

Does the Overdeveloped World Appreciate the Win-Win-Win Opportunities for HBLEDs in the Developing World?

Dave Irvine-Halliday* and Stewart Craine**

* University of Calgary, Alberta, Canada ** Hydro Tasmania, Australia

(www.lightuptheworld.org)

Summary and Philosophy

Light Up The World (LUTW) is a humanitarian initiative whose chief goal is to assist the poor villagers in the developing world, by donor and local entrepreneurial means, obtain a useful, healthy, safe, reliable, rugged, affordable and environmentally friendly White Light Emitting Diode (WLED) based form of home lighting – primarily in order that the children can study in the evenings.

Pico Power International Corp. is a digital lighting company, which was essentially born out of the need for LUTW to have a source of constant funding. It is the goal of Pico Power to develop successful and innovative home and commercial High Brightness LED lighting products for the North American market, transfer much of the technology and a significant portion of the profits to LUTW, and assist LUTW in the establishing of a world wide ‘franchise’ of Pico Power lighting companies for the benefit of the two billion people who are in the dark as soon as the sun goes down.

“It is a fundamental obligation for we in the developed world to assist those in the developing world to raise their standard and quality of living, by their own efforts and in a manner which they choose – it is also our privilege.

I sincerely believe that we can make a difference – we truly can.

Let us together, in this new millennium, light up the world.”

In light of the tragic events in New York on 11 September 2001 it is more important than ever that the developed world increase its efforts to help improve the basic educational standards throughout the developing world – and home lighting is a key component of that help.

1. LUTW a brief history [1, 2]

The Light Up The World initiative was conceived, by fate some would say, in the summer of 1997 when Dr. Dave Irvine-Halliday, after completing a project at the Institute of Engineering, Kathmandu, Nepal, was completing a trek around the Annapurna Circuit. It had become very obvious during the trek that though there might be school buildings in some of the villages there were often no teachers and the schools also had no form of adequate lighting.

The vast majority of rural Nepali homes are presently lit by kerosene wick lamps, raisin soaked twigs or candles (expensive), all of which are a fire hazard and a health risk due to the smoke produced. Also Nepali homes generally have no chimneys due to the belief that the smoke and the resulting creosote protects the wooden ceilings from insect attack.

Being a photonics engineer he concluded that there had to be some way to bring a safe, healthy, efficient and affordable form of ‘digital’ home lighting to the developing world – thus was born “a wee personally funded project” which has taken over his life!

Not being an ‘illumination engineer’ (his background is fiber optic networks, fiber sensors, fiber optic gyroscopes and also biophotonics) and struggling to convert between candela and lumens the decision was made right at the beginning that there would be no attempt to try and light up the Nepali village homes to a North American level of illumination, but only to provide light to those areas of the home where it was of most use. Another reason for deciding to go for some form of ‘solid state’ lighting was the fact that it promised to dramatically reduce the energy requirements as compared to the conventional lighting sources - and energy is a very, very precious commodity in the developing world. One also had to constantly keep in mind that the annual average ‘income’ of these villagers was of the order of \$200US therefore any lighting system had to be simple, rugged and economic.

Back in Canada at the University of Calgary the efforts to produce ‘white light’ by combining the light from LEDs of various colors was eminently unsuccessful! Fate however again lent a hand with the timely development of the high brightness White LED by Nichia around this period. The WLED test day in the photonics lab will never be forgotten. On switching on the single Nichia WLED in the pitch dark, he exclaimed to his technician, John Shelley, “Good God John, a child could read by the light of a single diode!” It truly was a defining moment in the evolution of LUTW and especially since a single WLED consumed less than 0.1 Watt.

2. WLEDs – a gift from God to the developing world [3, 4, 5]

In the early years from 1997 the LUTW initiative grew from field testing a handful of various shaped WLED lamps in a number of remote Himalayan villages to testing entire home lighting systems together with WLED headlamps and torches (flashlights) whilst being a member of the successful “AGF Canadian Everest 2000 Expedition”.

It is informative to keep in mind that a 9WLED cluster lamp, consuming less than ONE WATT, can illuminate a developing world home **to a very useful degree** therefore the energy used in a single 100 Watt incandescent bulb can effectively light an entire typical village. In our minds small is indeed beautiful - thus was born the philosophy of “pico power”. The energy sources for LUTW’s home lighting projects have included Person Powered Pedal Generators, Pico Hydro and Pico Wind Turbines and Solar Photovoltaic.

For the **LUTW 2000 installations** in Nepal we used human powered Pedal Generators to charge the 12 Volt sealed lead acid batteries for the worlds first two villages to be permanently lit by WLED home lighting (Thulo Pokhara 22 homes, a Buddhist temple and a school kitchen, and Raje Danda 31 homes); a 200 Watt low head Pico Hydro generator was used for the third village (Thalpi 28 homes); and a Centralized Solar PV system for the fourth village (Norung 68 homes). We used a selection of 6WLED and 9WLED cluster lamps for these villages.

The words of a villager who visited Thulo Pokhara after it was lamped will long be remembered:

“A foreigner has come and made Thulo Pokhara heaven.”

For the **LUTW 2001 installations** the following projects were initiated and 9WLED lamps were used in all cases.

Nepal

1. Two villages using Pedal Generators (Ratmate 18 homes and Akura 31 homes).
2. One village using a 200 Watt medium head Pico Hydro (Lamra 53 homes).

3. One village using a distributed Solar PV (Chaura 125 homes).
4. One village using an upgraded electrified Ghatta (Lapsi Danda 63 homes)
 A Ghatta (water mill) is an ancient water powered grain grinder which uses simple straight wooden turbine blades.
 An upgraded Ghatta uses curved steel turbine blades, which deliver up to four times as much power, thus allowing more grain to be processed and also the attachment of an electrical generator which can be used to run electrical machines and also to light the village.

India

1. Two adjacent villages of over 130 homes each were partially lamped due to a lack of funding using Pedal Generators (Upper Mamring 15 homes and Middle Mamring 15 homes).
2. One school classroom in the village of Kurseong was lit for night study using the local grid to charge the batteries (Equivalent of 12 homes).
3. Partially lit the St. Alphonsus Social and Agricultural Centre (SASAC) in Kurseong using both Pedal Generators and the local grid to charge the batteries and we are also experimenting with different colors of HBLED lighting for their chicken hatchery (Equivalent of 40 homes).
4. Lit a number of offices in the Daughters of the Cross, Navjeevan Hospital, Bagdogra using the local grid to charge the batteries and we are experimenting with the use of WLED lighting for the operating theatre table since the normal incandescent lamps consume 700 Watts, give off a great deal of heat in an already extremely hot environment and the electrical grid suffers continually from multiple daily brown outs (Equivalent of 20 homes).

Sri Lanka

1. Lit the village of Pukunutenna utilizing a previously installed Solar PV system (20 homes).
2. Installed two 9WLED cluster lamps in the Pukunutenna Buddhist temple.
3. Supplied HBLEDs for strobe lamps of various colors as our contribution to a rugged, low power, user friendly and affordable “Elephant Early Warning System” designed to keep the elephants out of the farmers crops and thus reduce the possibility of dead elephants (Equivalent of 20 homes).

The quote of LUTW 2001 came from a father of five children in the village of Pukunutenna the night after his home received their WLED lamps:

“This is the first time in the lives of my children that they have been able to read at night”.

For us it was a moment of deep satisfaction, a sense of accomplishment, a tiny wee bit of pride and above all a profound feeling of humility that we could do so much, with so little, to so positively influence the lives of so many’.

3. Lighting energy demand and supply relations have changed forever

The absolute magnitude of the energy requirements of even the poorest nations is mind bogglingly large for those of us who are not normally accustomed to working in this area, thus it becomes all the more important that we collectively find ways of reducing or optimizing those energy needs. The electrical power experts tell us that from 25% to 30% of all the worlds energy goes towards lighting, thus it is even more imperative that we use the most energy frugal form of lighting available – and ESPECIALLY in the developing world.

Lamps and Torches

Let us look at the potential home lighting energy needs of a small country like Nepal as an example for the developing world. There are approximately 25 million people in Nepal and probably more than 80% of them have no regular access to dependable electrical home lighting. If we consider that each home has an average of six people living in it then the number of homes without electric lighting is of the order of 4 million. If we were to attempt to lamp these homes using 25 Watt incandescent bulbs or 8 Watt compact fluorescent lights then the total power required country wide would be 100 MW and 32 MW respectively, whereas lamping each home with 2 Watts of WLED lighting would take only 8 MW. It is not just the dramatic decrease in the power required that is important but the ripple effects on the environment and the likely pollution increase that must be kept firmly in mind.

A power station not built is a good power station!

Torches or flashlights are very important in the developing world since virtually every single family possesses at least one. On average the batteries in a cheap three “D Cell” torch using an incandescent bulb would be replaced approximately every two weeks or so and the batteries are then simply thrown away, just like we ‘used’ to do, and of course the contents of many of them find their way in to the streams and rivers with obvious consequences upon the health of the locals!

There are at least 4 million, and probably considerably more, torches in Nepal since in the city the homes are likely to have more than one. This means that somewhere in the order of 312 million “D Cell” batteries are thrown away each year in a small country like Nepal. There is no recycling of small primary batteries in Nepal and in the vast majority of the developing world countries!

Our three “D Cell” WLED torch experiments in the rural villages and on Everest have shown conclusively that the light of a 3WLED torch compares very favorably with that of the typical incandescent bulb version, plus it has a much more user friendly beam pattern and the light is ‘white’. The real advantage however, apart from being virtually indestructible, is that the batteries in the 3WLED torch last almost 30 hours as compared to around 3 hours for the incandescent version. This means that the number of batteries thrown away could be reduced from over 300 million to ‘only’ 30 million, a dramatic reprieve for the environment. If rechargeable batteries can be introduced then the number of batteries thrown away annually can be reduced to a ‘few’ hundred thousand.

Power Generation

Since most of the villages in the developing world are unlikely to be part of a national electrical grid in the foreseeable future then we have to think in terms of “Distributed Power Generation” and that “Small is indeed beautiful”! With a person powered Pedal Generator a single unit can easily recharge upwards of fifty 12 Volt batteries per normal working day based on the battery being used to light a 9WLED lamp for four hours each night, and that they are recharged every day. Our present Pedal Generator design allows five batteries to be charged simultaneously and it takes only around 30 minutes to recharge each battery.

A 42 Watt Solar PV panel can supply the electrical energy for 16 homes each using a 9WLED lamp, under the same nightly usage conditions.

A 200 Watt Pico Hydro Generator can easily supply a village of 100 or so homes.

Numerous 12 Volt 6 Watt Chinese bike dynamos, used as tiny Pico Hydro generators, have been shown to consistently operate nonstop, day and night for well over three years in West Bengal, India and they cost less than 200 IRs each, i.e. around \$4US.

It is fair to say that with the advent of digital lighting that lighting energy demand and supply relations have indeed changed forever!

4. Developing world leads the world in the use of HBLEDS

Though slightly tongue in cheek one could argue that the developing world does in fact ‘lead the world’ in the use of WLED lighting since Nepal has close to 10 villages, a school kitchen and a Buddhist temple already lit; India has two villages, the St. Alphonsus Social and Agricultural Centre, chicken hatchery, and a hospital operating theatre all lit or partially lit; and Sri Lanka has a village, a Buddhist temple and HBLEDS are being used in the Elephant Early Warning System.

Given the limited funding available to LUTW over the past few years it is truly remarkable that so much has been done, by so few, for so many with so little! The loaves and the fishes indeed!

5. The staggering potential market for WLEDs in the developing world [6, 7]

The successes to date only give strength to our argument that LUTW has to put itself in a position where it can truly benefit from economies of scale and be a leading proponent in forcing the cost of WLEDs, Solar PV panels and batteries down to a level where the rural villagers can afford to purchase WLED home lighting systems without subsidies being required.

There is more than ample evidence world wide that the poor are very willing to pay for reliable and good quality services, and home lighting is very high on their list of priorities.

Given that we can look forward to a per unit cost for a 0.1 Watt WLED of say \$0.25 and for a 1 Watt WLED of say \$1.50, in large quantities, then the potential market could be somewhat as follows. There are over 2 billion people who are literally in the dark as soon as the sun goes down so let’s assume that we can service them with WLED lighting. If we assume that there are around five to six people in each home then the number of homes lit by WLED lighting would be approximately 400 million. If we further assume that each home has at least two lamps and that each lamp contains 10 WLEDs (0.1 Watt) then we will require 8 billion WLEDs. At \$0.25 for each WLED this represents a market of \$2 billion just for the WLEDs alone. The energy

required globally per annum to power these two 1 Watt WLED lamps for four hours per night amounts to approximately 1.3 G kWh and for the single 8 Watt CFL and 25 Watt incandescent bulb we would require 5.2 G kWh and 16G kWh respectively. It must be stressed that these energy figures are very conservative since it is very likely indeed that even poor families will strive to have more than two lamps in their home once the price of the lighting systems falls significantly.

We must of course also include the WLEDs required for torches and there will be at least one per home, and assuming we have 3 WLEDs per torch, then the total number of WLED needed is around 1.2 billion. This too has to be considered a very conservative figure as reflected by the popularity in the developed world of the long life, very small, pocket size WLED torches like the Micro Photon.

There are also many other very significant developing world markets already identified for HBLEDs of various colors.

6. The future can only be brighter – for the overdeveloped and developing worlds

If the near term predictions regarding the improvement in HBLED total light output, reliability, efficacy and cost are even half way correct then there can be no doubt whatsoever that the statement that “WLEDs are a gift from God to the developing world” will be truer than ever.

At presently the effective one time cost for LUTW to light a home with one 9WLED lamp, associated generating equipment and storage system, if required, varies from \$40.00US to \$60.00US depending largely upon the type of generating system chosen and the local distribution system used.

LUTW to date has not had the advantage of any economies of scale whatsoever so there is every reason to believe that with the implementation of large projects then the above figures could ‘instantly’ be reduced by at least 30% even with only moderate reductions in the cost of the WLEDs.

There remains then the twin challenges of reducing, in particular, the cost of Solar PV and batteries in parallel with that of the WLED in order to bring the total system cost down to an affordable level by the vast majority of the developing world.

Maybe there is a good case here for the developing world to drive the market and bring down the cost of “Digital Lighting” to the overdeveloped world – now that’s a novel thought eh!

Last minute thought - A challenge to the overdeveloped world!

In the light of world events of late maybe the major manufacturers of HBLEDs, Solar PV panels and batteries can extend the same sort of terms to the villagers of the developing world that LumiLeds is extending to its customers who wish to upgrade their traffic lights to HBLEDs!

References

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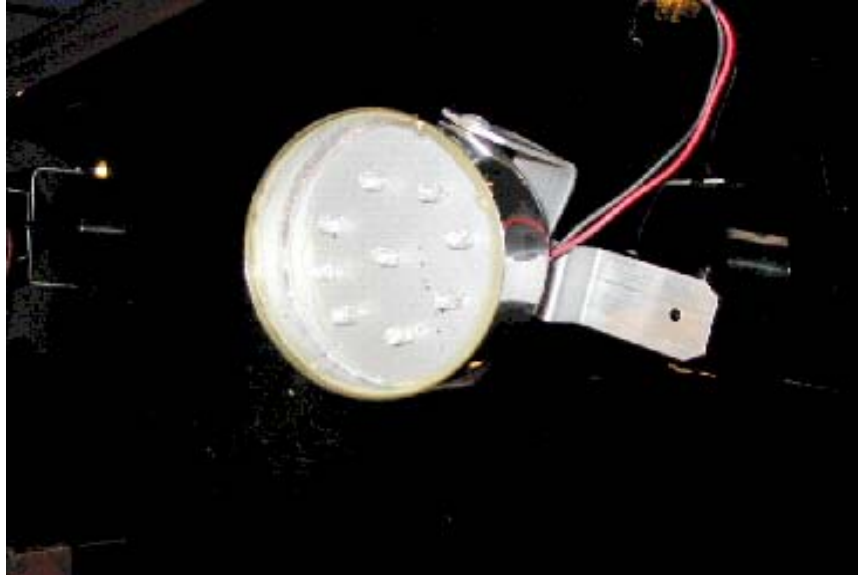


Fig. 1 LUTW 2001 9WLED Lamp.



Fig. 2 New and Old Pedal Generators



Fig. 3 Kerosene Wick Lamps, Nepal



Fig. 4 WLED lamps manufactured by Pico Power Nepal



Fig. 5 Old and New Ghatta Turbines



Fig. 6 Upgraded Ghatta with two grinders



**Fig. 7 Jumla lads' with Canadian
200 Watt Pico Hydro
Generator**



**Fig. 8 Early morning battery
charging
using old Pedal Generator
in Thulo Pokhara, Nepal**



Fig. 9 150 NRs (\$2 US) Clay stove with chimney, Nepal



Fig. 10 Battery charging in Mamring, India, using new Pedal Generator



Fig. 11 WLED lamp owner in Mamring, India



Fig. 12 Pico Hydro (6 Watt, 12 Volt Bicycle Dynamo) in operation in Mamring, India



Fig. 13 This 200 IRs (\$4 US) Pico Hydro Generator operated 24 hours a day for more than two years



**Fig. 14 Child studying with WLED lamp
In Mamring, India**



Fig. 15 The St. Alphonsus Social and Agricultural Centre (SASAC), Kurseong, India



Fig. 16 St. Alphonsus Social and Agricultural Centre, WLED toilet light, India



Fig. 17 Goose neck WLED reading lamp at SASACs, India



Fig. 18 Experimental WLED lamps in Dr. Regina's operating theatre in Dogbagra, India



**Fig. 19 Sir Arthur C. Clarke lends support
To LUTW, Sri Lanka**

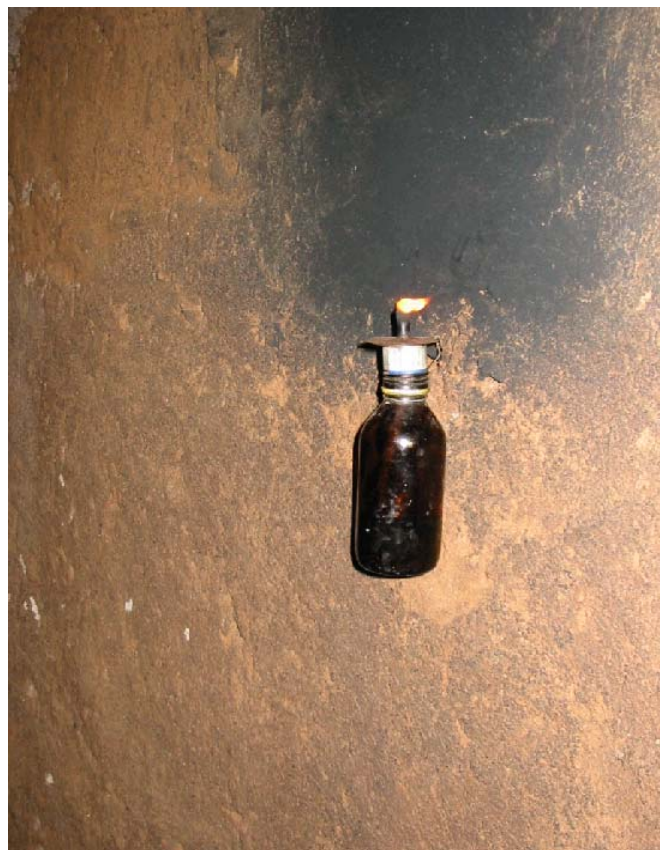


Fig. 20 Kerosene wick lamp, Sri Lanka



Fig. 21 Sri Lankan Mum and family with two WLED lamps



Fig. 22 Sri Lankan family with one of four WLED lamps (“Serpent protectors”)



Fig. 23 Rohan Pethiyagoda, a Sri Lankan ‘national treasure’ supports LUTW

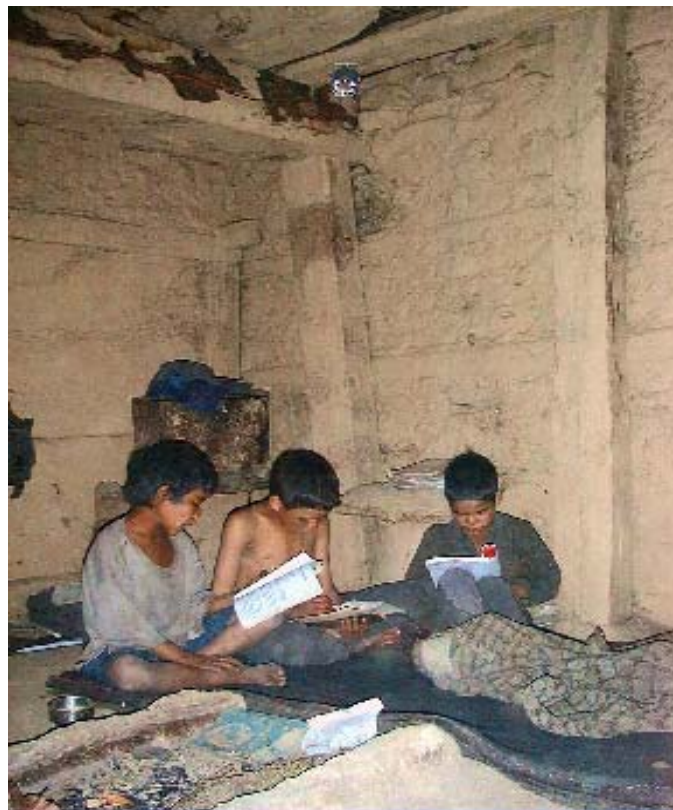


Fig. 24 Children studying by WLED Lamp in Jumla, Nepal



Fig. 25 Children with WLED lamp, Thulo Pokhara, Nepal



Fig. 26 Oldest man and grandchild with first village WLED lamp in the world, Thulo Pokhara, Nepal



Fig. 27 The Great Nepali mountaineer Babu Chiri Sherpa with a LUTW Pedal Generator at Everest Base Camp



□

Fig. 28 Tim Rippel with the first ever WLED head lamp on Everest

APPENDIX A

LUTW – Lapsi Danda, Nepal Electrified Ghatta Feasibility Survey, Cost Estimation and Proposed Cost Contribution

Feasibility Part

1. Name of the interested party: Mr. Shyam Bahadur Tamang
2. Address: Baireni 5, Kageswori Dovan,
Dhading District
3. Name of the Stream: Kheste and Rupung Khola
4. Walking distance from motor head: 2 hours
5. Survey conducted by: CRT/N and Micro-hydro Manufacturers’
Association
6. Survey duration and date: 7 days during August 2001
7. Technical Information:
 - a. Present status: Improved water mill is already there to run agro-processing units such as cereals grinding (wheat, millet and maize) and paddy hulling. So there is no need of further survey of civil and mechanical parts.
 - b. Discharge: 132 lps
 - c. Design discharge: 100 lps
 - d. Gross head: 3.96 m
 - e. Power mechanical generated: 1.9 kW
 - f. Power electrical generated: 1.443 kW
 - g. Power available for users: 1.15 kW (80%)
 - h. Turbine type: Improved Water Mill (Multi-purpose power unit)
 - i. Shaft size: 4 cm
 - j. Shaft rpm at no load: 340
 - k. Shaft rpm at load: 170
 - l. Penstock length: 5.2 m
 - m. Penstock slope: 49 degree
 - n. Pulley size: 45 cm
 - o. Pulley rpm at no load: 3950
 - p. No. of households: 35
 - q. Length of main transmission: 1631 m
 - r. Length of total transmission: 2483 m
 - s. Power per household: 33 watt
 - t. No. of bulbs per household: 3 (11 watt CFL + WLEDs)
 - u. Name of villages to be served: Lapsi Danda, Kolya, Di Danda and Dovan Danda

The project is feasible for an add-on electrification of 1.15 kW.

CFL - compact fluorescent light; WLED - White LED

Cost Estimation Part

Based on the survey report, Power Tech Nepal P. Ltd., one of the members of Micro-hydro Manufacturers' Association, did the cost estimate, which is as follows:

(In NRs.)

SN	Quantity	Description	Unit Price	Total
1.		Survey cost (2 persons for 7 days)		10,000
2.		Equipments		
a.	1	Induction Generator, 1.5 kW/1 ph/220v	10,000	10,000
b.	1	Induction Generator Controller, 1.5 kW, 1 ph with ballast tank and heater, main switch	16,500	16,500
c.	5.2 m	Penstock pipe (300 mm)	3,000	15,600
d.		Drive system: Pulley 4 No., Bet 2 No., Base frame and Shaft	13,000	13,000
e.	1	Spear nozzle	11,000	11,000
f.	2	Earthing plate	1,000	2,000
g.	5	Earthing pipe	200	1,000
h.	3	Lighting arrester	1,100	3,300
i.		Tools		1,500
3.		Transmission		
a.	3200	ACSR conductor "squirrel" wire	14	44,800
b.	115	Shackle insulator	55	6,325
c.	855	Service wire: 2.5 mm square, 2core	15	12,825
d.	35	PTC (Load limiting device)	600	21,000
e.	35	House wiring (includes 3 CFL, Nrs.250/unit)*	1,300	45,500
f.	70	Pole	100	7,000
4.		Installation (2 persons for 10 days)		15,000
		Sub-total		2,36,350
5.		Shipping/Handling + Contingencies (2+2=4 %)		9,454
		Total		2,45,804
5.		VAT (10 %)		24,580
6.		Grand Total		2,70,384

Note*: We can add WLED instead of CFL.

Cost required for CRT/N's technical support (survey, installation, operational training and at least 2 monitoring)

- | | | |
|----|--------------------------------------|-------------|
| 1. | Supervisor, 1 week @ NRs. 7,000/week | NRs. 7,000 |
| 2. | Overseer, 5 weeks @ NRs. 4,000/week | NRs. 20,000 |

Total NRs. 27,000

Proposed Cost Contribution

1. Government subsidy

It is expected that a subsidy amount of NRs. 40,000 at NRs. 27,000/kW will be available from the government. However, the government bureaucracy needs lots of paper and administrative works and may take quite long time, as this will be the first case to get a government subsidy. Moreover, the government agency providing subsidy, may like to observe the performance of this scheme before they decide about the government subsidy on Ghatta electrification.

2. Support from LUTW

SN	Item	Contribution (NRs.)	Remarks
a.	Transmission cost excluding cost of the poles (poles will be locally managed and contributed) 50 % NRs. 64,000 in grant, mainly for transmission wire and 50 % NRs. 64,000 in loan, mainly for house wiring including CFL and LED	1,28,000	The community is willing to pay back the loan within 3 years period. This repayed loan will be used by the community for repair and maintenance
b.	CRT/N involvement cost	27,000	
	Total	1,55,000	

- 3. Community contribution on a per head basis** NRs. 1,02,384
(NRs. 2,925/per head, cash or loan from local bank)
\$1.00Can = 46NRs

Project Operational Modality

1. The community will collect their contribution for installation of the project.
2. Power Tech and CRT/N will jointly install the project.
3. After installation, the owner will be made responsible for its operation.
4. CRT/N with the support of Power Tech Nepal P. Ltd. will provide operational training to the owner/operator.
5. The owner/operator will provide the necessary custom services to the customers.
6. A "Users' Management Committee" will be formed from among the community to supervise the operation.
7. The customers will pay the service cost (as decided by the community) to the owner.
8. The customers will also pay back the already agreed loan amount (received from LUTW) which will be used for repair and maintenance.
9. CRT/N will provide at least 2 monitoring support services.
10. CRT/N will submit periodic reports to LUTW.

APPENDIX B

LUTW WLED Pico-Hydro Electrification Program
Cost Estimation for 53 Household
Lamra, Jumla, Nepal
June 22 2001
Estimation of PICO-Hydro Powered WLED Lighting System

S. No.	Particulars	Qty.	Unit	Rate NRs.	Amount	Remarks
1	40mm HDPE pipe from water source to generator	300	m	40.00	12,000.00	
2	16mm HDPE pipe for underground transmission line to each house	1650	m	22.00	36,300.00	
3	3/22 gauge main line transmission line cable	550	m	18.00	9,900.00	
4	40/0060 Red + Black Wire for Household Wiring	12	coil	750.00	9,000.00	
5	WLED Lamps	60	sets	1,687.20	101,232.00	
6	Switch	60	pcs	10.00	600.00	
7	220VAC to 12VDC Converter	8	sets	2,000.00	16,000.00	
8	Transportation from KTM to Surkhet by road	100	kg	10.00	1,000.00	
9	Transportation from Surkhet to Jumla Airport by air	389	kg	36.00	13,986.00	
10	Site Supervision (transport, living, photography, instruction etc.)	1	person	10,000.00	10,000.00	
11	Salary of technicians (1 month)	2	person	8,000.00	16,000.00	
12	Tools	1	set	1,000.00	1,000.00	
13	Multimeter	2	set	500.00	1,000.00	
14	Wiring clips, nails, PVC tape etc.	1	lumpsum	2,000.00	2,000.00	
15	Bijuli Dekchi to balance generation and load	1	set	5,000.00	5,000.00	
16	Electronic load controller	3	set	400.00	1,200.00	
17	Circuit Breakers	6	set	600.00	3,600.00	
18	Control Valves	2	set	1,600.00	3,200.00	
19	Filter Screen	3	m	110.00	330.00	
20	Cement	3	bag	2,100.00	6,300.00	
21	Turbine Generator, stand, controls etc.	1	set	23,000.00	23,000.00	
22	Spare Pelton Wheel	1	set	6,900.00	6,900.00	
23	Loading and Unloading	2	person	1,500.00	3,000.00	
24	Transportation and lodging during purchase of goods	1	lumpsum	500.00	500.00	
Total	NRs				283,048.00	
Total	Can \$	\$1.00	rate	46.00	6,153.22	

Estimation of Transportation Weight from Surkhet to Jumla Airport

S. No.	Particulars	Qty.	Unit	Rate	kgs	Remarks
1	40mm HDPE Pipe	300	kgs/m	0.38	114	
2	16mm HDPE Pipe	1450	kgs/m	0.13	189	
3	Motor	1	kg	10.00	10	
4	WLED Lamps	60	kg	0.25	15	
5	Wire	1	kg/coil	36.00	36	
6	Other	1	kg	25.00	25	
Total	Weight				389	

Estimation of Community Work						
S. No.	Particulars	Qty.	Unit	Rate NRs.	Amount	Remarks
1	Power house building construction	1	set	5,000.00	5,000.00	
2	Excavation and re-fill work	1	set	35,200.00	35,200.00	
3	Material transport by porter	1	set	5,000.00	5,000.00	
Total	NRs				45,200.00	
Total	Can \$	\$1.00	rate	46.00	982.61	
Breakdown Cost per WLED Lamp Making						
S. No.	Particulars	Qty.	Unit	Rate NRs.	Amount	Remarks
1	PCB	1	pcs	120.00	120.00	
2	Lamp Case	1	pcs	15.00	15.00	
3	Stainless Steel Case	1	pcs	35.00	35.00	
4	Regulator IC	1	pcs	75.00	75.00	
5	Heatsink	1	pcs	20.00	20.00	
6	Spacer	1	pcs	10.00	10.00	
7	Resistors	1	pcs	5.00	5.00	
8	Painting	1	set	5.00	5.00	
9	Plastic Washer	1	pcs	5.00	5.00	
10	Rivets and Screws	1	pcs	5.00	5.00	
11	Metal Washers	1	pcs	5.00	5.00	
12	Adhesives	1	pcs	5.00	5.00	
13	Wires	1	pcs	10.00	10.00	
14	Fixing Brackets	1	pcs	20.00	20.00	
15	Glass Cover	1	pcs	25.00	25.00	
16	Purchasing, transport, assembling	1	set	250.00	250.00	
Total	Manufacturing Cost Per Lamp				610.00	
1	Government Tax.	10%	set	61.00	61.00	
2	Government Officers	10%	set	61.00	61.00	
3	VAT	10%	set	61.00	61.00	
4	PPN Machinery Depreciation	10%	set	61.00	61.00	
5	PPN Profit Margin	10%	set	61.00	61.00	
Total	Overhead Expenses				305.00	
1	WLEDs Exchange Rate	\$1.10	rate	78.00	85.80	
1	WLEDs Cost	9	pcs	85.80	772.20	
Total	WLEDs Cost				772.20	
Total	9 WLEDs Lamp Cost NRs				1,687.20	
Total	9 WLEDs Lamp Cost Can \$	\$1.00	rate	46.00	36.68	

APPENDIX C

LUTW WLED Solar Electrification Program						
Cost Estimation for 125 Household						
Chaura, Jumla, Nepal						
June 22 2001						
Estimation of Solar Powered WLED Lighting System						
S. No.	Particulars	Qty.	Unit	Rate NRs.	Amount	Remarks
1	Solar Battery 75Ah 12V	16	pcs	3,000.00	48,000.00	
2	Solar Panel 42 Watt	8	pcs	15,000.00	120,000.00	
3	40/0060 Red + Black Wire	3125	m	6.00	18,750.00	
4	Box Switch	125	pcs	14.00	1,750.00	
5	Wiring Clips	250	packet	6.00	1,500.00	
6	Charge Controller	10	set	2,500.00	25,000.00	2 Extra
7	MCB 1.5A	12	set	200.00	2,400.00	4 Extra
8	Wiring pipe 16mm HDP	2500	m	22.00	55,000.00	
9	Battery transport from Surkhet to Jumla	368	kg	36.00	13,248.00	
10	Panel transport from Surkhet to Jumla	72	kg	36.00	2,592.00	
11	Wiring, pipe transport from Surkhet to Jumla	313	kg	36.00	11,268.00	
12	Wiring wire, clips, tape, switch etc	75	kg	36.00	2,700.00	
13	Battery, Panels, Wire etc. from Ktm to Surkhet	500	kg	6.00	3,000.00	
14	Loading and Unloading	500	kg	2.00	1,000.00	
15	Electrification work - Technicians 1 month	3	person	8,000.00	24,000.00	
16	WLED Lamp	140	set	1,687.20	236,208.00	
Total	NRs				566,416.00	
Total	Can \$	\$1.00	rate	46.00	12,313.39	
Estimation of Community Work						
S. No.	Particulars	Qty.	Unit	Rate NRs.	Amount	Remarks
1	Solar Battery transport from Jumla Bazar to Chaur Gaun	368	kg	8.00	2,944.00	
2	Solar Panel transport from Jumla Bazar to Chaur Gaun	72	kg	8.00	576.00	
3	Wiring materials transport from Jumla Bazar to Chaur Gaun	20	kg	8.00	160.00	
4	16mm HDP pipe transport from Jumla Bazar to Chaur Gaun	313	kg	8.00	2,504.00	
5	Earth work excavation, pipe laying and filling etc.	375	m ³	130.00	48,750.00	
Total	NRs				54,934.00	
Total	Can \$	\$1.00	rate	46.00	1,194.22	
Breakdown Cost per WLED Lamp Making						
S. No.	Particulars	Qty.	Unit	Rate NRs.	Amount	Remarks
1	PCB	1	pcs	120.00	120.00	
2	Lamp Case	1	pcs	15.00	15.00	
3	Stainless Steel Case	1	pcs	35.00	35.00	
4	Regulator IC	1	pcs	75.00	75.00	
5	Heatsink	1	pcs	20.00	20.00	
6	Spacer	1	pcs	10.00	10.00	
7	Resistors	1	pcs	5.00	5.00	
8	Painting	1	set	5.00	5.00	
9	Plastic Washer	1	pcs	5.00	5.00	
10	Rivets and Screws	1	pcs	5.00	5.00	
11	Metal Washers	1	pcs	5.00	5.00	
12	Adhesives	1	pcs	5.00	5.00	
13	Wires	1	pcs	10.00	10.00	
14	Fixing Brackets	1	pcs	20.00	20.00	
15	Glass Cover	1	pcs	25.00	25.00	
16	Purchasing, transport, assembling	1	set	250.00	250.00	
Total	Manufacturing Cost Per Lamp				610.00	
1	Government Tax.	10%	set	61.00	61.00	
2	Government Officers	10%	set	61.00	61.00	
3	VAT	10%	set	61.00	61.00	
4	PPN Machinery Depreciation	10%	set	61.00	61.00	
5	PPN Profit Margin	10%	set	61.00	61.00	
Total	Overhead Expenses				305.00	
1	WLEDs Exchange Rate	\$1.10	rate	78.00	85.80	
1	WLEDs Cost	9	pcs	85.80	772.20	
Total	WLEDs Cost				772.20	
Total	9 WLEDs Lamp Cost NRs				1,687.20	
Total	9 WLEDs Lamp Cost Can \$	\$1.00	rate	46.00	36.68	