## Solar streetlight design

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The need for streetlights, for security and quality of life improvement, is well reported in the literature, however, there does not seem to be any research on the impact of streetlights, post deployment. The potential for increased energy access 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 has also been overlooked.

This document provides details on the components required to build a street light testbed. The components defined here are similar to those we will find locally. A per country design will be required for the exact models that can be provided by local suppliers.

Out of scope of this document are the components required for monitoring the streetlight. The monitoring will be described in two separate documents.

**1. Requirements**

The solar-street light must:

1. Provide adequate lighting to the area
2. Allow the residual energy to be used for a “productive/beneficial” purpose, in the case considered here; mobile phone charging.

**2. Required components**

The key components of the streetlight are:

* Solar panel
* LED lamp
* Charge controller
* Battery
* Mobile phone charging point
* Streetlight Pole

Solar Panel

Led Lamp

Mobile phones

Charge Controller

Battery

The key components, other than the charge controller, are interchangable, e.g., the brand of the LED lamps does not matter, it would still be used in the same way. These items are still discussed in this document as they need to be considered for a lab testbed.

The key design decision here is the solar charge controller, as this impacts on the energy monitoring.

**2.1. Charge Controller**

The charge controller is responsible for controlling the rate at which electric current is added to or drawn from electric batteries.

A suitable charge controller would be the Victron BlueSolar Charge Controller MPPT 75V/15A (£82.95) with a VE.Direct cable (£16) :   
<http://www.onboardenergydirect.co.uk/shop/BlueSolar-Charge-controller-MPPT-75-15-VBS75_15.html#SID=275>

The charge controller benefits from having an interface to collect the data about energy consumed/generated by the solar panels, load, and battery. Note: The three suppliers Practical Action have suggested in Nepal, do not seem to provide Victron Charge Controllers, however, we could commission them for everything else, and provide them with the charge controller. This is something we will need to sort with a local supplier, supported by Practical Action.

The charge controller does come with a streetlight mode; however, this presents some challenges for this application since, 1) Dusk/Dawn times change in Nepal, therefore if controlled by a solar charge controller it would frequently have to be updated, 2) turning on/off from the solar charge controller will also turn mobile charging off, 3) during bad weather lighting may need to come on in low-light conditions.

**2.1. LED Lamp**

The illumination of the light under the area covered should be within the International standards i.e. 10-20 Lux. At a height of 8 meters Practical Action have calculated that the LED should be at least 40W. The streetlight should be able to be powered by a supply of 12V DC. We would source a local product from a supplier when commissioning.

The street light must also switch on from dusk-dawn. This must be enabled by the LED lamp itself with a dusk-to-dawn system.:

For testing purposes, we have two options 1) We buy a streetlight direct from the manufacturers, or 2) we use a standard floodlight. It is of my opinion we use the floodlight for 3 reasons 1) time to receive the item, 2) costs, 3) the streetlight we buy now, is not necessarily the version we will use in the field.

Streetlight (£57.37): <https://www.aliexpress.com/item/Direct-Sale-Solar-Compatible-DC-12V-24V-40W-LED-Street-lights-Apply-Road-Street-Park-Plaza/32623479073.html?spm=2114.search0104.3.14.24de6d6fFYCdc3&ws_ab_test=searchweb0_0,searchweb201602_3_10152_10065_10151_10344_10068_10130_5722815_10324_10342_10547_10325_10343_10340_5722915_10548_10341_5722615_10696_10192_10190_10084_10083_10618_10307_10820_10301_10821_10303_5722715_10059_100031_10103_10624_10623_10622_5722515_10621_10620,searchweb201603_11,ppcSwitch_5&algo_expid=d4c424f6-6eae-4f0c-8971-a697c0fe2c20-2&algo_pvid=d4c424f6-6eae-4f0c-8971-a697c0fe2c20&transAbTest=ae803_2&priceBeautifyAB=0>

Floodlight (£11.99) <https://www.amazon.co.uk/Floodlight-Daylight-Waterproof-Security-Driveway/dp/B074GVX7ZW/ref=sr_1_2?rps=1&ie=UTF8&qid=1528804312&sr=8-2&keywords=12v+floodlight&refinements=p_76%3A41915803>

For both options, finding an example with a dusk-to-dawn sensors is difficult. Therefore, the solution is to wire in a photoswitch:

Photoswitch (£7.99): <https://www.amazon.co.uk/Sensky-Photocell-Street-switch-Sensor/dp/B011UCDJCM/ref=sr_1_1?ie=UTF8&qid=1528801833&sr=8-1&keywords=12+volt+photo+switch>

**2.3. Solar Panel**

PA have specified a solar panel is required which is >160W to cater for a 40W LED lamp. As the solar panel provides a DC supply, we can simulate this on the bench power supply, removing the reliance on the weather for testing. The solar panel and appropriate fixings would be sourced from local supplier when commissioning.

Required capacity

If we assume:

* A single 40-watt LED bulb is powered at night for 12 hours
* A single RaspberryPi monitoring system draws 0.165W (at 3.3V) and is powered for 24 hours
* To charge one mobile requires 7Wh
* We charge 10 phones a day

|  |  |
| --- | --- |
| Device | Consumption (Wh) |
| 1x LED bulb | 480 |
| 1x Monitoring system (est.) | 9.6 |
| 10x mobile phones | 70 |
| Total | 560Wh (0.56kWh) |

With a 200-watt solar panel we should expect to generate approx. 0.65kWh/day, suitable for the above. This value needs to be modelled by Jonathan/Yevheniaa.

**2.4. Mobile Phone Charging**

To support mobile phone charging, we would need:

* 1. 12V to 5V USB converter:

<https://www.amazon.co.uk/GEREE-Converter-Module-Output->Adapter/dp/B01KX00U2Y?th=1

* 1. USB universal lead  
     <https://www.amazon.co.uk/CNL-UNIVERSAL-MULTIPLE-CHARGER-DEVICES/dp/B008CNWSOI/ref=sr_1_fkmr0_4?s=electronics&ie=UTF8&qid=1528718538&sr=1-4-fkmr0&keywords=multiple+phone+usb+charger+cable>
* We would also need to be able to control when the phone charger is in use, based on residual power, this could be achieved using a USB power control board.  
  http://www.switchdoc.com/usb-powercontrol-board/

**2.5. Battery**

The battery needs to be a 12V deep-cycle battery, with a capacity of 200Ah for 2 days of autonomy. It would be sourced from local supplier when commissioning.

For testing purposes, we have a 100Ah battery, which will be suitable as we can re-charge with a car battery charger,

**2.6. Cables**

## To wire the street light we would need 1.5mm2 copper cable. For in lab testing we would need approx. 3m (more to account for off-cuts etc.)

**2.7. Support Pole**

For testing this is not needed, but would be sourced from local supplier when commissioning.

**2.7. Lab testbed**

We need to build a testbed to 1) test the monitoring system, 2) understand the performance of the monitoring system, 3) be able to debug if any issues occur in-field, 4) be able to perform experimentation to create any algorithms needed, e.g., energy disaggregation.

To build a testbed in the lab we will need:

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| --- | --- | --- |
| Item | Model | Cost |
| Floodlight | Unbranded-direct from manufacturer | £11 |
| Photoswitch | Sensky SK020 | £8 |
| Charge controller | BlueSolar Charge Controller MPPT 75V/15A | £83 |
| Cable (3m) | Bimble Solar | £12 |
| Universal phone charger | CNL Universal Charger | £5 |
| 12V to 5V USB converter | CPT | £7 |
| Isolator | Screwfix | £15 |
| MDF & fixings for mounting & junction box | B&Q | £20 |
| **Total** |  | £161 |

In terms of timelines the testbed could potentially be built by the end of the week, depending on approval of this proposal, and delivery of parts.