# LOW COST LIGHTING SYSTEM TO REPLACE THE KEROSENE LAMPS

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ABSTRACT: Vast majority of the rural population of the developing world are still deprived of any kind of electrical energy. Most of the rural people of Nepal complete their afternoon household chores in the harmful environment of wicked kerosene lamps. Traditional and moderately higher capacity solar photovoltaic systems, though technically mature and widely accepted, are not affordable to bigger portion of the rural mass primarily because of high initial investment cost. A low cost lighting system based on White Light Emitting Diodes (WLED) is proposed for displacement of kerosene lamps at affordable cost. The proposed WLED lamps can be charged by using very small solar PV modules. These lighting systems are field tested, technically and socially accepted in Nepalese context. Technical details, cost estimates and results of the field tests are discussed.

Keywords: low cost, solar lights, kerosene lamps

## I. BACKGROUND

Nepal, a land-locked country in South Asia, has very low level of energy consumption. The vast majority of the rural population do not have access to electricity. It is unlikely that with present pace of grid extension, the rural people will have access to electricity in the remote future. Alternative sources of supplying electricity are being introduced in Nepal. The leading form of this source is electricity from decentralized micro/pico hydro plants. Even this initiative is not sufficient to electrify all the rural households, simply because this technology is very site-specific. The another alternative to hydro-based electricity is solar Photovoltaics. The Government of Nepal came up with very attractive subsidy policy to encourage people to use solar PV as a source of electricity. The amount of subsidy provided to the users is up to 50% of the total system cost.

By October 2003 over 44,000 Solar Home Systems (SHS) have been installed in Nepal providing electricity to around 220,000 people in rural areas [1]. Despite the growing popularity of solar PV, vast majority of the rural mass are still deprived of this technology mainly because of its high initial investment cost. And even today over 80% of the rural population of Nepal are still forced to spend their evenings under the light of hazardous kerosene lamps called "Tuki". The Centre for Renewable Energy (CRE), with financial assistance from Swedish International Development Cooperation Agency (Sida) and coordination from Asian Institute of Technology (AIT), Bangkok under

Renewable Energy Technology in Asia - a Regional Dissemination and Research Program, played a pivotal role in disseminating solar PV technology in Nepal.
The Centre for Renewable Energy came forward with a motto "Light for All" and introduced a new reliable, durable and above all affordable to majority of the rural mass appropriate technology to replace the "Tuki" forever.

Solar Energy Test Station (SETS) established under auspicious of Royal Nepal Academy for Science and Technology (RONAST) is now in process of finalization and adoption of the draft standards for solar PV lighting systems based on WLED lamps. This paper discusses the technical, commercial and social aspects of the low cost replacement of kerosene lamps by solar powered electric lights developed by CRE under RETs in Asia programme.

## II. THE TECHNOLOGY

The new technology introduced was named "Tukimara - or the tuki killer". The Tukimara (TM) comprises (Figure 1) of a small solar PV module (around 2-3 Watt-peak) and two units of White Light Emitting Diode based versatile lamps. The TM lamp is made of three tiny semiconductor devices called White Light Emitting Diodes (WLEDs) that convert electricity into white light more efficiently than traditional filament lamps. These WLEDs are extremely durable, consume less power and robust. A TM lamp consume only 0.3 Watt of electrical power but produces sufficient light to replace traditional kerosene lamp. A study conducted by Centre for Energy Studies, Institute of Engineering, Tribhuvan University, Nepal indicated that the illumination level produced by a lamp with three WLEDs at a distance of 30 cm fom the source is 275 Lux. The illumination level produced by a kerosene lamp at the same distance was only 29 Lux [2]. As per the prevailing norms, the illumination level required for reading purpose is 150-250 Lux [3].

Figure 1. The TM Lighting System

Each TM lamp is packed with three environment friendly rechargeable Nickel Metal Hydride batteries. The lamps have a socket for connecting PV modules, an outlet to connect a small battery-less radio, a switch and a charge indicator. The lamps can be used as table lamp (Figure 2) or wall

mount lamp or a torch light. Small 3 V operated battery-less radio can be directly connected to the lamps.

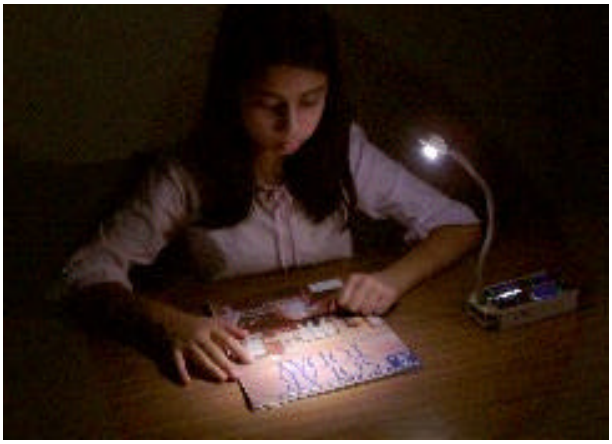

Figure 2. Reading with a TM light is better than the kerosene lamp

With a 3 Wp module and good sunshine[1], two lamps and a radio can be operated around 5 hours per day.

Technically, the construction (Figure 3) of the TM lamp is very simple and does not require high skills for assembly [4]. The number of electronic components is reduced to minimum to enhance the reliability and cost reduction.

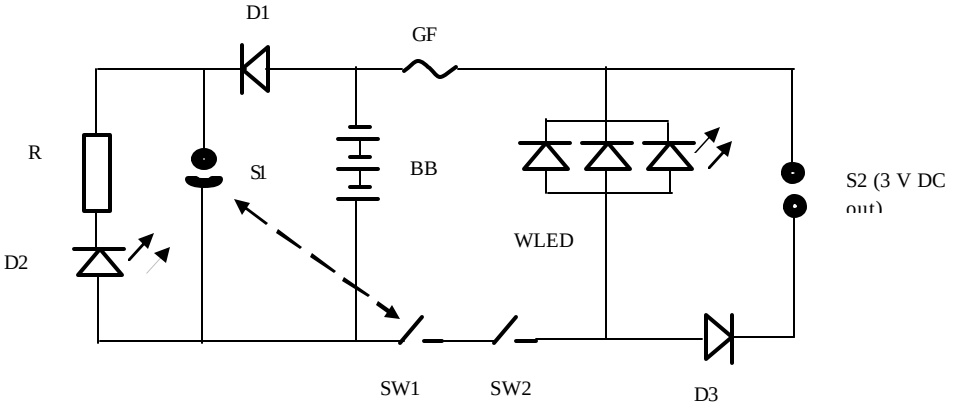


Figure 3. Electronic Circuit Diagram of TM Lamp

[1] About 4-5 hours of peak-sun per day

## III. COST

The initial cost of the system as well as the operating cost plays a deciding role when new technology is introduced to replace the current technology. The TM is primarily intended to displace the traditional kerosene lamps from the rural areas. An analysis has indicated that the money spent over two years on kerosene (for two lamps burning around 4-5 hours daily) and dry-cells to operate radio and torch light is almost sufficient to buy a TM system without any subsidy. The present low volume manufacturing cost of the TM system (inclusive of all the components) is around Nepalese Rupees 3,000 (~US $ 40). The operating cost is very minimal, and is associated with the replacement of rechargeable batteries once in two years. The annual operation cost is about Rs. 300 (~US$ 4.00).

The cost of the system could be further reduced by manufacturing them in larger scale.

## IV. DISSEMINATION

Every new technology requires huge effort to penetrate into the real-life existence. People, especially money trapped, do not buy things without being convinced about their usefulness in daily life and resulting saving in expenditure. CRE experimented with a new modality to disseminate the TM technology. First of all, a demonstration cum training program was organized for the potential users of the system. They were convinced that the money they spent on kerosene for a year would buy them the smoke free lamps. Moreover, they were given option to pay the amount they spent on kerosene every day to a local care-taker and they will get the system. This option prompted some 25 users (Figure 4) to take the system on daily payment basis. Now they are happy that they have good light.

Figure 4. Happy owner of the TM system

Up to October 2004, over 150 TM systems are being tested in the field since over a year under direct supervision by CRE technicians.

## V. FEEDBACK FROM THE USERS

A survey of 43 users was conducted to evaluate various aspects of the TM system. Table 1 below summarizes the major findings of the survey.

Table 1: Findings of User Survey

| S. No. | Question | Response (Percent, hours, liters etc.)) | | | |
|---|---|---|---|---|---|
| 1 | Is TM brighter than kerosene lamp? | Yes (74%) | | No (9%) | |
| 2 | Is the illumination acceptable? | Yes (93%) | No (2%) | | - |
| 3 | Is kerosene lamp still in use? | Yes (5%) | No (53%) | - | Occasionally (42%) |
| 4 | Is TM good for your health? | Yes (98%) | - | | |
| 5 | What is your opinion about the cost of the system? | High (44%) | Low (0%) | - | Acceptable (56%) |
| 6 | Is the TM lamp user friendly? | Yes (95%) | No (5%) | - | - |
| 7 | Has it changed your evening working hours? | Increased (35%) | Decreased (0%) | - | No change (65%) |
| 8 | Was the increase in evening working hours related to income generating activities?[a] | Yes (47%) | No (53%) | - | - |
| 9 | Is there any change in sleeping hours? | Yes, delayed by average 2 hours (47%) | - | - | No change (53%) |
| 10 | Change in children study hours | Increased in average by approximately 1 hour | | | |
| 11 | Monthly average consumption of dry cell batteries | Decreased in numbers by 70 (before installation of TM the 43 users consumed 72 pieces of dry-cell batteries[b], now it is only two) | | | |
| 12 | Monthly average consumption of kerosene | Decreased in volume by 193 liters (before installation of TM the 43 users consumed 196 liters of kerosene, now it is only three) | | | |

[a] *E.g. weaving plastic ropes in evening hours and extended hours of grocery shop opening*
[b] *To operate flash lights and radio*

The most important result of the survey is the indication of substantial reduction in kerosene

consumption and use of dry-cell batteries. The survey indicated that on an average of 4.5 liters of kerosene per household per month is saved. This is equivalent to decreasing the $CO_2$ emission by 11.8 kgs. per household per month [5]. Similarly an average of 1.6 units of dry-cell is saved per household per month.

## VI. ACCEPTANCE OF THE TECHNOLOGY AND TRANSFER OF TECHNOLOGY

The TM system gained popularity among the rural mass and even the city dwellers swiftly. Tukimara became buzz word in the areas where few samples were disseminated. News coverage in daily newspapers boosted the popularity of TM system. Some journals on appropriate technologies published articles on TM system as lead article [6, 7].

To ensure adequate supply of TM systems, CRE has signed Memorandum of Understanding with three leading manufacturers of solar PV in Nepal for transfer of technology and commercial production of the systems. All the three industries are now manufacturing different versions of TM systems.

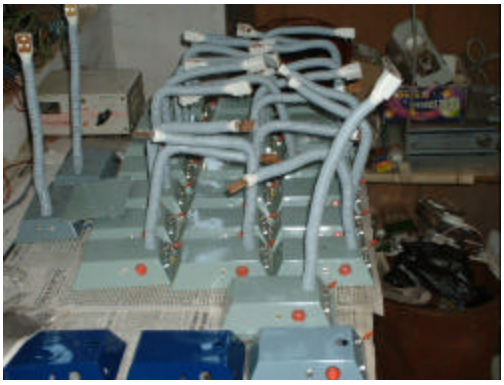

Figure 5: Commercial production of TM light sets

To facilitate the industries and entrepreneurs in manufacturing the TM system, CRE prepared and published a comprehensive manual on design of WLED based lighting systems [3]. Similarly users' manual in Nepali language was published for the benefit of users of TM systems.

## VII. GOVERNMENT POLICY ON TM SYSTEM

Realizing the positive impact made by the TM system in displacing kerosene lamps, the Alternative Energy Promotion Centre (AEPC) of His Majesty's Government of Nepal decided to conduct a study on the usefulness, reliability and social acceptance of the TM system with an objective to draft a policy to provide subsidy for small solar PV lighting systems based on WLED lamps [8]. The study

recommended AEPC to initiate pilot dissemination project on TM systems and initiate drafting of Government policy to provide subsidy to small solar PV systems based on WLED lamps ( at present the government policy on subsidy is restricted to solar PV systems with than module capacity larger than 10 Watt-peak).

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