Cost-effective Standalone Solar Smart Light for Village Roads

Unnat Bharat Abhiyan 2.0

Program Project-No:

RP-03525G

Date: 23rd November 2023

Submitted By:

Amrita Vishwa Vidyapeetham,
Coimbatore

Village:

Kaliyapuram, Thirumalayampalayam Panchayat,
Coimbatore district

Principal Invigilator

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Amrita Vishwa Vidyapeetham, India- 641112

SEG Details
Rural Energy Systems
(IIT Delhi)

Final Project Report of Unnat Bharat Abhiyan

1. Name of the Institute (in Block Letters): AMRITA VISHWA VIDYAPEETHAM, COIMBATORE

2. AISHE Code: U-0436

3. Title of the Project: Cost-effective Standalone Solar Smart Light for Village Roads

4. **Name of Subject Expert Group (SEG):** Rural Energy Systems (IIT Delhi)

5. Name of the Regional Coordinating Institute (RCI): Tamil Nadu Agricultural University, Coimbatore

6. Name of village(s) where project development activities were carried out: Kaliyapuram, Thirumalayampalayam Panchayat, Coimbatore District

7. Project Duration (with date): 8 Months (17.03.2023 to 30.11.2023)

8. Project Budget: INR 50,000

9. Technology (Development/Customization): Technology Customization

10. Introduction of the Project:

(*The basic problem importance of the project and final benefits to the villagers. A detailed description is essential for future use of this information. Please note the eligibility to future projects depends on quality of the report*).

As part of UBA project the PI (Participating institution) Amrita Vishwa Vidyapeetham had done base line survey and PRA (Participatory Rural Appraisal) in Kaliyapuram village, Thriumalayampalayam panchayat. Mostly underprivileged Scheduled Caste people live in the village. One of the important findings through PRA was absence of street light facility due to which school and college children have difficulty especially the girls.
Problem statement identified from PRA were:

- Low road visibility - *Night travel, early morning travel*.
- The village is near the foot hills of Western Ghats, needs road visibility and thus safety for the villages from animals and reptiles.
- Unethical practices such as eve-teasing are reported in this area during the night-time.
- Students pursuing higher education and working women, who require to spend extended time in the city, are unable to do so.

11. Project Objective(s) :

The project objective is primarily a social objective, translated into a technical objective

Social Objective:
The societal objective is to ensure visibility for the villagers during night hours and early morning hours for travel and thereby:

- Support education of especially students pursuing higher education, who require to spend extended time in the city.
- Support the villagers employed in the city who return back late.
- Ensure safe walk from/to the village with good visibility- safety from both unethical practices and harmful animals
- Ensure visibility even during power outages at night.

From social objective, technical objectives were formulated.

Technical Objective:
The technical objective is to provide a customized technological solution in the village context to ensuer visibility for the villagers during night hours and early morning hours for travel. The customized technology which when compared to conventional method has:

- Low capital cost
- Low system size
- High Energy Efficient
- Uses Clean Energy
- Ease of operation and maintenance
- Long Lifespan

For the technical objective, a customized technology suitable for the village is selected.

(a) Current status: The technology is presently deployed in village and working good.

(b) Achievement of the project (In details): The major achievement of the project includes

- **Reduced Size**- Battery & Solar PV size is significantly reduced by around 80% – with occupancy sensor integration
- **Reduced Capital Cost** – because of significantly reduced size and in-house development
- **Reduced Operating Time** - because of reduced ON time with twilight based ON/OFF control and occupancy based On/OFF control. This would enhance the life of the lamp, however switching may reduce the life of the lamp.
- **Reduced Electricity Consumption**- With reduced operating time, energy consumption is reduced.
- **Improved Energy Efficiency.** Energy Efficiency of the system is the highest because LED lights are more Energy efficient. As DC sytem with PV- Battery- LED lamps are used, energy conversions (AC/DC) losses are also minimum.
- **Sensorless Illumination Control**- In absence of solar PV power output, LED turns on automatically, thus no need for illumination sensor.
- **Single Assembly**- PV-Battery-LED- Occupancy Sensor
- **Improved Lifetime.** Life of solar PV is 25 years.Lifetime of LED lamp is around 12 years considering 12 hours of daily use.
- Replication potential in any Indian village.
- Improved visibility for vehicles in the road.
- In house fabrication of poles, resulting in reduced cost.

- Moral upliftment for the underprivileged Scheduled Caste people live in the village.

Scalability potential In India – Local to National: The project has significant scalability potential in areas such as:

- Remote roads without electricity.
- Flood/Disaster prone areas.
- Villages with frequent power outages
- University /Schools/Educational institutions/Industries
- Residential Villas /Apartments

12. Project Outcomes: (Photographs of the final products, Performance data)

The performance study was conducted, with the villager. The auto turn on/turn off functionality, and occupancy based dimming control functionality is tested and validated.

The performance video is available in: UBA Project

Stage1: Lights in dim mode, no occupancy

Stage2: Light-1 in bright mode, as it detects occupancy

Stage3: Light-2 also in bright mode, as it detects occupancy

Stage4: Light-3 also in bright mode, as it detects occupancy.

Fig1. Performance Study- *Lighting system functionalities*

13. Description of Project (In details) (Technology, Methodology, etc.):

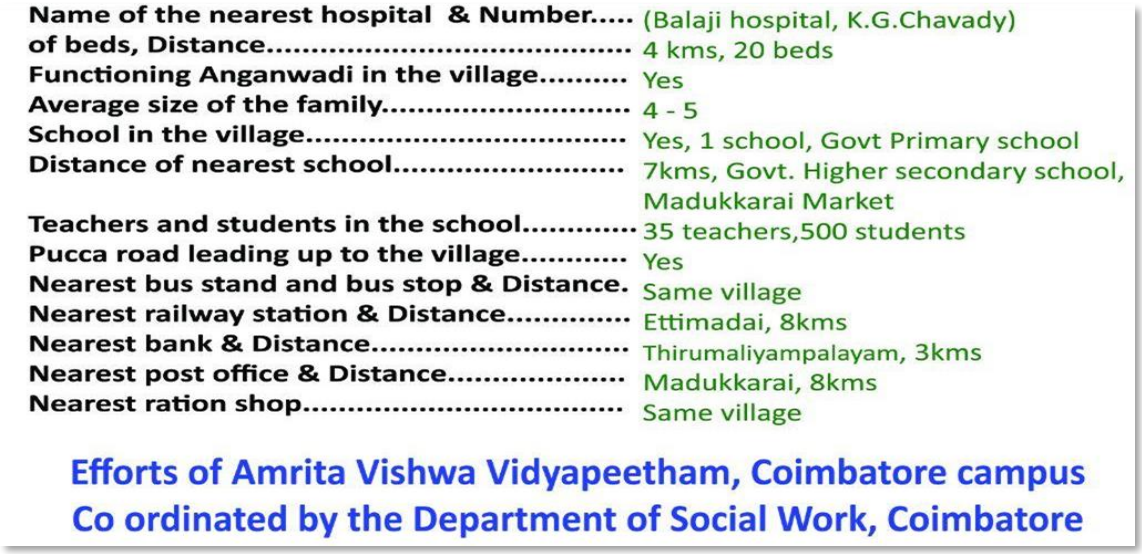
Village Details:

Fig2. Kaliyapuram village

Mostly underprivileged Scheduled Caste people live in the village.

Table1. Kaliyapuram village details

Village Name	Kaliyapuram
Panchayat	Thirumaliyampalayam town panchayth
Block	Madukkarai
District	Coimbatore
State	TamilNadu
Population (Men/Women)	1417
No. of Families	483
No. of Men	713
No. of Women	704
No. of BPL Families	110 (approx.)
No. of Anthodaya Families	20
Number of castes in the village	Arunthathiyar, Christian, Gounders
Area	6.24 acres
Nearest town	Coimbatore
Distance from nearest town	20
Best way to reach village	By bus
Name of nearest railway station	Ettimadai
Local language(s)	Tamil, Kannada, Telugu
Distance of the nearest PHC (Public Health Center)	3 kms



Problem Identification Methodology: *Participatory Rural Appraisal (PRA)*

As part of UBA project the PI (Participating institution) Amrita Vishwa Vidyapeetham had done base line survey and PRA (Participatory Rural Appraisal) in Kaliyapuram village, Thriumalayampalayam panchayat.

Problem Statement:

One of the important findings through PRA was absence of street light facility in the village road connecting to the main Palakkad- Coimbatore National Highway (NH) road due to which school and college children have difficulty especially the girls. The Problem statements are summarised as:

- Low road visibility - Night travel, early morning travel.
- The village is near the foot hills of Western Ghats, needs road visibility and thus safety for the villages from animals and reptiles.
- Unethical practices such as eve-teasing are reported in this area during the night-time.
- Students pursuing higher education and working women, who require to spend extended time in the city, are unable to do so.

Road Description: The distance of travel from the adjacent Palakkad- Coimbatore National Highway (NH) to the village is 1.4km. By walk, it takes around 17 minutes to travel from the NH to the village.

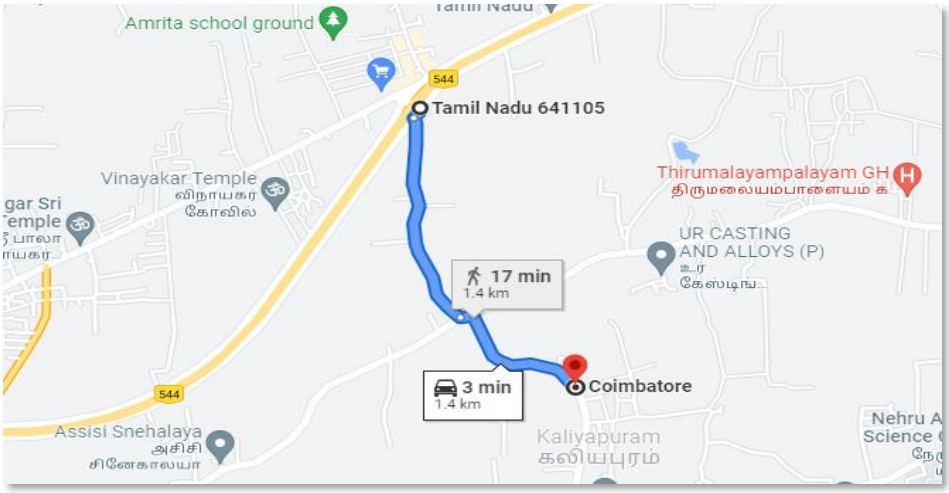


Fig 3. Road Map to Kaliyapuram village from National Highway

Stakeholder Details:

The main stakeholders are the Kaliyapuram panchayat and people residing in nearby villages. Project team has explained about the project to panchayat officials and people and there is a positive response from the stakeholders for further execution of the project. They also expressed that this would solve the multiple challenges in the village. The role of participating stakeholders during execution is detailed:

- **UBA Institution**: Procurement of materials and installation including civil work, performance monitoring.
- **Kaliyapuram panchayat:** Governmental approvals, no objection from the villagers (including land owners) for lamp post placement, support of local manpower for installation and civil work.
- **Selected Group:** Selected individuals from the villagers will be trained and empowered to do routine O&M including Solar PV panel cleaning. They will be authorised to monitor the system and report the equipment health, if necessary.
- **Student Team:** Student team is formed for working on the Hardware implementation.

The project is done in association with Kaliyapuram panchayat who will further maintain the established structure and ensure sustainability. Kaliyapuram panchayat: will be the authority of ownership of the Street lighting infrastructure asset.

Fig 4. Student team selection

Fig 5. Student team working on the Hardware implementation.

Solution Methodology | *Process of execution of the project*

Step 1: Street lighting Illumination Study, Site identification for optimal placement location
Step 2: Street Lighting System: Design as per IS standards
Step 3: Street Lighting System: Fabrication, testing, installation (including civil work) & Commissioning, and technology transfer to the user (village community)
Step 3: Awareness Campaign for the villagers – including O&M training for selected villagers
Step 4: Continued Performance monitoring & Verification (Post installation)

Illumination Study: In the initial stage, PI has already interacted with the Panchayat officials and villagers to understand the need for street lighting infrastructure for the villagers. Subsequently, an illumination study is conducted and the existing street lighting infrastructures and lighting levels are studied. It is concluded that there is a need to provide lighting facilities for villagers, as it becomes significantly dark over long distances.

Technology Customization: The idea is to provide a customised technology solution to meet the needs and constrains of the village. Overcoming technology challenges with right application & Overcoming application challenges with right technology.

Table 2. Complementarity of technology and village community expectations.

Village Community	Proposed (LED+ Solar PV+ Battery+ Occupancy Sensor)
Occupancy: Less Occupancy During Night	Light glows with less brightness, in energy saving mode. When it detects occupancy, it comes back to full brightness
CAPEX: Low investment potential in villages	With occupancy based sensing Solar PV and Battery size can be reduced. Thus System cost reduces significantly. (Solar PV Capacity :Low, Battery Size: Low, System Size: Low, Thus Capital Cost: Low
OPEX-1 Electricity Demand/Cost	As the electricity demand is low, the operating cost including the electricity consumption cost will be low.
OPEX-2: Operation & Maintenance facilities will be low in villages.	Now wires required, solar PV and LED lights have long life. Operation & maintenance requirement and thus cost will be low.

A comparative study of the proposed lighting scheme and the presently deployed street lighting schemes is conducted (Table 3). It is found that the proposed system is better technically and economically (CAPEX, OPEX).

Table 3. Comparative Analysis: Existing lighting scheme vs proposed scheme in the village context.

Application- User Group	Present Technology-1 Grid + LED	Present Technology2 LED + Solar PV+Battery	Proposed LED+ Solar PV+ Battery+ Occupancy Sensor
Less Occupancy During Night	Light Glows bright	Light Glows bright	Light glows with 30% brightness
Electricity Demand	High	High	Low
Solar PV	NA	High	Low
Battery Size	NA	High	Low
Electrical Wiring	Required	Not Required	Not Required
System Size	High	High	Low

Pole Fabrication Methodology: Our campus has in house fabrication team, for all kinds of infrastructural fabrication with good experience in diverse street light pole fabrication and installation. The specifications for Mechanical structure (including the pole) and associated foundation requirement (based on the soil type) is decided and approximate costs estimated with help of field engineers. Light on Demand functionality is tested. Upon completion of Lab testing, field testing is done in the village.

Fig 6. In-house pole fabrication results in reduced fabrication cost

14. Technical details, Design/drawing of the project:

The mechanical design details of the electric pole is shown in figure 4. GI pipe is used for pole fabrication. The pole has a height of 5.5m above the ground level.

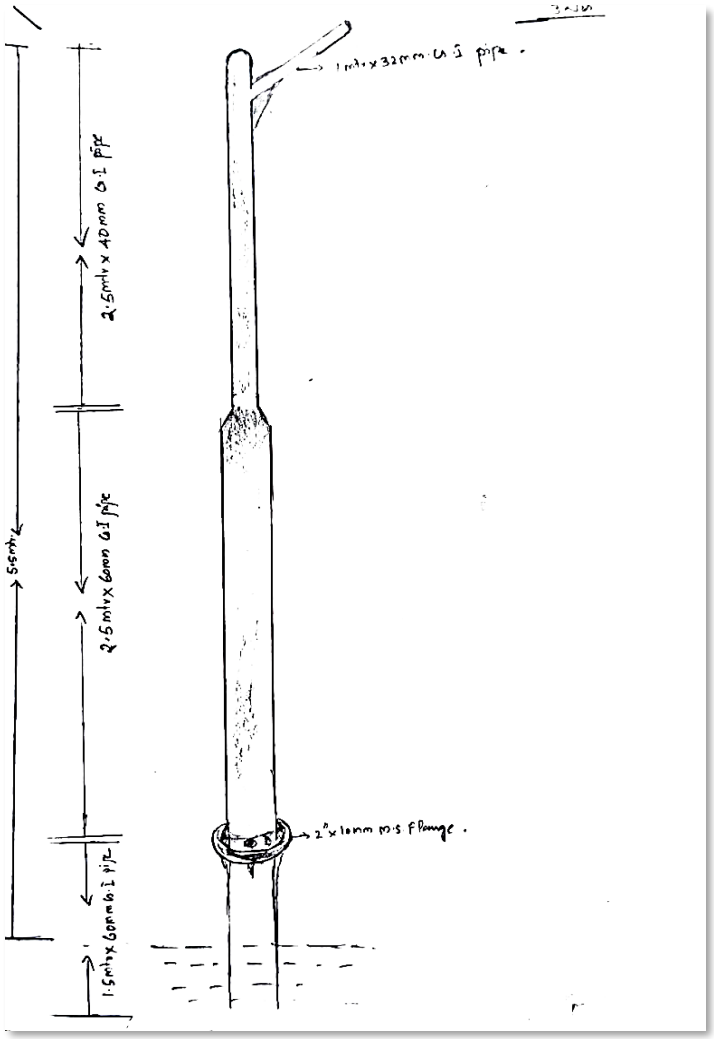


Fig 7. Electric Pole Dimensions

The technical details of the system is shown in Table 2. A radar motion sensor is used as the proximity sensor.

A Typical Day

During Daytime(7am to 6pm)

- During dawn, when the solar PV power output goes **above** an upper threshold, LED turns on automatically, thus there is no need for separate illumination sensor.
- The Lithium Ion battery is charged from solar PV during the day (S2B mode).
- During dusk, when the solar PV power output goes **below** a lower threshold, LED turns on automatically, thus there is no need for separate illumination sensor and switching relays.

During Night time (6pm to 7am)

- The battery discharges to the LED based lighting load during night (B2L).
- The occupancy sensor gives occupancy based feedback to LED light.
- When there is occupancy LED lamp switches ON and when there is no occupancy LED lamp switches OFF.
- This operational optimisation is expected to give 80% savings in energy consumption , and 80% reduction in PV-BESS sizing and capital cost.

Table 4. Technical Specifications – Solar PV, LED Lamp, Battery

Solar Panel	
Voltage	10V
Power	20W
Type	Monocrystalline
LED Lamp	
Luminous Efficacy	120 lm/W
Power	30W
Voltage	3.2V
Battery	
Type	Lithium Battery
Voltage	3.2V
Capacity	6 Ah*3=18Ah
Charging Time	6-8 Hrs
Backup Time	8-12 Hrs

15. Cost analysis of the equipment: Refer Table 5

16. Details of the Manufacturer: Refer Table 5

Table 5. Cost Analysis & Details of Manufacturer

Sl. No.	**Item Description**	**Preferred Brand**	**Quote By**	**Unit Price (incl. GST)**	**Qty**	**Total**	**Total (incl GST)**
1	30W Solar Street Light- LSTCOL30N	Luker	Luker Electric, Coimbatore	5150	5	25750	30,385
2	Node MCU ESP8266	-	Globatronics, Coimbatore	230	6	1380	1,628
3	PIR Sensor DC	-	Globatronics, Coimbatore	320	6	1920	2,266
4	Electric Poles	-	In House	5052	3	15156	17884
						Total	52,163

17. Impact of this project in the adopted village(s)/centre, etc. (Minimum 100 words):

Mostly underprivileged Scheduled Caste people in the village. The street lighting installation would be done in association with Kaliaypuram panchayat which will ensure the sustainability and maintenance of the project. The street lighting infrastructure will help Night travel, early morning travel.

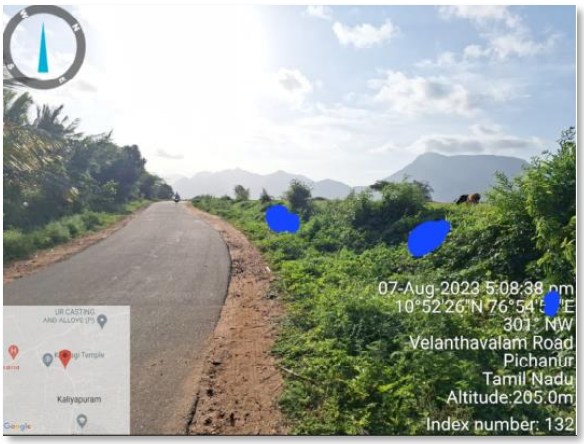
- School children studying in the city can attend after-school self-development sessions in the city.
- Working women can extend their working hours in the city.
- As the village is near the foot hills of Western Ghats, it will ensure visibility and thus safety for the villages from animals and reptiles.
- With visibility, it will also reduce certain unethical practices such as eve-teasing that are reported in this area during the night-time.
- Even during a power outage at night, the street lighting system will continue to provide visibility.

18. **Number of Families/peoples benefited:**

All members of the Kaliyapuram village (population of 1417 people) are benefited with visibility and thus safe connectivity with the main roads.

19. **Photos with captions of the projectactivities (Maximum of 6 photographs of high resolution):** Various activities related to the project is highlighted in Figure 7

20. **Description of each photo inamaximum of 25 word:** The description of the photo is provided in Figure 7



Step1. Site Selection.
A suitable site by the side of the road is selected with approvals from the authorities.

Step2. Civil Excavation Work
The pole spacing

Step3. Laboratory Testing
Lamp Automation & wireless communication– Tested in laboratory

Step4. In house Pole Fabrication
Pole fabrication work - completed

Step5. Pole & Lamp installation
Pole with lamp installed at appropriate orientations.

Step6. Final Installation
Lamps becoming functional at twilight.

Fig 8. Various activities related to the project with description

21. Link of feedback videos of villagers (If any):

Feedback by the school children of the village:

Fig.9 Village School Students Feedback (Video Link : UBA Project)

"My name is Subiksha, I am studying in 11th standard. I am coming from my school in Kaliapuram. From 6th standard onwards, in this manner we walk to school and walk back. We were finding very difficult without lights. From UBA project, we got help. It's of great help, these solar lights. We request that these light can be extended till Ettimadai (till highway). Thanks to UBA project team and Amrita University".

Elderly Villagers also were happy, when we took one of them for a trail test of the lighting system.

Fig.9 Village Elder Trial walk (Video Link : UBA Project)

22. Other relevant information (Minimum 100 words):

 # Awareness Campaigns: As a part of Anokha 2023, the Annual National Level Techfest by Amrita Vishwa Vidyapeetham, Coimbatore Campus the Department of Social Work organized a stall based on Unnat Bharat Abhiyan (UBA), where the UBA Solar Street Light Project team conducted an orientation session was on possibilities of "Cost Effective Standalone Solar Street Light for Village Roads".

 # UBA Name Boards. Also, UBA Nameplates are designed, printed and fixed in each street light.

Fig 10. UBA Solar Street Light Project team giving orientation on "Cost Effective

Fig 11. UBA Solar Street Light Project name boards

Standalone Solar Street Light for Village Roads”

 # Student & Teacher Participation. Mainly it was be great learning for the students and as well as teachers to resolve the community level multiple challenges previously mentioned. The students gained exposure in executing real-world projects for societal benefit. During the *product development*, they learned about the technical aspects of street lighting design and installation. The societal commitment of students also improved. Teachers became motivated to replicate the proposed model in other nearby villages also. More Teachers began to align their research with societal needs. Overall, a translation of classroom learnings to experiential learnings leading to community benefits.

Post Installation- *Sustenance Plan*

 # Street Light O&M Support. The UBA institution has an in-house electrical distribution system O&M team. With support from faculty students and the O&M team, O&M support can be thus availed anytime for equipment failure rectification.

 # Electric Pole O&M Support. The UBA institution has in-house fabrication and O&M team for attending to any pole related O&M.

 # Monitoring & Verification (M&V). Performance monitoring post installation and commissioning.

 # Training & Development. Villager’s buy-in and awareness campaigns are to be conducted to empower the villagers with the basic working and operation and maintenance (O&M) methodology of the automated street lighting system. Awareness Campaign for the villagers and training the selected group of villagers for operation and maintenance (O&M) post installation

23. Comments from the SEG:

24. Comments from National Coordinating Institute (NCI):

25. Clarification from Participating Institute (PI):

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