Maintenance and Refinement of Solar Signposts on a School Campus

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Abstract. Following global warming and the recent energy crisis, schools at all levels have built several types of green energy facility to achieve educational and promotional goals. It was observed that electronic signs powered by solar energy (solar signposts) and lighting systems on campus could no longer function normally after an average of 2–3 years, resulting in waste. To alleviate this situation, the solar signpost system of this school was tested and repaired, and maintenance was completed to ensure that functions were normal. To refine the system, after data collection and analysis as well as considering human factors engineering, a battery and controller were installed in a location where they could be easily tested and repaired. In an overall review, green energy systems must undergo regular maintenance and testing for systems to function normally; they also enable students to obtain relevant knowledge and capabilities.

Introduction

MingDao University promote green energy, organic operation, and health as their development goals. Since the establishment of the solar signposts, wind–photovoltaic hybrid streetlights, solar powered boats, solar-heated swimming pools, 5 kW wind turbines, and solar powered electricity system for agricultural use were implemented in sequence. The examined project was solar signposts by a road surrounding the school site; these devices have not been operational for several years. Figure. 1 shows the internal photo of the signpost. A teacher led students to perform repairs of various subsystems and function checks to complete overall function recovery, enabling the students to benefit greatly from actual practice. All green energy facilities must undergo regular repairs and maintenance to continue refinement and sustainable operation.

System Architecture

The system architecture of solar signposts is simple and clear, suitable for beginners in green energy as a basis for research. Its operational interface is shown in Figure. 2. The power generated by the solar panel of this system is 10W/10V. The storage battery is a lithium battery (3.7V/2600mAh/cell).
with two cells in a series. The controller has reverse charge protection and protection mechanisms for battery overcharge and overdischarge. Power for use by the load (light) is provided by the controller.

![Diagram showing solar power, controller, and load](image1)

**Figure 2.** The operational interface of signpost.

### Maintenance Work and Refinement

#### Maintenance Procedure

A multimeter was used to measure the output voltage of the solar panel and storage battery, and a DC power supply was used to provide power for the load (light) and controller to confirm whether each subsystem was normal. Data of one of the signpost systems after measurement are presented in Table 1.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Voltage [V]</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar panel output</td>
<td>12.3</td>
<td>ok</td>
</tr>
<tr>
<td>Controller</td>
<td>-</td>
<td>Damaged (does not provide power)</td>
</tr>
<tr>
<td>Battery output</td>
<td>2.1</td>
<td>Damage (unused for a long time)</td>
</tr>
<tr>
<td>Load (light)</td>
<td>7.3</td>
<td>OK (normal operation)</td>
</tr>
</tbody>
</table>

**Table 1.** The subsystem measurement on one of the signpost.

### Measures for Refinement

The overall signpost testing results revealed that the failure rates of the controller and battery were high; this was because these two items were installed in the light box of the signpost and sealed with silica gel, and thus, could not be disassembled or measured easily. After discussion, it was determined that the lines of these two items should be pulled out and placed in a box at the rear of the light box to facilitate easy elimination of obstacles in the future as well as for staff to complete maintenance more efficiently, as shown in Figure 3. Additionally, the battery was replaced with a lithium battery, which had a smaller size, greater power, and longer life.

![Image of the new box for battery and controller](image2)

**Figure 3.** Put the battery and controller in a new box.
System Testing and Analysis

Performance Testing

Figure 4 presents the data of measuring the power of the lithium battery after charging (in the evening when the sun had set) and after being consumed by load (in the morning before the sun had risen); the measurement was conducted for 30 days. The average voltage after charging was 7.9V, the voltage after power consumption was 7.7V, and the load current consumption was 0.3A. The generating efficiency of the solar panel demonstrated an approximately 5% difference between sunny and cloudy days. The overall system operated steadily and could utilize indication and warning functions.

![Figure 4. The measurement data of a signpost.](image)

Durability Testing

The battery was a series of two lithium batteries; its total capacity was 5200 mAh and the load current was measured as 0.3 A. It was estimated to be able to provide up to 17.3 hours of electric power. During the testing period, it rained for 2 days consecutively; this solar signpost system was proven to still be able to operate normally, as shown in Figure. 5.

![Figure 5. Durability testing.](image)
Results Discussion

(1). For stand-alone solar energy systems, regular maintenance and testing are required for the system to operate normally and exert its functions.

(2). The batteries of statistically independent solar energy systems are relatively easy to damage and should be listed as regular replacement parts. Furthermore, lead-acid batteries should be replaced with lithium batteries because of their smaller size, greater power, and longer life.

(3). The failure rate of the controller was high; it will subsequently be developed in-house and can be tailored to system specifications to reduce costs and grasp key technologies.

(4). The battery and system controller are recommended to be moved to a location where they are easy to repair, test, and replace to reduce labor and time.

(5). The average voltage of the battery in this solar energy system after charging was 7.9V and the voltage after power consumption was 7.7V, which could survive 2 consecutive days of rain; the system was still able continue to operate.

(6). Students gained a deeper understanding and mastery of green energy facilities through the processes of testing, maintenance, verification, and analysis for system maintenance and refinement.

References


[2] Min-Sheng Wu, Charge and discharge control of high-performance solar lighting system, Department of Mechanical Engineering, National Taiwan University, 2005.


