2 billion people are without access to electricity

1.1 billion without safe drinking water

2.4 billion without adequate sanitation

2.4 billion relying on traditional biomass for their daily energy services
And almost all of these people live in developing countries.

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2.4 billion people relying on traditional biomass for their daily energy services.

2.4 billion without adequate sanitation.
Benefits from a Renewable Energy Village Electrification System

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University of Montana USA
Nepal’s Stage of Development
Nepal’s Stage of Development

1. Nepal opened its doors for the world only in 1953
2. Nepal still counts among the least developed countries.
3. Population: 28.5 Mio. ~80 % in rural, remote mountain areas.
4. Average annual population growth 2.3 %.
5. Overall literacy rates: 40% - 60% in cities, but in the remote mountain areas 4% - 20% for both, women and men.
Nepal’s Stage of Development

6. The average income per head per year is 30 US$ - 1500 US$.
7. 80% of Nepal’s people have no access to electricity.
8. Annual per capita electricity consumption (2004) 68.5 kWh, Australia (2004 with 20.1 Million) 11’746 kWh = 171 x more, USA (2004 with 265 Million) 15’728 kWh = 230 x more.
9. 40 % of Nepali live below the poverty line, and there is a clear relationship between poverty and access to electricity.
10. Nepal's potential hydroelectric power capacity amounts to an estimated 83,000 MW, with 42,000 MW to be technical and economical feasible.

11. Nepal's installed total hydro-electric generating capacity (September 2005) is 548 MW. With a capacity factor of only 47% that amounts to just 0.6% of its feasible potential.

12. Average of 300 sunshine days a year, and daily average solar insulation of 4.5 – 5.5 kWh/m².
Nepal’s Stage of Development

Demands a Holistic working approach, addressing the
• Social
• Physical
• Mental and
• Spiritual

Needs of the people in sustainable ways

Through Holistic Community Development
There is no road to the remote district of Humla in the north-west of Nepal. Either one has to walk 16 days from the south through the most difficult and harsh Himalayan mountain range, or ...
… one takes a one hour adventurous flight with an old Twin-Otter over and through the mountain valleys up to Simikot in Humla, and then walks for one day.
At 30 ° North lat., 81 ° 49’ East long., at an altitude of 3,000 meter (9,443 feet) above sea level, lies our High Altitude Research Station (HARS) in Simikot.
At 30 ° North lat., 81 ° 49’ East long., at an altitude of 3,000 meter (9,443 feet) above sea level, lies our High Altitude Research Station (HARS) in Simikot.

Here the research project prototype WLED lights, solar PV modules, stoves, solar water heaters etc. are first installed and tested, re-designed and improved, before they find their final destiny and application in the local communities.
The remote and impoverished mountain communities’ needs demand particular requirements from technologies.
The remote and impoverished mountain communities’ needs demand particular requirements from technologies.

1. Technologies must be appropriate, suitable, and apt for a particular situation, and for a particular people group.
2. Sustainability comes before efficiency.
3. Technologies need to be contextualised, to be accepted by the community, to build a strong ownership.
4. They need to aim for better living conditions, to raise the living standard of the people.
Dhadhaphaya Village
Lat. 30° North, 81.57° East, Altitude 2550 m

Karnali, Nepal’s longest River

3 Days walk to Tibet

Dhadhaphaya Village
Lat. 30° North, 81.57° East, Altitude 2550 m
The village community identifies their needs with the following priorities . . .
The village community identifies their needs with the following priorities... 

Light in the home
Smokeless metal stove
Pit latrine near the home
Clean drinking water
Dhadhaphaya Village

29° 59' Northern Latitude, 81° 48' Eastern Longitude, at 2,550 m (8,366 feet) altitude

Population (August 2005): 167 homes with 1,067 peoples. One primary school class 1-7, one health post
Dhadhaphaya Village

The Village situation in 2004:
- 167 homes, and 1,067 people
- No house had light
- All homes cooked on open fires
- No home had a toilet
- All drank dirty river water
Dhadhaphaya Village

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Light In the Home
In order to define and calculate the Dhandhaphaya Solar PV Village System properly, the local available solar energy resource (the insolation) has to be known.
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This resource is defined through 3 Processes: The NASA satellite data, the Meteonorm software simulation, and measuring the local available solar insolation in Simikot.

Average Annual Daily Solar Insolation for Dhadhaphaya Village, at 30° North, and 2’550 m.a.s.l. is ~ 5.2 kWh/m² on a 30 ° south tilted surface
METEONORM
Solar Insolation Simulation Software

For the Dhadhaphaya Village
For the Dhadhaphaya Village
For the Dhadhaphaya Village

Included in the Simulation is the 360 ° Horizon around Dhadhaphaya
Simulated Dhadhaphaya Solar Insolation Data with Horizon, on a 30° South Tilted Surface

For the Dhadhaphaya Village

<table>
<thead>
<tr>
<th>Month</th>
<th>H_Gh</th>
<th>H_Gkhor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>138</td>
<td>195</td>
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<td>Nov</td>
<td>148</td>
<td>205</td>
</tr>
<tr>
<td>Dec</td>
<td>118</td>
<td>164</td>
</tr>
</tbody>
</table>

Sunrise and Sunset over Dhadhaphaya Village throughout the year

Legend:
- H_Gh: Irradiation of global radiation horizontal
- H_Dh: Irradiation of diffuse radiation horizontal
- H_Gkhor: Irradiation of global rad., tilted plane, with high horizon
- H_Dkhor: Irradiation of diffuse rad., tilted plane, with high horizon
- H_Bnhor: Irradiation of beam, with high horizon
- Ta: Air temperature

Radiation in [kWh/m²]
Temperature in [°C]
Gh: Mean values of climate zone
Ta: Only 1 station(s) for interpolation
In order to understand the local available solar energy resource the solar radiation is monitored and recorded in the High Altitude Research Station (HARS) in Simikot, at three different positions.

- Horizontal (international Standard)
- 30° South inclined (most used in Nepal)
- 2- axis self-tracking frame (maximum)
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Measured Data in Simikot
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*SPC 80 Pyranometer from SolData Denmark*

Measured Data in Simikot
Example of one Week Recorded Solar Insolation with three Pyranometers on different surfaces, as well as Ambient, Solar PV Module and Battery Bank Temperature from the 1st – 7th December 2004, in Humla Nepal
Example of one week recorded solar insolation with three pyranometers on different surfaces, as well as ambient, solar PV module and battery bank temperature from the 1st - 7th December 2004, in Humla, Nepal.

High Altitude Research Station Simikot Humla Solar Insolation Data Monitoring 1st - 7th December 2004

Weekly Average 2-axis Tracking Solar Insolation: 7.811 kWh/m²/day (+130.46% over Horizontal and +40.81% over 30°)
Weekly Average 30° Solar Insolation: 5.557 kWh/m²/day (+63.70% over Horizontal)
Weekly Average Horizontal Solar Insolation: 3.337 kWh/m²/day
Example of one Week Recorded Solar Insolation with three Pyranometers on different surfaces, as well as Ambient, Solar PV Module and Battery Bank Temperature from the 1st – 7th December 2004, in Humla Nepal
Solar Home System (SHS)
Solar Home System (SHS)
Central Village, 2-Axis Self-tracking Solar PV System
Central Village, 2-Axis Self-tracking Solar PV System
For the Dhadhaphaya Village a ...
For the Dhadhaphaya Village a . . . Cluster Solar PV System is being installed
Dhadhaphaya Village Solar PV System Definition

Solar Energy Resource:
Daily Average Solar Radiation 4.778 kWh/m²
(Meteonorm simulation with high horizon)

Dhadhaphaya Village
29° 59' Northern Latitude, 81° 48' Eastern Longitude, at 2,550 m (8,366 feet) altitude
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Dhadhaphaya Village Solar PV System Definition

15 clusters, each with up to 15 homes with each 3 W LED lights for 5-7 hours/day, consuming up to 315 Wh daily.

Solar Energy Resource:
Daily Average Solar Radiation 4.778 kWh/m²
(Meteonorm simulation with high horizon)

Each cluster has one 75 W solar PV module, seasonally adjustable.
Up to 5 Days the Battery Bank will provide Energy Independent from the Sun

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Dhadhaphaya Village Solar PV System Definition

Dhadhaphaya Village
29° 59' Northern Latitude, 81° 48' Eastern Longitude, at 2,550 m (8,366 feet) altitude
Population (August 2005): 167 homes with 1,067 peoples. One primary school class 1-7, one health post
Two clusters each with one 19 Watt Solar PV Module, plus battery bank and charge- and discharge controller, for 2 - 5 homes per Cluster with each home . . .
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3, one Watt WLED Lights
Training and Hands – On Practical Installation

Creating Ownership
Ten chosen Local People have been Trained to Look After and Maintain the Solar PV Systems
Training and Hands – On Practical Installation

Creating Ownership

Each Household Participates in the Building and Underground Cabling

Ten chosen Local People have been Trained to Look After and Maintain the Solar PV Systems
Thus Dadhaphaya Village has now . . .

15 Clusters with each a 75 Watt, and 2 Clusters each with a 19 Watt Solar PV Module powering total 501 x 1 Watt WLED Lights, 3 in each Home
Thus Dadhaphaya Village has now . . .

15 Clusters with each a 75 Watt, and 2 Clusters each with a 19 Watt Solar PV Module powering total 501 x 1 Watt WLED Lights, 3 in each Home in 167 Homes
15 clusters each with one 75 Watt Solar PV Module, plus battery bank and charge- and discharge controller, for 8 - 15 homes per Cluster with each home . . .
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3, one Watt WLED Lights
15 clusters each with one 75 Watt Solar PV Module, plus battery bank and charge- and discharge controller, for 8 - 15 homes per Cluster with each home.

3, one Watt WLED Lights
Thus from previous dark, smoke filled rooms . . .
Thus from previous dark, smoke filled rooms . . .

. . . people have now small, long lasting lights
Thus from previous dark, smoke filled rooms... people have now small, long lasting lights.
No Smoke - Less Firewood

Smokeless Metal Stove in the Home
No Smoke - Less Firewood

Open Fire Place = Homes Full of Smoke. The Daily Firewood Consumption is as high as 30 kg per family, and the Health of Women and Children is in great danger.
No Smoke - Less Firewood

No Smoke inside Homes through a Smokeless Metal Stove. Daily 40% - 50% less Firewood Consumption. Great Improved Health Conditions.

Open Fire Place = Homes Full of Smoke. The Daily Firewood Consumption is as high as 30 kg per family, and the Health of Women and Children is in great danger.
Pit Latrine
1. Improved Health
2. Improved Hygiene
3. Cleaner Walking Paths
4. Cleaner Fields
5. Cleaner Rivers
1. Improved Health
2. Improved Hygiene
3. Cleaner Walking Paths
4. Cleaner Fields
5. Cleaner Rivers

For healthy Families
Pure and Clean Drinking Water
In close partnership with the local community the drinking water system is defined, and planned. Where the pipes have to go through, where the water taps have to be, are issues decided by the community. The whole system is built together and enjoyed together . . .
Pure and Clean Drinking Water

In close partnership with the local community the drinking water system is defined, and planned. Where the pipes have to go through, where the water taps have to be, are issues decided by the community. The whole system is built together and enjoyed together . . .
Thus the Basic Issues to Address in a Holistic Community Development Project in the impoverished Nepal Himalayas is . . .
the Family of 4: Light, Stove, Pit Latrine, Water
Strive for Sustainability
Strive for Sustainability

Technical Sustainability
Reliable components
Sound design
Local O & M services

Economic Sustainability
Least-cost preferred systems
Services that consumers can afford
Periodical fee collection

Social Sustainability
Participation of all stakeholders
Training of consumers (system use, safety & maintenance)
Cultural acceptance by end user

Environmental Sustainability
No ecological impact through installation and operation
Removal/recycling of batteries, lubricants
Expected Benefits
Expected Benefits

- **Health**: With WLED lights and the smokeless metal stove, no more exposure to hazardous CO, soot and PM indoor air pollution.
- **Education**: Access to indoor lighting has a direct influence on the education level in the community.
- **Social Life**: Increased social gatherings after dark, resulting in increased community development activities.
Expected Benefits

- Income Generation: Minimal lighting in the home allows small income generating activities through handicraft skills.
- Physical Conditions: Decreased firewood collection time for women for lighting, cooking and heating.
- Environment: Considerable less greenhouse gas emissions through WLED lights and the efficient smokeless metal stove.
Expected Benefits

The New, Holistic Community Development Project, approach enables the described synergetic benefits with a significant faster increase of the Human Development Index (HDI).
The worldwide trend to privatise utilities, to have electricity generation, transmission and distribution under the direct influence of the free market, aiming for maximum profits, favours the fulfillment of the “wants” of the rich rather than the “needs” of the poor.
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Against this background rural electrification schemes stand no chance unless new ways, such as the “Elementary Solar PV Village Electrification” approach, integrated in a long-term Holistic Community Development project, is put into action.
Traditional medium to large-scale electrification schemes will not be able to address the urgent needs for basic energy services such as light, due to their shear project size, costs and dependence on external technical and financial support.

But basic lighting services, provided with reliable and field approved technologies, such as WLED lights, with a mere 3 watts power consumption per household for 3 WLED lamps, have now become a reality for previously unreached and "forgotten" communities in Nepal and indeed other developing countries around the globe.
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