Background

Harbinger has developed a complete set of software and services required for the planning, deployment and operation of smart micro-grids in lean environments. In Bolivia, Harbinger has partnered with AXS Bolivia SA on the program ‘All connected, All is possible’ to provide energy services to remote indigenous communities in the Amazon basin. This program is a public-private partnership between the Government of Bolivia and AXS Bolivia, and supported by the Bolivian Chamber of Commerce and the Military Engineering School.

Working principle

An smart micro-grid combines local clean energy sources and advanced information and management systems. The energy produced by the PV modules is stored in maintenance-free photovoltaic batteries. A high efficiency inverter/charger converts this energy into alternative current so that all common appliances can be used. More PV modules and batteries can be added to the system thanks to its modular design. Extra power from generators or the grid, can back-up the system during periods of poor solar insolation or high demand. These characteristics increase the long term viability of the project and allows for smarter allocations of capital.

However, the most significant part of the system is Harbinger’s unique software management system that enables local and remote management and control of the micro-grid. Indeed, micro-grid components such as low cost PV smart meters can execute rules and commands defined in a low cost server. This flexibility in software allows that ‘pre-paid’, ‘time of the day’ or other business models can be implemented in these remote locations.

The work flow and business logic of the micro-grids operation is also captured in software tools that allow, for example, that local vendors retail electricity and log simple operation and maintenance tasks using low cost wireless thin clients. The system can be connected to ‘cloud’ services and telecom operators via GPRS/3G/SMS so that remote teams can track its performance and assist in case of emergencies. Finally, the micro-grid includes a local Wi-Fi network that offers the backbone for future internet ready services.
San Benito is located inside the Indigenous Territory Isiboro Secure, accessible only via motorboat. Despite these constrains, the systems designed by Harbinger can be installed in less than 48h. This is because the main components are modular and pre-wired. The aerial or subterranean distribution energy network is optimised with geo-localization software tools that also keep track of inventories and simplify the construction schedule. Each household is equipped with a ‘starting-kit’ consisting of 3 high efficiency lighting points, an AC power outlet and the corresponding electrical accessories and protections found in any modern installation. The participation of local communities is key to ensure ownership and understanding of the maintenance and use of the electric service.

Operation

Each client in the micro-grid has a unique metered account that can be customised with energy, power and time limits. A costumer ‘buys’ energy through a local vendor with a wireless interface. When the vendor completes the transaction, the server updates in real time the client account and electricity is immediately delivered to the clients house. The system monitors the usage of the energy and alarms can be set-up to prevent costumers when their credit is low. When the credit is finish, the system automatically disconnect the client, who needs to buy again credit to obtain service. As all transactions and events are stored in software, better decisions can be made over time in order to increase the sustainability of the operation. Local utilities or institutions in charge of regulation of the service can access this information and verifies the quality of the service.

Before and after
San Benito’s people used kerosene and candles for lighting, expending over 10 USD a month. With the micro-grid AC power is available to run radios, tv and devices like fridges, that can be used for productive uses.

Construction and vendor
The construction is eased thanks to the modularity of the system. The local vendor sells credit and realizes simple maintenance tasks. More complex service operations is made through a remote team that monitors the micro-grid
**Technical Specifications**

| Power plant | 2.2kWp Solar PV, array of 8 modules of 283Wp class A Polycrystalline PV 72 cell, Junction Box IP67 rated. PV combiner with DC protection (4 lines @ 150V DC) 90A DC charge controller with communications port 4300W DC to AC inverter/charger for 48V DC input range. Peak efficiency of 91%, 30A transfer relay to connect a generator. Includes temperature protection, remote control and communications module via TCP/IP and RS485. |
| Smart meters | 30 individual connections for a service of 6A @ 230V 50Hz through 3 Trinity meters Input: Single Single Phase Two Wire System – 1P2W, Direct Voltage Input : Up to 300V L-N Whole Current Input : 6A Max, Auxiliary Supply: 90 - 300 VAC, 50-60 Hz Output: 10 Latching Relays, Switching Voltage : Max. 250 VAC, Switching Power : Max. 2000VA, Expected Mechanical Life : >1 million switching operations Measurements: True RMS Basic Parameters: Voltage (Volts L-N) Accuracy : 0.5% of Reading, Current (Amps for each load) Accuracy : 0.25% Active Power (P) Accuracy (For IPF>0.5): 1% Total Active Energy Communication: Ethernet MODBUS-RTU protocol, USB 2.0 For programming network parameters & local data management. WiFi router. |
| Energy Storage | Battery bank wired in 48v based on VLRA gel lead acid technologies (8 batteries of 220Ah @ 12V for 10.6 kWh/day based on 50% DoD). Expected design life 2000 discharge cycles. |
| Power network | 5000m star network with aerial and subterranean connections. Electrical protections for AC at the micro-central and mini-circuit-breakers of 6A AC for each circuit |
| BOS | PV modules support in aluminum and steel pipe components. Lightening and grounding protection Outdoor cabinets for IP65 protection, constructed on powder coated aluminum and stainless steel |
| Services | 28 clients installation includes 3 fluorescent lamps (1 for outdoors), 1 AC outlet and electric accessories Illumination of the school (4 lighting points ), Health Centre (1 lights point + 1 PV fridge for vaccines) and the teachers quarters (5 lighting points and 2 Ac outlets). Public lighting with photo-cell of 6 LED lighting points |
| Software | Harbinger software basic suite for local management (energy meter control, source controllers, communications, real time credit processing, dynamic pricing models, load limiter, energy limiter, local data store) |

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