CHAPTER 5

# Innovations

**Figure 5.1: CHWs at work**

New technologies and innovative solutions are changing the way energy and infrastructure planning and project implementation is executed in developing countries. Alongside more traditional technologies and projects, the MVP Energy and Infrastructure sector has developed new solutions to common development challenges. This chapter profiles four innovations that have had shown an impact at the village level and are now being scaled to the national level.

## ChildCount



Reducing child and maternal mortality by 66% and 75% respectively are core MDGs. In much of sub-Saharan Africa, 10 to 20 percent of children die before turning five, while the death of women during childbirth, a rare event in industrialized countries, occurs far too frequently.

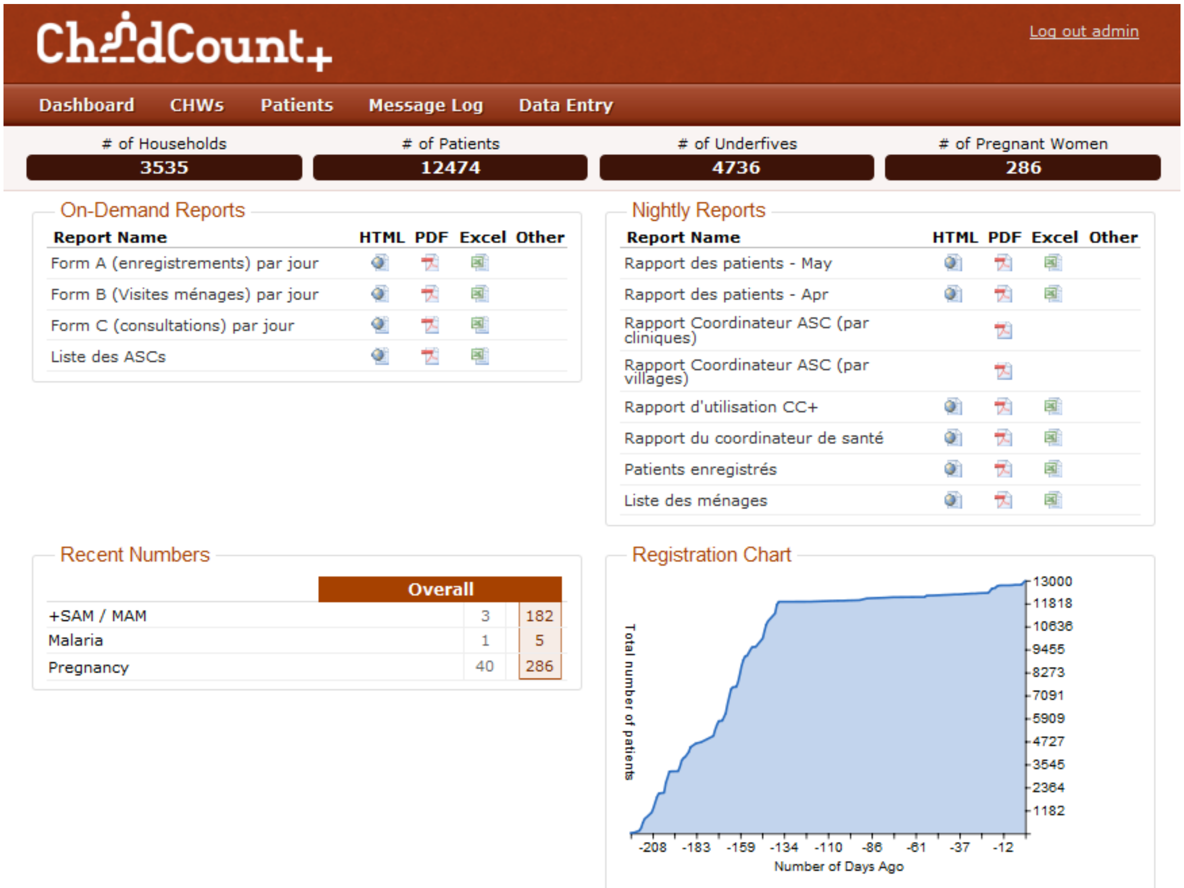
There is substantial evidence that several simple, cost-effective interventions can greatly increase maternal and child survival rates, including vaccinations, oral-rehydration therapy and insecticide-treated bednets as well as strengthened antenatal and delivery care and the integrated management of sick children [1–4].

The MVP aims to address these gaps through the co-ordinated delivery of proven health and development interventions in 14 sites in 10 countries. In the health sector, the MVP emphasizes the integrated delivery of free maternal-newborn-child health services, with the goal of achieving universal coverage through inputs to referral hospitals and primary care clinics, alongside providing direct household support via a cadre of paid-professional community health workers (CHWs). Evidence suggests that CHWS can be effective in reducing maternal and child mortality and improving health outcomes.

In the MVP, CHWs—who number nearly 800 across 14 MV sites—are salaried secondary school graduates—generally from the local community—who are trained in a minimum set of core competencies. There is approximately 1 CHW for every 100–200 households, depending on geography and population density, and each household is visited at least once per quarter. By taking healthcare from clinics directly into vulnerable households, the goal is to improve on disease prevention as well as the early detection, treatment and referral of sick individuals.

While CHWs can provide life-saving interventions, they can also deliver vital household health information. During routine household screening visits, CHWs can generate collect data on the registration of

**Figure 5.2: ChildCount Dashboard**




community health events, including recent births and deaths; the burden of illnesses such as acute malnutrition or malaria; and the prevalence of essential interventions such as immunizations, antenatal care and skilled delivery.

This collection of household information is greatly facilitated by new advances in mobile communications technology. Each MV CHW is provided with a cell phone. Through a partnership with Ericsson, nearly all MVs have high levels of cell phone coverage. The MVP is piloting the use of electronic mobile phone systems to collect health information at several sites. For example, in Sauri, Kenya, a new program called ChildCount has electronically registered 90 percent of children under 5, who will then be monitored via a text message-based system for nutrition, immunizations, and signs of common childhood illnesses (see www.ChildCount.org).

This project includes a scalable model for the delivery and monitoring of critical maternal-newborn-child health interventions in regions of the world where effective strategies to address health-related MDGs are urgently required.

### IMPLEMENTATION

Currently, ChildCount has registered more than 140,000 people. It is used in vaccination campaigns, to accurately gauge the coverage of a vaccine, and flags children for follow up who have not been immunized. It helps CHWs to spot malnourished children during home visits by providing support regarding upper arm circumference measurements (MUACs), and reminds them to check up 48 hours later on any child referred to a clinic for care. The system also produces reports for CHWs, helps them plan future activities and enables them to see at a glance the status of all those under their care. It produces reports for CHW managers to assist in performance monitoring and counseling for those who need improvement as well as reports with detailed indicators for health section heads, to help them see where interventions have been successful and make broader program decisions.

Modular components for ChildCount+ are also designed for specific cases. For instance, the PMTCT (Prevention of Mother to Child Transmission of HIV) module provides enhanced antenatal tracking for pregnant women and tracks childhood health visits for children under 18 months. The module, which is currently in use in Sauri, Kenya and Bonsaaso, Ghana, reminds CHWs when a pregnant woman or child has an upcoming appointment and prompts her to visit the the client's home for a reminder and to emphasize the importance of regular antenatal care. It notifies the CHW if a woman misses an appointment. It also prompts him to go over an expectant mother's birth plan with her three weeks before her due date to help ensure delivery by a skilled birth attendant. Presently, some 400 pregnant women have used the program, and utilization increases monthly

### RESULTS

The program has encouraged CHWs to expand and improve their work by helping managers balance their workloads and give spot training when necessary. Sites can install additional models to to expand the capabilities of ChildCount+. It currently tracks over 40,000 children across the Millennium Villages. It empowers CHWs to perform their tasks more efficiently and helps deliver high quality community-based health care. It has successfully aided health workers in peri-urban settings as well as nomadic herding communities; using both paper-based and SMS centered deployments. ChildCount+ has helped improve the detection and systematic monitoring of childhood deaths, malaria and cases of malnutrition. ChildCount+ has contributed to a number of other improved health outcomes across the spectrum. A few examples from the Sauri cluster: The percentage of infants under seven days old receiving an in-home checkup went from 31% at the outset of the program to over 80%. These results are not exclusively due to ChildCount+, but it has been an integral part of the CHW program.



## Open Data Kit Collect

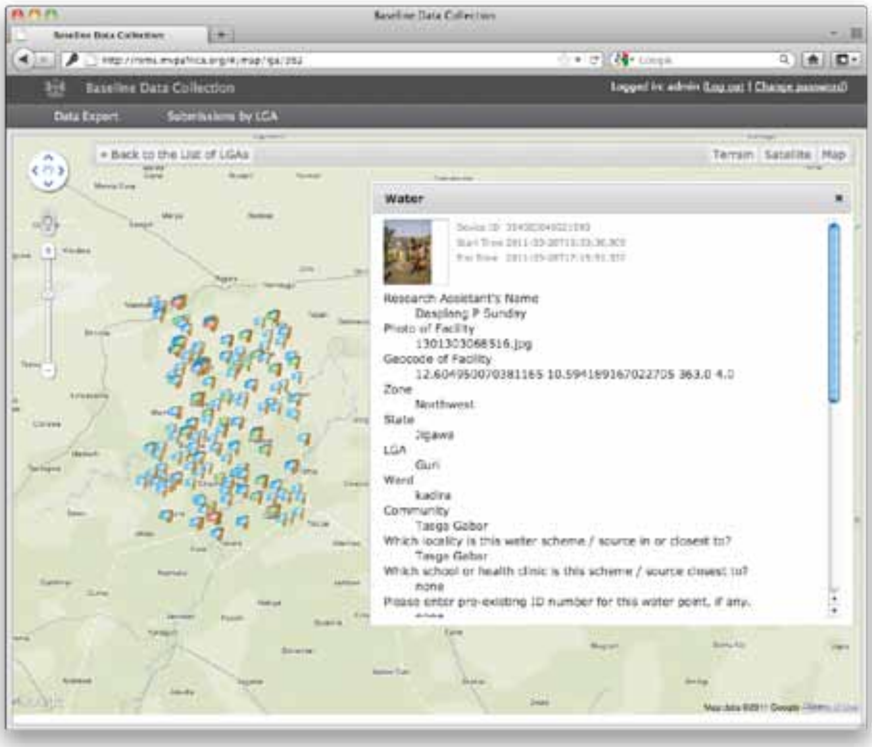
ODK (Open Data Kit) Collect is an open source Android application for collecting survey data in developing countries that was originally created at the University of Washington. Since ODK Collect is designed for the Android operating system, surveys can be collected using consumer-grade Android OS smart phones. Surveys for ODK Collect are written as XForms following the OpenROSA specification.

ODK Collect is easily installed on an Android phone using the Android Market application. By opening Market and searching for "ODK Collect", one can quickly install and use the application. Survey forms are stored on the SD Card in a folder called "/odk/forms/" and survey data is stored in a folder called "/odk/instances/". The major features of ODK Collect can be found at: http://opendatakit.org/

In a January 2010 study in which researchers at the Modi Lab at Columbia University surveyed around 300 farmers in rural Mali were surveyed, data collection took place using smart phones running ODK. This approach allowed for immediate digitization of data for analysis and remote monitoring of the collection progress. It also facilitated the gathering of data and eliminating the need for paper surveys, thereby

**Figure 5.3: Surveying**

Figure 5.4 Screen Shot of Data View




significantly reducing survey times. Enumerators were quickly able to navigate the touch screens, and within just a few trials the time required to conduct interviews was reduced by 50 percent. Frequent phone contact between field researchers and researchers in New York allowed for instant feedback to the field, permitting immediate notification of progress and irregularities. The success of this trial led the Modi Group to adopt the approach more generally.

## CURRENT PROJECTS USING ODK COLLECT

The Earth Institute and the Nigerian government worked together to run four large-scale surveys using ODK Collect. ODK Collect was used to collect a facility inventory of 40 out of 774 Local Government Areas (LGAs). Data on schools, health facilities, and water distribution points were collected. This allowed for a detailed and comprehensive picture of development in Nigeria.

The next major planned survey is an in-depth household survey on malaria. By collecting detailed information on all household members, with a particular focus on the most vulnerable populations—children under five and women ages 15—49—and bed net usage, this survey will provide very detailed data informing how to best combat the disease.

Coordinating such large-scale surveys typically requires significant preparation and work. Training 210 surveyors in how to use ODK Collect and maintaining the hardware takes about a week of five people working full time.

## WRITING SURVEYS FOR ODK COLLECT

Columbia University's Modi Lab has developed tools for authoring surveys for use with ODK Collect as well as those for storing and displaying data collected using Android smart phones. When programming surveys for ODK Collect, lab staff members found that the existing Web-based interfaces would require significant copying and pasting of question information and would not allow for the necessary customization the surveys required. Developers in the Modi Lab created a Python computer code library for writing XForms for use with ODK Collect. Below are the major features of the library pyxform that set it apart:

1. Easily convert Microsoft Excel files into XForms for use with ODK Collect—Pyxform allows users to write surveys offline, using a familiar spreadsheet format, and then compile that spreadsheet into a survey for use on the phone.

2. Dynamic question types—It is easy to add new question types to pyxform and to add response constraints timeframe or units.

3. Multiple choice questions with an "other" option—ODK Collect does not have an easy way to enter "other" into multiple choice questions. Pyxform offers an easy syntax for creating these two questions at once.

4. The ability to include xls and json templates—Pyxform allows the author to break a survey up into multiple templates and then include those templates in a base template.

#### STORING DATA FROM ODK COLLECT



The Modi Lab has also developed its own tool for receiving data from ODK Collect. We have written a pluggable Django application called XFormManager. This application receives XML and media files submitted from ODK Collect and stores them in a database. By making this application modular, we have made it easy for other Web developers to add ODK support to their Django projects. To illustrate how these tools are being used, see a screenshot of survey data:

The tools created by the Modi Lab have increased the utility of ODK. Working with Google docs, pyxform allows developers to quickly collaborate with survey writers. Survey authors can focus on the wording and flow of the survey, while developers ensure that the skip logic and data constraints are in place. The xform manager Web application allows data analysts to monitor survey activities in real time. Watching surveys appear on a map as they are submitted allows users to at once see the big picture and gain perspective on the finest details.

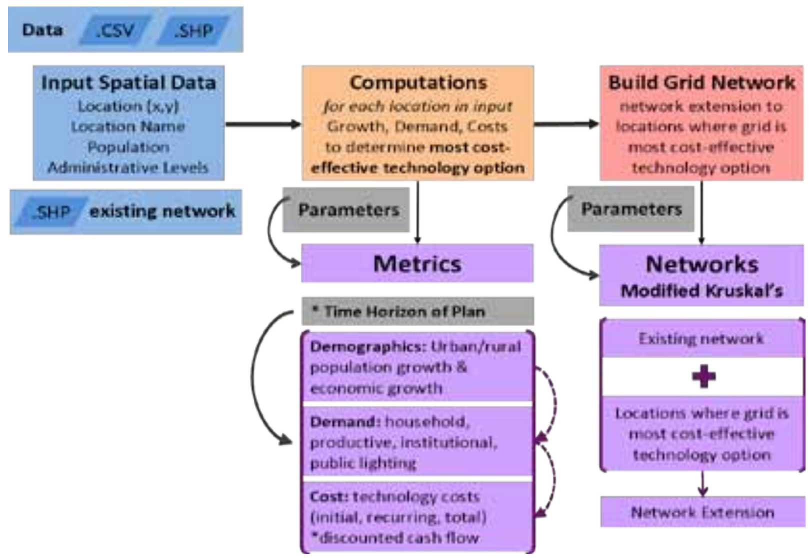
## Network Planner

Network Planner is a decision support tool for infrastructure planning. Broadly stated, the tool's purpose is to help planners determine the most cost-optimal type and placement of infrastructure to serve populations over a given time horizon, in a manner that promotes transparency and the participation of multiple stakeholders in the planning process. This fills an important need, since traditional infrastructure planning is often inefficient, non-transparent, or too limited in scope to guide the equitable and rapid scale-up of essential services required to meet the MDGs.

Network Planner was designed to provide key decision makers—utilities, planners, governments and communities—with the outputs they need to make rapid, iterative, and data-driven assessments on infrastructure costs at various administrative levels (national, district, and community). The system incorporates spatial data (i.e. location of populated places, existing infrastructure, and administrative units); key modeling parameters (population growth and demand, costs of technologies and financial variables) and cost-optimizing geospatial algorithms to provide the most cost-effective, long-term infrastructure plan. The system has potential application in a number of other planning efforts, such as water resources and distribution.

Network Planner helps answer questions such as how best to provide electricity to settlements that currently lack access. To evaluate the options, the tool uses a three-stage process (see fig. 5.5 below):

## Figure 5.5: Concept Diagram of Network Planner Tool




1. **Data gathering**—First, geospatial data is collected on populated centers as well as utilities (grid lines) and social infrastructure (health and educational facilities), market centers and government offices. Various modeling parameters are added. For example, electricity demand in various sectors (domestic, commercial, industry, agricultural); cost metrics for grid and off-grid electricity systems (equipment, installation, fuel, operations and maintenance) and socioeconomic data (economic and population growth rates and electricity demand elasticity).

2. **Least-cost electricity system optimization**—The model projects future electricity demand at each point (accounting for such factors as economic growth, population growth, electricity demand elasticity). It computes the technical requirements (such as system sizing) and costs (fixed and recurring) of meeting each location's estimated power demand by grid extension as well as standalone technologies such as diesel mini-grids and solar systems. Finally, the system uses this cost and technical information to create a cost-optimized electricity plan for the system as a whole, for both grid and off-grid power systems.



## Figure 5.6 Network Planner Input and Output Interfaces

3. **Data rich outputs**—Network Planner supports the presentation of results in a "prospectus" framework, with detailed cost reporting. Results may be summarized by specific geospatial area (nation, region, district, etc.), by energy technology (solar PV, grid, minigrid), or other key planning categories, as needed.

Important aspects of the model's value are the speed, geospatial specificity and quantitative detail. The model's standardized algorithms rapidly produce plans with a long-term vision, including access targets and financing requirements, with rigor and accuracy that leads to the kind of quantitatively credible project documents that are essential for major funders and donors.

The system is also user-driven and highly dynamic, allowing all input data, assumptions and equations to be viewed and changed by users. This facilitates rapidly collaborative and participatory planning in which users modify settings and quickly produce detailed results. These rapid results provide immediate feedback, allowing users to quickly fine-tune results in successive model runs.. At a more fundamental level, the system is transparent regarding the underlying logic and calculations it performs and allows revisions in its basic computational methods.

Another benefit of this approach is that it improves the participation of multiple stakeholders in the planning process. Government officials will only sanction a plan with a clear approach to meeting national targets. Financiers require clear details on the investment required. Utilities will only extend their services if they have an understanding of the costs of service delivery (e.g., labor and material costs) and the additional services (energy, water) that their networks must provide. Engineers require drafts of where demand for services is highest as a basis for more detailed technical assessments and design work. Finally, communities and customers want to know when and how services will be supplied, and how communities can and will be expected to contribute. All these stakeholders can contribute valuable inputs to the model.



Moreover, this tool and approach can be integrated into planning activities at international development banks, national ministries and utilities in a manner that builds capacity and develops institutional memory so planning can be localized. The automated and algorithmic aspects of the model promote speed and objectivity, while its adaptability ensures relevance to local standards and priorities identified by local planners, utilities, ministries and stakeholders, rather than relying on international consultants. Finally, the model described here need not be limited solely to the analysis of electricity infrastructure. Other issues involving rural infrastructure design, such as water and communication networks, or determining the location of new health care and educational facilities, could also benefit from this approach to maximize penetration and cost effectiveness of service delivery.

### APPLICATION

In practice, Network Planner has been used in electricity planning as described above and also to perform detailed sensitivity analyses on the impact of key variables, such as demand growth and the relative wealth and poverty of sub-national areas, on electrification plans for Kenya, Senegal and Ghana.

## SharedSolar

SharedSolar is architecture for delivering solar electricity to remote areas where grid extension is not feasible. The electricity is provided via a prepaid payment model that is widely used for the purchase of mobile phone time. Currently, each SharedSolar generation system supplies up to 20 households with electricity and communicates with a central server.

SharedSolar provides a near grid quality connection without the capital cost of grid extension or requiring large consumer investments. Research throughout the Millennium Villages has shown that the rural poor pay as much as $5 per month for kerosene, batteries, and other energy inputs for power that could be more efficiently and cheaply supplied by electricity from a centralized source. This $5 per month of energy use is equivalent to about 1.5 kWh. Thus, the poor are paying often in excess of $10/kWh for inconvenient energy sources. A detailed analysis of grid connection costs has shown that extending the grid to reach the rural poor typically requires more than $1000/household, and even then would only connect the few who reside near existing infrastructure (roads). Furthermore, traditional post-pay metering is too expensive given the low energy use levels these populations can afford, and the variability of their use.

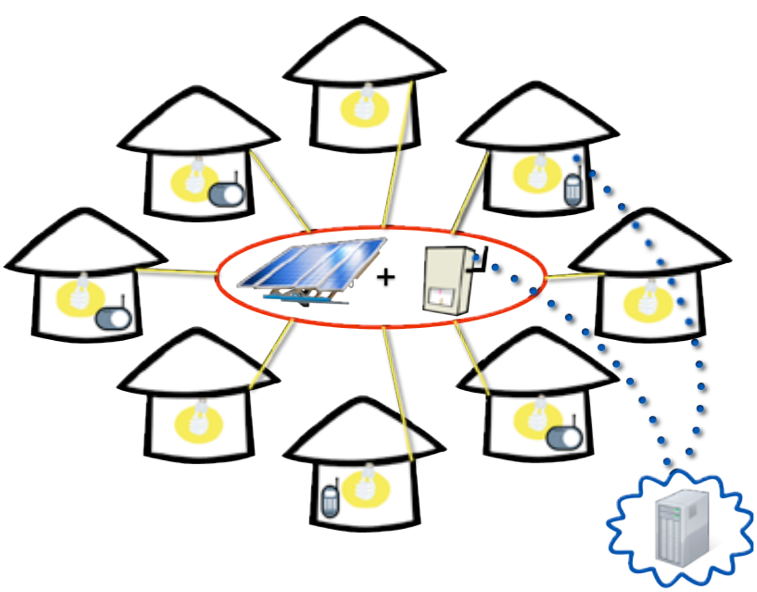
Currently, the poorest are paying the most for the lowest quality energy, but more efficient and reliable alternatives require a capital investment that is out of the reach of these customers. The vision of SharedSolar is making high-quality electricity available in small purchase amounts, bringing a better electricity source to the consumer while lowering the initial cost barrier.

### THE INNOVATION

Prepaid metering utilizing manually keyed codes or RFID cards on the meter is a technology that has been employed in traditional macro-utility managed grid-based systems in India, China, South Africa and other places. Similarly, aggregated sub-metering or meter circuit metering has been utilized in a wide variety of applications. Mobile telephony providers have also developed a profitable prepaid business model throughout the developing world that supplies an analogous pattern of service—a low amount for highly variable use. Furthermore, small (1 kW), stand-alone power technologies such solar PVs or diesel-solar hybrids are well understood and highly flexible thanks to their modular characteristics, and often provide better reliability than 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 5.8.) This solution clears two barriers to energy access, upfront cost and credit risk. By creating a robust system that can be managed remotely and amortized confidently, a utility can comfortably invest in expensive solar power generation costs. This leaves the much lower initial investment of home wiring and light bulbs to the consumer. The prepayment mechanism allows for the purchase of electricity in small amounts at irregular intervals. This avoids the problem of non-payment that is common with post-paid billing. This architecture could provide a business opportunity for a utility.

**Figure 5.7: Micro-grid Star Topology and Remote Server (Payment Gateway) Communicating with Meter over Mobile Network**

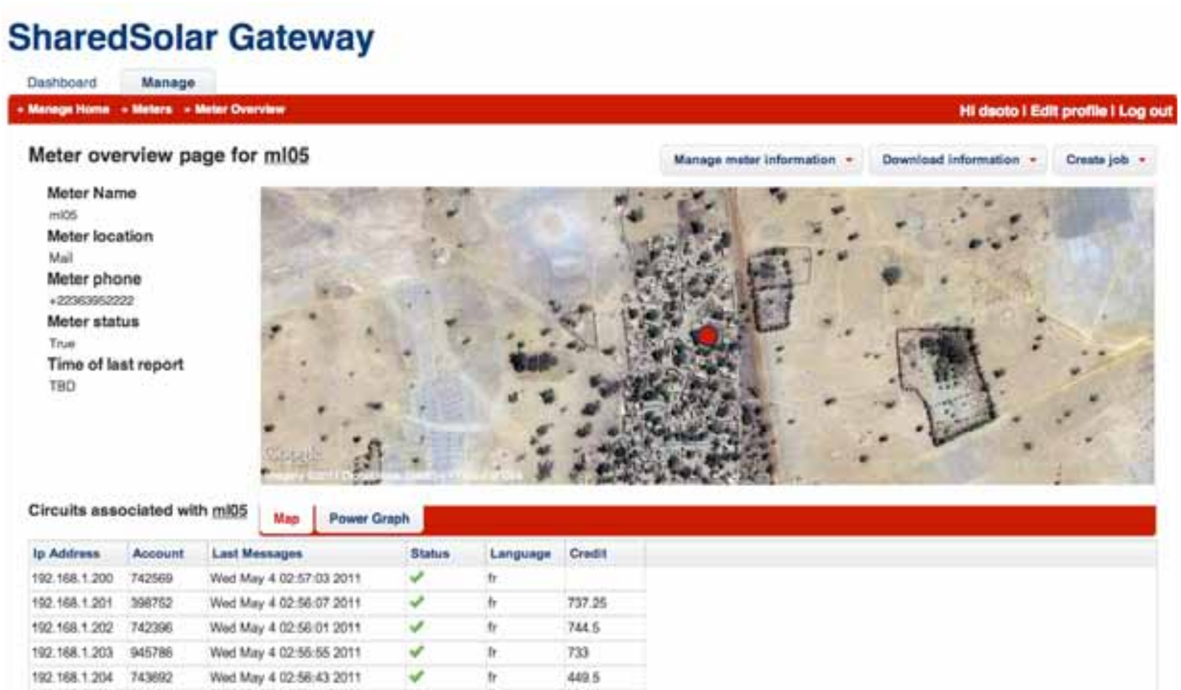


### SYSTEM DESCRIPTION

Connected households buy scratch cards from local vendors, similar to those purchased for prepaid airtime, and send the revealed codes via SMS to credit their accounts. The text message reaches the payment gateway server via HTTP. The gateway communicates, also via SMS and HTTP, with power meters connected to each household. When the customer's credit is exhausted, the meter shuts off his circuit.

Through remote management, the metering costs of SharedSolar are significantly minimized, while automated dispatch further drives down the expenses of monitoring and maintenance. These specially designed meters allow for the low loads that are typical of such energy customers. System modularity provides flexibility and even a path toward eventual grid

**Figure 5.8: Screenshot of Web application for Monitoring SharedSolar Installations**




connectivity—users can increase electricity use as incomes rise, and additional systems can be deployed in areas with demand growth.

The risk of tampering is also eliminated—the wire leaving the centralized meter is the property of the household that it powers.

## RESULTS



A pilot system in Pelengana, Mali was initiated in late 2010 to test the technology. At this writing, two systems have been commissioned at sites in Tiby, Mali, and one in Ruhiira, Uganda. This system includes software and hardware at the metering site as well as a server that aggregates information from multiple meters (Figure 5.8). The project has contracted with local telecommunications providers for access to their infrastructure.

Early results have confirmed predicted use patterns: Consumers are happy to replace their kerosene and dry-cell purchases, enjoying the significantly improved light from efficient electric lighting and find electric outlets useful for charging their mobile phones and powering other small appliances. Figure 5.9 shows the difference in lighting quality. Lighting is typically 20-50 watt-hours per household per day, while household with televisions consume up to 150 watt-hours per day.