Lighting up the World

By Jennifer Perry

More than two billion people or one third of humanity have no access to electricity and are therefore without access to proper lighting. These people rely on fuel-based lighting such as kerosene, animal dung, wood or other carbon-based fuel, as well as other inefficient energy resources such as disposable batteries, candles and imported fossil fuels for running small generators. The challenges of these communities couldn't be further from those facing major cities and their strategies for sustainability. Lighting Magazine spoke to a number of visionary people working in under-developed communities about how they are creating safe and reliable lighting systems at a grassroots level.

LIGHT IN THE DEVELOPING WORLD

The kerosene that's used for lighting alone is an estimated US$48 billion per year industry. Yet fuel based light production is extremely inefficient, dangerous and expensive, and has extensive economic, health and environmental costs, both locally and globally.

Kerosene is more expensive than electric lighting, at 325 times higher ($/lumen hour of light) than the "inefficient" incandescent bulb, and 1,625 times higher than compact fluorescent lighting. The burning of kerosene causes both indoor and local air pollution, with fuel based lighting responsible for the emission of 244 million tons of carbon dioxide into the environment each year from developing countries.

Denuding the landscape in search of wood fuel for lighting is also recognised as a primary environmental problem in the developing world, as well as the release of heavy metals into local environments from the disposal of millions of non-rechargeable dry cell batteries. In a country like Nepal with a population of over 24 million, hundreds of millions of non-rechargeable batteries are discarded directly into the environment each year.

Health effects are serious, commonly including respiratory and eye problems, and death.

"The world bank estimates that 780 million women and children breathing particular laden kerosene fumes inhale the equivalent of smoke from two packets of cigarettes a day. Two thirds of adult female lung-cancer victims in developing nations are non-smokers."

According to Lawrence Berkeley National Laboratories, the single-greatest way to reduce greenhouse-gas emissions associated with lighting energy is to replace kerosene lamps with white light emitting diode (LED) systems in developing countries.

WHO PROVIDES AN ALTERNATIVE?

The inefficient use of current energy sources in developing countries has created a significant market into which energy efficient and renewable energy technologies can be utilised to improve livelihoods.

The installation and maintenance of transmission lines (grid electricity) into these often small and geographically remote populations is almost impossible. However, there are international humanitarian organisations, individuals and companies who for some time now, have been applying 21st century technology to create ultra energy efficient lighting systems for disadvantaged communities both overseas and in Australia.

The following individuals and organisations are forging humanitarian-entrepreneurial relationships with industrial partners; some of the world's leading manufacturers of energy efficient lighting technologies, as well as partnerships with local communities themselves, NGO's and academia, together shedding light on a global problem and mutually benefiting from the process.

They have not only been lighting up the households and communities of some of the poorest and most remote regions on earth, but have succeeded in lighting up the faces and hearts of thousands.

Opposite page –
LEFT:
A father shows his daughter light for the first time inside their home. Photo courtesy of Alex Zahnd.

TOP RIGHT & BOTTOM RIGHT:
Indoor light – First time life experience. Photo courtesy of Alex Zahnd.

TOP:
Dr Dave Irvine Halliday, founder of Light Up The World.

BOTTOM:
Indoor light – First time life experience. Photo courtesy of Alex Zahnd.

LIGHT UP THE WORLD (LUTW) – DR DAVE IRVINE-HALLIDAY

"A foreigner has come and made Thulo Pokhara heaven."Villager, Nepal 2000.

LUTW was the first humanitarian organisation to utilise white LEDs or Solid State Lighting (SSL) technologies in order to replace fuel-based lighting, thereby bringing affordable, safe, healthy, efficient and environmentally responsible lighting to people currently without access to proper lighting.

Dr Dave Irvine-Halliday, a Professor at the University of Calgary envisioned LUTW during his sabbatical in Nepal in 1997 where he was dismayed at the living conditions of villagers whose only source of light at night was that from dangerous and unhealthy kerosene lamps.

He says that prior to LUTW's arrival basically no communities had reliable access to light. It is LUTW's general policy not to go where an electricity grid already exists, as their efforts are better spent replacing kerosene or candles rather than incandescent bulbs.

Their typical system consists of one 5W solar panel; two or three 1W white LEDs; and a sealed lead acid battery. Being a solid state device, their white LEDs are extremely robust and durable, withstanding severe shock and vibration. Having no filament generates light with little heat, with a single diode generating light continuously for up to 100,000 hours; about 40 years worth of light when used for six hours daily (the light source becomes less bright over time).

Because white LEDs are typically two times more efficient than traditional incandescent lamps, an entire village can often be lit with less energy than that used by a single conventional 100W light bulb. In most places in developing countries this works out to be the cost equivalent of a two-year supply of kerosene.

Since its initial installations of some 50 lighting systems in two remote villages in Nepal in 1998, LUTW and its partners (including generous individuals, host country organisations, governments, international foundations and industrial partners) have together lit up more than 8,000 homes in countries including Afghanistan, Bolivia, China, Costa Rica, Dominican Republic, Ecuador, Guatemala, India, Mexico, Nepal, Pakistan, Peru, Philippines, South Africa and Sri Lanka.

Their projects include the:

Tsunami Refugee Camp Lighting project in Sri Lanka; Canadian Hydro – Calgary Zoo Joint Project in Ghana; Demonstration Project for the Dalit people or "untouchable" cast in Andra Pradesh, India.

By the end of 2005 LUTW's installations had changed the lives of nearly 35,000 people and their goal is to reach approximately 2 billion people worldwide without access to adequate lighting. They will come a step closer to achieving that with the upcoming signing a long-term partnership with one of the largest lighting companies in the world. Dr Irvine-Halliday hopes that once this occurs, others will follow.

ALEX ZAHND – NEPAL

Armed with a Mechanical Engineering degree and a Masters in Renewable Energy, Swiss-born Alex Zahnd is involved in applied research of renewable energy technologies and the implementation of these on a village scale in the remote and impoverished mountain districts of Nepal.

Since Alex and his family came to Nepal in 1996, he has worked as a volunteer with the United Mission to Nepal, the first five years developing and leading a community development project in partnership with 16 villages in

"Dark nights used to turn me into a cripple, making me totally dependent on others, now I can move about and do my work like a teenager!" (90 year old Zeest Shah)

LEFT:
A central PV system (300W) for 63 homes and 189 LEDS, Nepal. Photo courtesy of Alex Zahnd.

RIGHT:
Cleaning a solar PV frame after sunset, Nepal. Photo courtesy of Alex Zahnd.

the remote district of Jumla. Since 2001, besides being a current expatriate staff member of Kathmandu University and teaching courses on Renewable Energy Technologies, Alex has developed and leads 16 individual implementation and research projects in the even more remote district of Humla.

Alex says that as a trained Mechanical Engineer he quickly recognised that while Nepal lacks fossil fuel resources, it is rich in renewable energy resources, particularly water and solar energy, and the utilisation of such resources could drastically improve the low standard of living for remote Nepalese villages, amongst the poorest in the world.

He says that the often low caste Nepalese communities, having no exposure to the developed world, have simply not known that electric light is possible. However, once community awareness is built through individual village surveys that are regularly conducted, Nepali people are themselves quickly able to identify and understand their own problems and needs.

Amongst such other essentials as pit latrines, smokeless metal stoves and clean drinking water, the need for indoor lighting has been of top priority for these people.

The current use of the locally available "jharro"; resin soaked pine wood tree sticks that generate toxic black smoke, is a sure contributor to the average 40 year life expectancy for people such as those in Humla.

Alex began using white LEDs in Nepal seven years ago because he felt that SSL technology was appropriate for first time village electrification projects. "The 9 diode Nichia white LED lamps, with a 50 degree light output angle, consume between 0.75 – 0.85W only, around 26 Lumens per Watt," he says.

"With the 500Wh that a toaster in an average Australian home consumes during one 30 minute breakfast, we can provide 30 families with three white LEDs each which produce 5-6 hours of light daily. That really is 'small is beautiful!'"

TOP:
Village project committee meeting, the local people are involved in every project step and decision, Nepal. Photo courtesy of Alex Zahnd.

BOTTOM:
Measuring the output of a compact fluorescent lamp, Nepal. Photo courtesy of Alex Zahnd.

Both the white LEDs that are used in villages, and the high power factor compact fluorescent lamps (CFL), used for AC systems in places such as their high altitude research station in Simikot, have shown extremely satisfactory life expectancies - some CFLs still running after six years (more than 12,000 hours) of intensive use, and the white LEDs (Nichias NSWP510BS) effective after 22,000 hours.

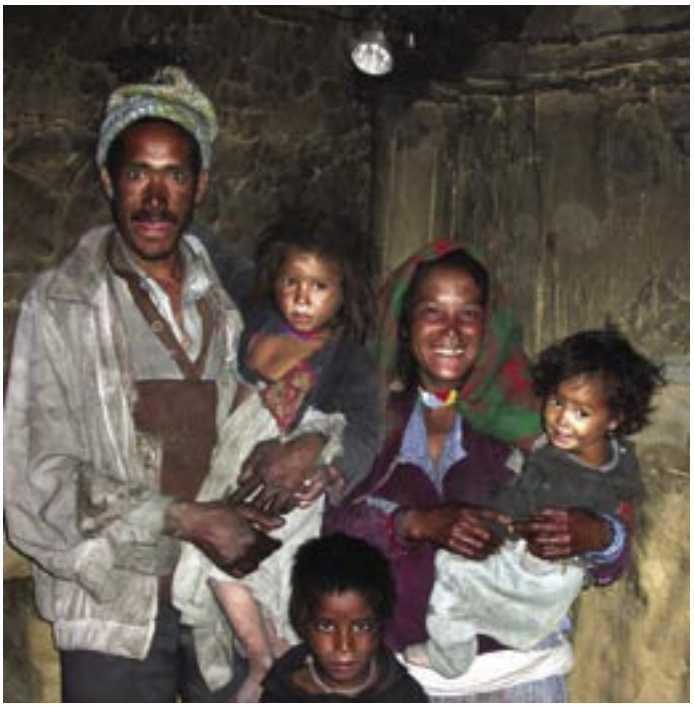
Alex says that both lighting systems are powered by either solar PV array systems ranging between 75 and 900W, or pico hydro power plants, with power outputs from 200W to 1kW. Because the white LEDs are powered by DC, they minimise the use of expensive and often unreliable inverters, with the direct current particularly useful for their solar PV systems as it is generated and stored in battery banks.

Alex says the costs for rural village electrification systems remain small, the lighting systems remain easier to transport, and are installed and maintained through trained local people. Using just 300W (with four 75W solar PV modules) for three white LEDs, that produce 5-6 hours of light per day for 63 homes, and using 1,182W for three white LEDs for 170 households, per village.

A rural village electrification project for light typically consists of initial village meetings out of which a formal request letter is produced and signed with a thumb print by each family head of the village. Planning is discussed and defined with the now established local committee, a budget made, funds raised and secured, equipment ordered and wherever possible, locally manufactured.

Several trained, local people are chosen for installation of the project, and once installed one of Alex's staff visits the village as part of their "follow-up" project, as well as a yearly village survey.

"This is the first time in the lives of my children that they have been able to read at night!" (Villager, Sri Lanka 2001)



TOP LEFT:
Indoor light – First time life experience. Photo courtesy of Alex Zahnd.

TOP RIGHT & BOTTOM LEFT:
Indoor light and smokeless stove bring mutual health, education and social benefits in remote Nepal. Photo courtesy of Alex Zahnd.

Obviously such projects are long term, often with 15-20 years of close partnership in order to address village needs over several generations.

What's unique about projects such as these is they are sustainable and appropriate for the local context. All possible project equipment has been developed and manufactured in Nepal, generally through student research projects at the Kathmandu University, and trained local Nepalese manufacturers. This not only brings light, but important skills and payable work to a country with an unemployment rate of more than 40 per cent.

Alex says that light, together with smokeless metal stoves, pit latrines and clean drinking water (a concept he refers to as "The Family of Four"), brings forth particular synergetic benefits.

"The projects benefit from each other through their parallel implementation; these synergetic benefits are all important 'preventative' health measurements, they enable better education and more social gatherings within the village."

With a 2006 project budget close to quarter of a million US dollars, to date Alex's main donor has been the Bermuda based ISIS Foundation, with others including LUTW, Energreen and Switzerland's Lin (Light in Nepal).

While Nepali people often have no food to feed their families, they provide all the voluntary work and organisation of local materials for the projects.

When asked what more can be done, particularly by those lucky enough to live in first world countries, Alex says that against such undignified human conditions none of us have an excuse valuable enough not to get involved in one way or another, be it as an individual, company or any other business.

BAREFOOT POWER – STEWART CRAINE AND HARRY ANDREWS

Australia's Stewart Craine and Harry Andrews, and their recently established company Barefoot Power Pty Ltd, have combined their expertise in renewable energy with a humanitarian vision and a corporate bottom line.

TOP LEFT:
Villagers discuss energy options and the benefits of using a lighting kit provided by Stewart Craine, PNG. Photo courtesy of Stewart Craine.

TOP RIGHT:
Batteries like this one, used to provide energy to rural villages in PNG, can harm people and the environment by exploding and leaking toxic gases. Photo courtesy of Stewart Craine.

BOTTOM LEFT:
The various levels of rural lighting in PNG such as the kerosene bottle lamp shown here are often indicators of wealth within villages in PNG. Photo courtesy of Stewart Craine.

Barefoot Power's aim is to assist rural communities and leaders in developing countries to plan and execute renewable energy projects that result in more sustainable use of energy resources.

In attempting to minimise bureaucracy and layers of distribution, Barefoot aims to help villagers source low capital costs materials, particularly for household lighting. Craine says that, "by conserving valuable capital, our aim is to evolve, rather than build power system developments, which means it's less capital intensive. It's a gradual process; we're building small power systems and improving them over time as well as increasing the skill of local people."

"There's 1.5 billion people in the world without electricity, about 300 million households spending $100 each on kerosene. That's a potential market of $30 billion and that's just for starters," he says.

Having worked two years with non-profit organisations and a Nepali hydropower developer, and providing technical assistance to several NGO's for over six years (including LUTW), Stewart believes that the donor and charity models have failed developing countries for 50 years. "In general my feeling is the world is the way it is because of business, and business will pull it out."

In having a multi-business platform of consulting services and project development including village electrification and micro-power stations, Barefoot Power can remain nimble in order to survive.

Starting from the power business, with an initial focus on Pacific Island nations such as Papua New Guinea (PNG), they are currently consulting in Fiji with the National Electrical Authority to develop strategies and identify power stations that will allow Fiji to become "100 per cent renewable" by 2010.

"They are well on track to achieve this via a combination of bio-diesel, hydro and biomass projects from coconut and hardwood plantations."

Stewart says that once their commercial village electrification

"In the few months we have had the white LED lamps the improvement in the children's academic performance has been absolutely remarkable!" (Master Satar, Headmaster, Mubarak Village, Pakistan 2004)

TOP & BOTTOM:
Education becomes even more possible with the light of LEDs. Photo courtesy of Alex Zahnd.

business is in place they can then piggy-back micro-credit, decentralised coconut oil processing etc., which has already been proven possible and profitable by the Grameen Bank in Bangladesh since the 1970s.

For their village electrification projects, Stewart used his own funds together with generous assistance from UltraLite and PSSPNG, one of Barefoot Power's partners in Lae, to buy 200 battery chargers and 500 low capital cost ($80 per household) lighting kits. Each kit comprises a 17 AH Amp hour field lead acid battery, a 1W LED, with 3 and 7W CFLs being added in the future - sourced from China.

Barefoot have transported 100 of these to Fiji and Stewart Craine says the response on price and product has been positive.

The response to night-time demonstrations from villagers in PNG and Fiji has been encouraging, as has investment support from Australian-based investors to the concept of the company. "The people in rural PNG have just never had anyone offer to come out and provide a service since Australia left during independence."

Stewart says that despite the $400 million of aid a year that AusAid channels into PNG, 80 per cent of their population of around four million people are still without power.

"Not only does light decrease these people's current expenditure on kerosene and batteries, light enables manual cottage industry such as bamboo stool making, to create, for example, the $5 a month income required to pay for the electricity. But the most interesting aspect of the benefits is the belief that the future can be different from the past," says Stewart Craine.

"When you've been given apples and food by the poorest people on Earth… that's when you know you've got to give something back. Not through charity…(but) by working with them. If you show them an alternative future for their children then they will get very interested, very quickly."

BUSHLIGHT – AUSTRALIA

With a vision of "Light and Life in the Bush", Australia's Bushlight program began in July 2002 and aims to improve the livelihood choices of targeted remote Indigenous communities through increased access to sustainable renewable energy (RE) services.

Bushlight's key objectives include reducing greenhouse gas emissions by reducing diesel consumption; and stimulating further development of the Australian renewable energy industry and research sector.

In the late 1990s, an audit of renewable energy systems in remote communities including Indigenous communities, pastoral stations and tourism operations, conducted by the Australian Cooperative Research Centre for Renewable Energy, and the Centre for Appropriate Technology, identified a number of areas where RE systems fell short of expectations.

Grant Behrendorff, Group Manager for Bushight said that statistical analysis showed that RE installations in Indigenous communities were considerably less successful, working only 66 per cent of the time, than in other sectors, where the success factor was about 80 or 90 per cent.

"Bushlight could ensure that the AGO's (Australian Greenhouse Office) money was wisely spent, therefore improving on past outcomes," says Grant.

With a budget of $8.4 million, the AGO is Bushlight's principle source of operational funding, providing $8 million over four years, with Family and

Community Services (FACS) providing an additional $400,000.

Working with targeted communities in remote Australia who often rely on diesel or small petrol generators for electricity, Grant Behrendorff says that no communities that Bushlight have worked with have had access to 24 hour, reliable power.

He says that Bushlight develops regional energy plans which identify Indigenous communities in need. "Communities need to fulfill a basic eligibility criteria; Bushlight only works with communities that are permanently occupied; have government provided housing; drinkable water and some kind of tenure on the land."

Acting on the internationally recognised link between the availability of energy and peoples' health, Bushlight uses a demand responsive approach that recognises the actual needs of the communities they work with. "Lighting and refrigeration are the principle services that Indigenous communities have themselves identified," says Grant.

Like many international humanitarian organisations, Bushlight also adopts the sustainable livelihood approach that supports livelihood opportunities through the provision of RE services.

However, Grant Behrendorff says that Bushlight's projects are different to overseas humanitarian lighting projects that are designed to help people emerge from third world situations where the provision of RE is linked to micro-enterprise in order for such projects to generate income and be economically sustainable.

"In welfare-driven societies in the remote areas of a first world country like Australia, the people that we provide light to don't go and find a way to generate income from that light. The food on the table comes from government welfare and support. What Bushlight is trying to do is provide access to fundamental basic services, a basic level of service which is the expectation of anyone living in Australia today."

Bushlight negotiate with regional stakeholders to agree on a set of

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Mecabay

"A foreigner has come and made Thulo Pokhara heaven."
(Villager, Nepal 2000)

For more information about any of the programs we have presented here please contact:

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priorities for those communities and subcontracts their RE installations out.

Darwin's Delta Electrics (DE) is one of the major contractors for Bushlight, and Bruce Hanton and his company Alternative Energy Consultants is one of DE's subcontractors.

He says that central Australia has a fairly large RE market, and while there is a high demand for tenders of Bushlight work, there aren't too many who are actually prepared to do the work.

"People working out bush these days don't come along very often. We're fairly unique because we've got the people; if we lose the people we lose the work."

He says that the government's renewable energy rebate program which is based on diesel rebates is one of the reasons companies like DE are so busy.

"The rebate is the biggest one in Australia and pays up to 50 per cent of the cost of installation."

For Bushlight projects he typically uses what is specified by Bushlight; 18W CFLs. "We use standard off the shelf products, and import only because we can't compete with overseas companies."

"One of the most important factors is the cost, repair and ease of replacement of equipment. Electronic ballasts they are a waste of time. They aren't readily available here, they're three times the light fitting price and the power savings are minimal. LEDs aren't readily available either. We get isolated in the wet season, Aboriginals can't go and buy LED light but they can buy a tube."