INTRODUCTION

This report aims to give a complete overview of the installation of the e.quinox solar powered Energy Kiosk in the village Kavure in the district of Bugesera in the Eastern Province of Rwanda. The design of this system was based on the data and feedback gathered from e.quinox's pilot Kiosk in Kanka, Minazi Sector, Gakenke District. It includes the new version of the Battery Box, e.quinox's distribution model, as well as an improved electrical system design. These changes have direct changes on the costs of the system and thus the business model of the Kiosk, which - at least - aims to cover the running costs and depreciation of the Kiosk.

Implementing an Energy Kiosk involves a variety of different aspect. A shopkeeper needs to be trained to understand the system, take good care of it, and promote it to the local population. The population needs to be introduced and sensitized to the system. It needs to be clear what benefit they have from entering, compared to their old lifestyle. Furthermore, e.quinox entered in an agreement with the local microfinance institution to facilitate locals to become a customer of the kiosk.

Though the concept seems simple at first, an Energy Kiosk is a complex system that needs to be finely tuned to strike the balance between providing an attractive system that benefits the local community, all whilst keeping the Kiosk running well, covering all running costs as well as maintenance and depreciation. This report relies on e.quinox experience to outline a new and improved system. Whilst this might not be the optimum solution, we believe that it is a big step in the right direction and will provide valuable insights for future systems.

ELECTRICAL INSTALLATION

The electrical system installed in Kavure is able to provide a maximum power output of 720W at 230VAC in order to charge the circulating stream of battery boxes. The system is very robust and reliable mainly because of the following reasons:

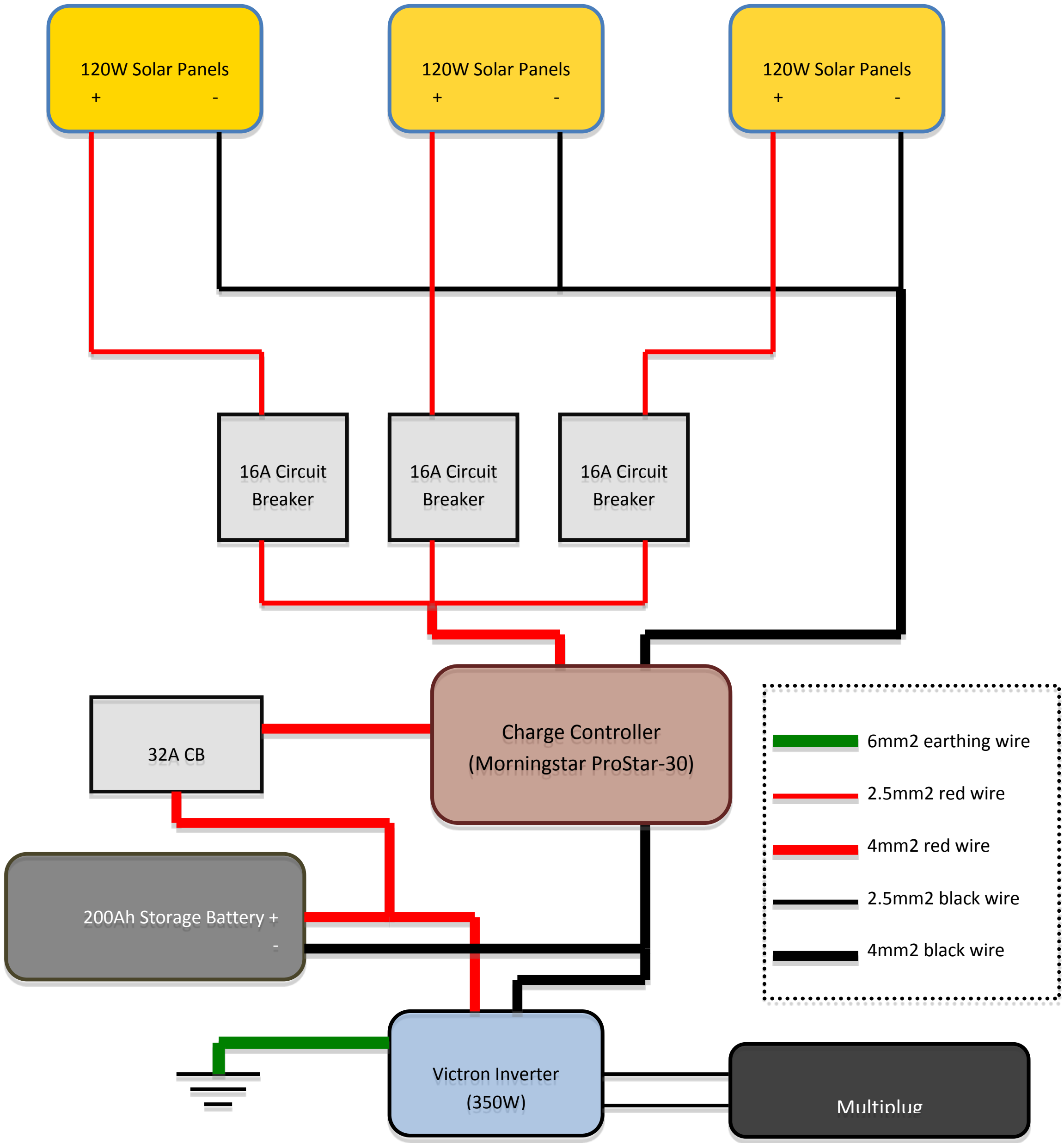
a) The division of the entire system into two identical and independent sub-systems, a feature which adds redundancy to the design and the ability to keep the system running even in the event of component failure.
b) The inclusion of a 200Ah deep cycle, lead acid storage battery in each subsystem, which introduces temporary energy storage to the system and enables it to be operational even in periods of sustained rainfall.
c) The conversion of the voltage output to AC via the inverter and the use of a multiplug, which allows the use of the AC charge controllers for the battery boxes instead of their expensive DC counterparts.

Each subsystem works as follows: Six polycrystalline solar panels are fixed onto the roof of the Energy Kiosk. These charge the storage battery via a solar charge controller (Morningstar ProStar - 30) inside the Kiosk. Following from the battery there is an inverter (350W, Victron Energy Phoenix model), which converts the 12V DC output of the storage battery to 230VAC.

A 6-socket multiplug is then connected to each inverter in order to be able to plug in the battery boxes' chargers.

Electrical design

The electrical design for each subsystem is illustrated below:

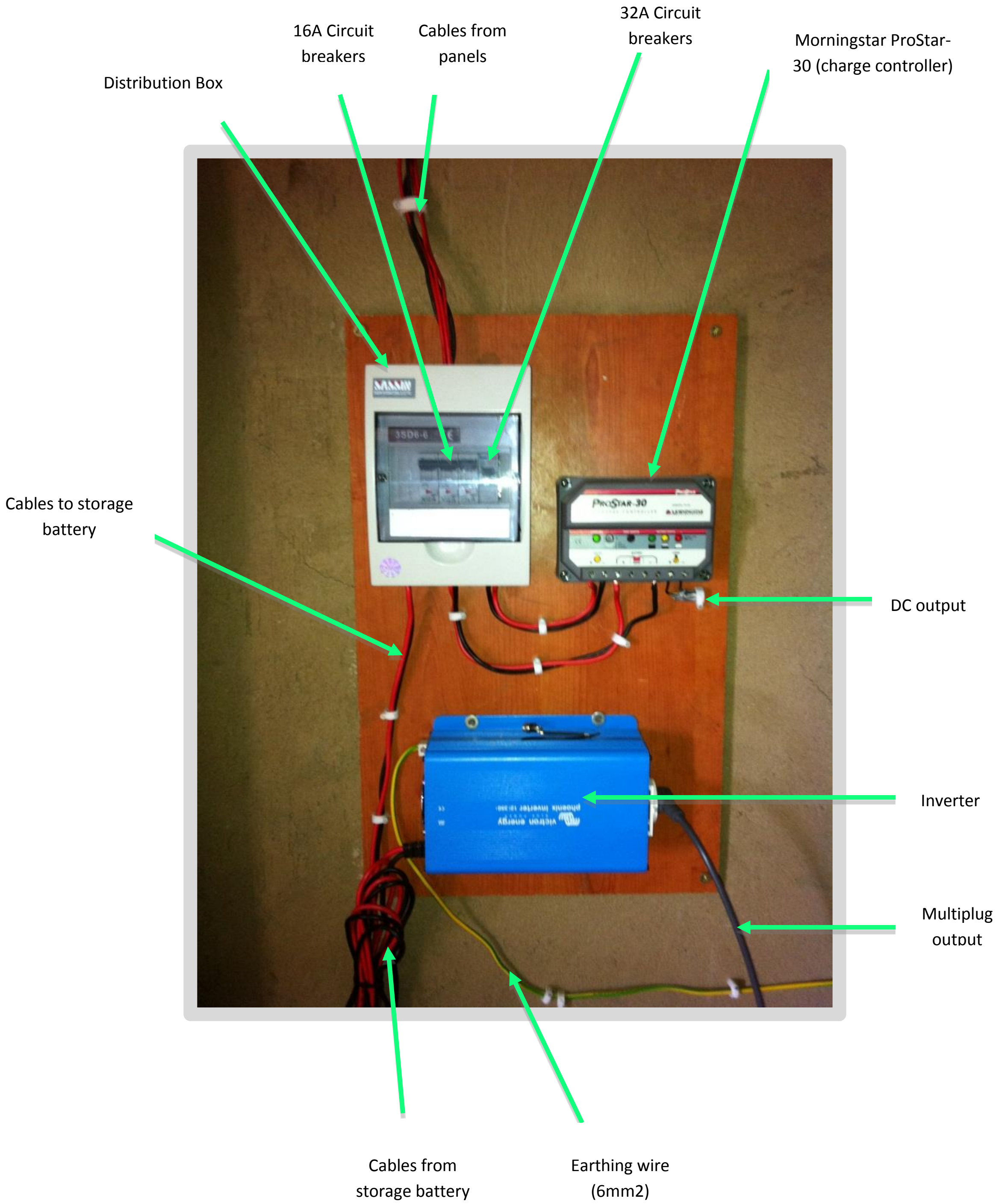


Protection

We placed great importance in making the electrical installation safe. Single pole circuit breakers are used to protect the solar panels (rated at 16A) and the storage battery (rated at 32A), and these will isolate the equipment in the event of a current surge and also introduces modularity in the sense that each equipment can be separated when they need to be repaired. The inverter is grounded via a 6mm^2 earthing wire. The system is also equipped with lightning protection.

Electrical installation layouts

For easier implementation some electrical equipment was fixed onto wooden boards prior to the installation. One board was used for each subsystem as illustrated below.



MECHANICAL MOUNTING OF SOLAR PANELS

This section summarises the mounting of solar panels on the roof of the Kavure Kiosk, which took place in September 2011. Assembly procedures will be discussed along with the reason for the specific layout. Furthermore, some of the difficulties we encountered will be examined as well as ways of avoiding these in the future. The minimum time to build and assemble such a frame is estimated to be 3 days and the recommended minimum number of people working on the frame is also 3.

Solar Panels

In the system there are 6 polycrystalline panels in total with a power output of 120 Watts each. Each panel has a length of 119cm.

Frame Layout

The frame was constructed in 2 columns of 3 solar panels each. The three long rods stretched from the front to the back of the kiosk, and on these 8 shorter rods were bolted across - 2 with a rectangular cross section at either end for structural integrity, and 6 flat rods on which the panels were bolted.

The long rods were located such that they could be bolted into the wall of the kiosk, and the outermost rod lies above the left wall of the kiosk. There were some problems in achieving grip in the concrete, and therefore the screws in the wall should be inspected upon the next team visit.

Mechanical Mounting

The following rods were decided upon for the frame of the solar panels:

- 25x15 mm rods of 6m length (3 pieces)
- 20x20 mm rods of 3m length (2 pieces)
- 25mm wide 2mm thick rods of 3m length (6 pieces)

One big factor in this decision was the availability of these rods at the metal market in Kigali. The maximum length of the rods which can be acquired at the metal market is 6m, which means that the smaller rods were simply cut in 2 at the market. The thickness of the rods was high enough to give structural rigidity to the frame design.

The frame was assembled on the ground and the holes attaching the small to the big rods were drilled using a 6.5 mm drill. The short battery life of the drill was extended by ensuring runing the drills off of the battery boxes of the storage battery. M6x40 mm nuts and bolts were used to hold the pieces together.

Once the solar panels had arrived, exact placement of the not-yet-assembled rods (every second) were measured, marked out and drilled through. Also, the exact location of the holes used for fixing the solar panels was marked out. The solar panels were fixed using M6x25 mm nuts and bolts.

The structure was then assembled on the ground. Afterwards, the whole assembly was lifted onto the roof. The lifting was aided by a large pile of wood at the left side of the kiosk, which acted as scaffolding. The 3 big rods were then fixed onto the roof, by means of drilling through corrugated roof and into the concrete wall, where a flasher plug was fitted. 6 mm screws and 10 mm washer plugs were used to provide optimal fixation.

Since the roof was of a very poor quality we only had one person on the roof at a time, and that person stayed at the side of the roof where the roof is more stable.

Anti-Corrosion Measures

Before any work was done on the metal, the rods were wiped clean from dust and then painted with red anti-rust paint and then left to dry for a day. The ends of the rods were closed using Styrofoam bits that were sealed off using electrical tape.

Wiring

The wires in the kiosk come down from the panels in two group of three panels each, and these wires are fed through the air vent at the side of the kiosk and into two separate circuit breakers.

Lightning Protection

A 1.5 long copper rod (18 mm diameter) was put into a hole in rod B between the solar panels in row 2. Three metal wires were then attached to the top of the rod and fixed to the top 2 corners of the frame and between solar panels in row 3. The copper rod was attached to a thick copper wire (>5mm diameter) and attached to a copper rod of 1 m length that was hammered into the ground.