Alternatives to Fuel-based Lighting in Rural Areas of Developing Countries

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“We will make electricity so cheap that only the rich will burn candles”
- Thomas Edison

As of 2000: in the developing world, 14% of urban households and 49% of rural households had no electricity ...
... In fact, there are more non-electrified households today than the total number in Edison’s time.

Lighting Inequities

Although one in three people obtain light with kerosene and other fuels - **paying $40 billion/year** - about 20% of global lighting costs, they receive only 0.1% of the resulting lighting energy services.

**Other issues:** literacy, safety, women’s work, indoor air quality, subsidy, scarcity, price volatility
Non-electrified Population is Falling Only 0.4%/year

- Excluding China, population is growing faster than electrification, e.g. 4-x faster in Sub-Saharan Africa

![Graph showing population and electrification trends in different regions.](source: International Energy Agency)

Electrification: Not always effective

Photos: Evan Mills ©

Yunnan China
The $40B Lighting Market at the Bottom of the Pyramid

<table>
<thead>
<tr>
<th>GNI/per capita</th>
<th>Global Population</th>
<th>Total Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>US$ 26,490</td>
<td>0.9 Billion</td>
<td>US$ 25 Trillion</td>
</tr>
<tr>
<td>US$ 5,110</td>
<td>0.3 Billion</td>
<td>US$ 1.7 Trillion</td>
</tr>
<tr>
<td>US$ 1,400</td>
<td>2.4 Billion</td>
<td>US$ 3.4 Trillion</td>
</tr>
<tr>
<td>US$ 430</td>
<td>2.5 Billion</td>
<td>US$ 1 Trillion</td>
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</tbody>
</table>

Note: Based on the “The Fortune at the Bottom of the Pyramid”, C.K. Prahalad and World Bank Development Indicators, 2004

Greenhouse Gas Emissions

- **Per Lantern:** 100 kg CO₂/year
  - 40-times as much per unit of light as incandescent lamp;
  - 180-times as much as compact fluorescent lamp

- **Globally:** 190 million tonnes CO₂/year
  - would be 8th most-emitting “country”
Small & Medium Enterprises (SMEs)

India: street vendor
Tanzania: night market

Photos: Evan Mills ©

Wick Lanterns

Tanzania
Kenya (Kibera)

Photos: Evan Mills ©
Merchant (Candle)

Market (Candles)
Textile Seller (Propane Mantle Lamp)

Asaam, India

Yak Butter

Nepal

Yunnan, China
Whale and Seal Oil

Greenland

Fuel Wood is Widely Used for Lighting

Nepal
The Burden of Fuel-based Light

Huangshan, China

India: propane lamp

Photos: Evan Mills ©

Kitchen: 2% Recommended Level

China

Photo: Evan Mills ©
Refugee Camps

- Classroom light levels as low as 2% of western standards
- Teachers grading homework with light levels 1% of western standards

Photos: Evan Mills ©
“Electrification”
(Yunnan, China)

Traditional Solar-Fluorescent Systems
Have only 0.2% Market Penetration
(and less at the bottom of the pyramid)
White Light-emitting Diodes ("LEDs")

- Efficient
- Long life
- Low voltage
- Directional
- Portable
- Rugged

White LEDs: Rising Light Output; Falling Cost

Source: Lumileds

Performance: 30x increase decade
Cost 10x decrease per decade

Source: Lumileds
Total Cost of Ownership:
LED Payback is 1 month to 2 years

- 10-100x a hurricane lantern’s light output
- Cost of saved oil: $15/bbl

Stanford + IDEO + LBNL (and others from Silicon Valley)
“The 93,000,000 mile extension cord”

Productive Uses

Tanzania: shoe seller - flame [left]; 1-watt white LED [right]

Photos: Evan Mills ©
“I can see the money!”

Kenya: vegetable stand in Kibera slum

Photo: Evan Mills ©

Proposed GROCC Demonstration

• *Interactive* design - end users as co-developers

• Insight into lighting structure and behavior

• Understanding productive uses

• Synergisms with the mobile phone market & a diversity of SMEs

• Innovative distribution & assembly strategies
Building and leasing solar-fluorescent systems: rural high school, Tanzania

More Information

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