## Solar streetlight energy monitoring: Design and implementation

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Solar street light can be deliberately oversized to increase energy access to refugee and displaced communities. This can be achieved by providing the solar streetlights residual energy (i.e., the energy generated but not needed to power the LED Lamp) to the camp, for activities such as phone charging. In the HEED project we aim to undertake this task and assess its success.

To understand the usage of the solar light we plan on measuring:

1. The energy generated by the solar panel
2. The energy consumed by each of the solar streetlights loads (LED lamp, monitoring system, mobile phone charging).
3. The state of the battery.

Each of these data, can be collected directly from the Solar charge controller, and data analysis.

**1. Proposed Monitoring System**

The street light energy monitoring system is a sense, send, and store system targeted at the collection of energy data from a solar street light. The energy monitoring system is designed to gather sensor data (solar generation, load consumption), transmit that data to a remote server, and log data every hour to a removable USB drive.

This section details the overall energy monitoring system and each sensing component. The system here is heavily based on the work in Coventry University’s STAR project and has been trialled in-field.

The solar streetlight will be equipped with a Victron BlueSolar MPPT solar charge controller. The solar charge controller can:

* provide data about solar generation including the voltage, current, and power being generated by the solar panels.
* Provide the current draw of the load, which can in turn be converted to an instantaneous power value (since we know we are outputting 12V)
* Provide the voltage and current from the battery.

These data points will allow us to resolve the three measures, detailed in the introduction.

The sensing system makes uses of Victron’s proprietary Victron Energy Direct (VE.Direct) communication protocol. To interface, a VE.Direct to USB cable is connected between the charge controller and a Raspberry Pi. The RaspberryPi will be equipped with 1) a 3G modem, 2) a removable USB drive.

Every 60 seconds readings are taken from the charge controller, by the RaspberryPi. When the data is received it is transmitted over a mobile network (via MQTT) to a remote server at Coventry University where it is stored in CSV files. In addition to sending, the sensor readings are saved to a USB flash drive.

The solar streetlight will include the facility for mobile phone charging, in this first prototype we will just consider the case where mobile charging is accessible 24/7. In further prototypes we will need to intelligently enable/disable this facility based on the state of the battery.

**2. Energy disaggregation**

## Disaggregating the energy

The charge controller only provides total energy consumption, and not consumption disaggregated by appliance. However, through post-processing this data can be disaggregated.

We know:

* The RaspberryPi is on all the time and will be pull current at a near constant rate (energy consumption will slightly increase during periods of data transmission).
* The Street light will be on from dusk-to-dawn (approx.12 hours) and will pull current at a constant rate.

From this we can expect a chart with a similar profile to the below:

Any deviation from these two states would indicate mobile phone/appliance charging. Defining the algorithm is out the scope of this document.