for the low load levels typical of the targeted contexts. System modularity provides flexibility and even a path toward eventual grid connectivity. Tampering is also eliminated – the wire leaving the centralized meter is the property of the consumer it powers.

An initial pilot in Pelengana, Mali was initiated in late 2010 to test the technology. Early results have confirmed the assumed typical use patterns of the systems: consumers are happy to replace their kerosene and dry-cell purchases, enjoying the significantly improved light from efficient electric lighting and immediately find the electric outlet useful for charging their mobile phones and powering other small electronics (see Figure 4).

Figure 4: Pelengana Mali BEFORE (a) Woman with kerosene lantern (b) child studying by kerosene lantern light, AFTER (c) Woman with SharedSolar electric lighting, (d) child studying by SharedSolar electric lighting.