Power to the People: The Role of the Power Engineer in Alleviating Energy Poverty

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Figure 75. World net electricity generation by fuel, 2008-2035
(trillion kilowatthours)

Figure 8: Coal-Fired Build Rate
China and U.S.
Sources of U.S. Electricity Generation, 2011

- Renewable: 13%
- Nuclear: 19%
- Natural Gas: 25%
- Coal: 42%
- Other: <1%

Source: U.S. Energy Information Administration, Electric Power Monthly (February 2012). Percentages based on Table 1.1, preliminary 2011 data.

Capacity (MW)

- 40 GW in 2010
- 47 GW in 2011

Text below the graph:

The wind energy industry brought over 4000 MW of new capacity online in the fourth quarter of 2010, nearly doubling the previous quarter’s additions. In addition, new installations contributed to the growth of wind power facilities in 2010, helping to bring the sector into the mainstream and acting as a bright spot in the economy.

At the same time, the continued trend of cutbacks in government policies and market signals about total investment in the manufacturing sector for new solar and wind capacity was observed. The result was a job loss in the manufacturing sector, which was compounded by the slow growth in the service sector.

America’s wind power fleet will soon add an estimated 32 billion tons of carbon emissions annually, equivalent to 3.1% of the nation’s economy, and will consume approximately 20 billion gallons of water annually, which would otherwise be used for cooling in conventional power plants.
To reach 1,300 GW it would take:

15% growth rate (2011)
- 23 years (install 200 GW in 2034)

9.9 GW/yr (all-time US high)
- 127 years
What about Photovoltaics?

Need 2,280 GW of PV capacity

8.15 billion panels (280 W each)

That’s 27 panels for every person in the US
Energy Poverty

1.6 billion people without regular access to grid
If the 7 billion people in the world all used 12.4 MWh/yr...

19,100 TWh

86,800 TWh
We would need to build a 1000 MW coal power plant every day for the next 21 years.

If the population continues at its current 1% growth rate:

2050: 10.2 billion people
Need to build 143 1000 MW coal plants that year

2085: 14.4 billion people
Need to build 202 1000 MW coal plants that year
What if per capita demand also increases?

Assuming 0.5% per capita demand increase per year

1 coal plant/day

Assuming we start with enough capacity
Case Study: Zambia

Improvised Rural Micro (pico?) Grid Systems

Characteristics
- Modified sine wave inverter
- Lead acid battery <30Ah
- <30 W Solar panel
- No meters, fuses
Improvised Rural Micro (pico?) Grid Systems

Solar Panel → Inverter → DC Loads → Generator → AC Loads → Battery → Spare Batteries

Community Solutions Initiative
Polak’s Rules

• Use a market-based approach
• Aim for people who earn less than $1 per day
• Affordability isn’t everything. It’s the only thing.
• Must be expandable
• Must be scalable
• Must support income generation

Solar Trailer
The Market

Market Surveys Indicate Potential For Viable Market

<table>
<thead>
<tr>
<th>(all prices are in gourdes; 40 gourdes/USD)</th>
<th>Min</th>
<th>Max</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Willing to Pay Per Month for Electricity</td>
<td>15</td>
<td>1000</td>
<td>150</td>
</tr>
<tr>
<td>% of Income Spent on Electricity</td>
<td>10%</td>
<td>52%</td>
<td>15%</td>
</tr>
<tr>
<td>Cost to Use Charging Station</td>
<td>10</td>
<td>275</td>
<td>50</td>
</tr>
<tr>
<td>Cost to Charge Cellphone</td>
<td>5</td>
<td>75</td>
<td>15</td>
</tr>
<tr>
<td>Price of Generator Fuel (gourdes/gallon)</td>
<td>100</td>
<td>350</td>
<td>200</td>
</tr>
<tr>
<td>Monthly Cost of Candles</td>
<td>20</td>
<td>550</td>
<td>100</td>
</tr>
<tr>
<td>Monthly Cost for Kerosene</td>
<td>20</td>
<td>2000</td>
<td>170</td>
</tr>
</tbody>
</table>

Approximately $10.50 US spent each month on electricity and lighting.

The Technology

- 1.5 kW solar trailer
  - Six 245 W PV panels
  - Daily energy production: 7.2 kWh/day
- Used to charge battery packs
The Technology

• Integrated battery pack
  – 9 AH @ 12 VDC
  – One light for 31 hours
  – Three lights for 9 hours
  – Charge 9 cell phones
  – Charge laptop
  – Run radio 2 days

• Rent battery kits

• Cost: 80HTD (2USD)/month
  – Recharge battery up to once per day (charges in 3 hrs)

The Business Model
The Results (so far)

- All six units operate as anticipated
- Over 1,400 people reached
  - +2,000 homes on waiting lists
- Reported biggest benefit: not having to use kerosene
- Many families use one light indoors, and one outside for the community
- Families wanted to buy the home units

What about Wind?

Locally-Sourced

Commerciially Purchased
Headlines from Zambia

ZESCO RECORDS 6.9% DECLINE IN POWER SALES
GOVT TO BORROW $400M FOR ELECTRICITY PROJECTS
SHANGOMBO RESIDENTS RESIST RELOCATION OF ZESCO GENERATOR

Headlines from Zambia

MONKEY NEARLY DROWNS [Defense Minister]
MPOMBO IN SWIMMING POOL
Headlines from Zambia

MONKEY PEES ON [PRIME MINISTER] RUPIAH

LOCATION

- Municipality: Monze, Zambia
- Village: Miyoba – 60 Households, 10 km from town (30 min drive)
OPERATOR BIOGRAPHY

• Age 42, Family of 11
• Farmer, Small electrical system
  – Yr Income 13.9m ZKW = ~$2,800 USD
  – Batteries excessively discharged
• Small cell phone, 12V battery charging business
  – Yr Income 2.8m ZKW = $560

Micro Wind Power
REPORTING
Results to Date

Nearly all designers make products for the richest 10 percent of the world.

- paraphrased from Paul Polack
References


Learn More

- www.communitysolutionsinitiative.org/
- www.drhenrylouie.com
- @henrylouie
These slides and other presentations available at www.drhenrylouie.com/Presentations.html