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

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Community Solutions Initiative

IEEE PES Power & Energy Society

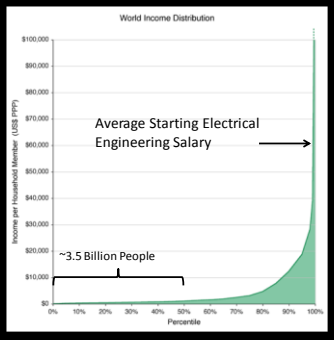
Seattle University 1891

Professionals Without Borders

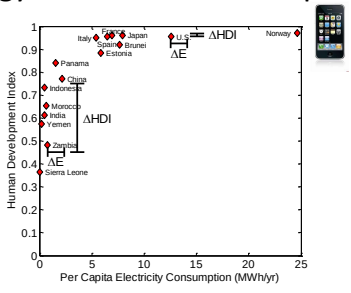
Engineers Without Borders USA

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

-paraphrased from Paul Polack

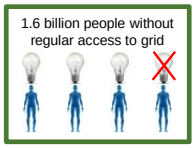


Energy and Human Development



Energy Poverty

1.6 billion people without regular access to grid



Centralized grid expansion faces many challenges

Headlines from Zambia

GOVT TO BORROW $400M FOR ELECTRICITY PROJECTS

SHANGOMBO RESIDENTS RESIST RELOCATION OF ZESCO GENERATOR

Energy Poverty

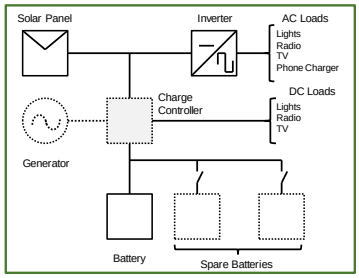
1.6 billion people without regular access to grid

Centralized grid expansion faces many challenges

Cellular phones, radios, etc. proliferation rates surpass electrification rates

Fees to charge batteries are ~1000 times $/kWh in the US

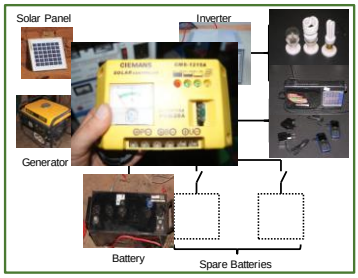
Improvised Rural Micro (pico?) Grid Systems



Characteristics

Modified sine wave inverter
Lead acid battery <30Ah
<30 W Solar panel
No meters, fuses

Improvised Rural Micro (pico?) Grid Systems

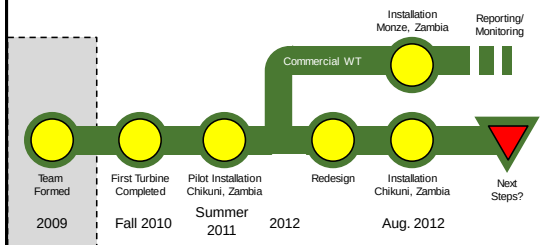


Wind Turbine Taskforce Update

Goal

Determine technical and economic feasibility of using wind power for rural electrification of impoverished communities

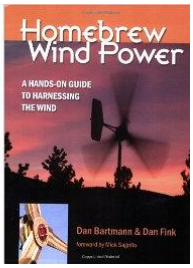
Timeline



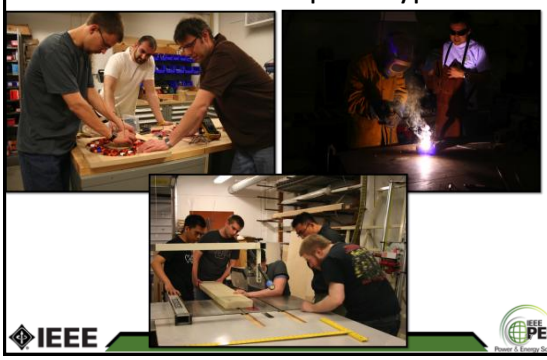
Wind Turbine Team Formed

- Seattle University Faculty, Staff
- Seattle University Students
- Industry Volunteers
- Engineers Without Borders
- IEEE PES CSI

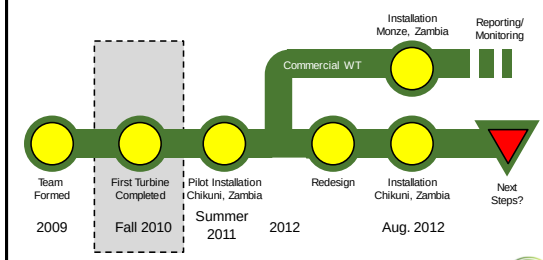
Start from an existing design…

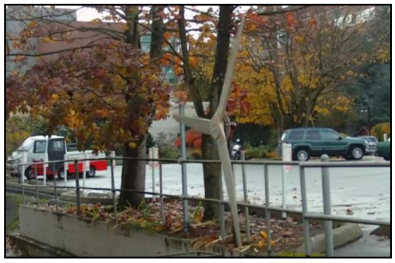


…and build a prototype

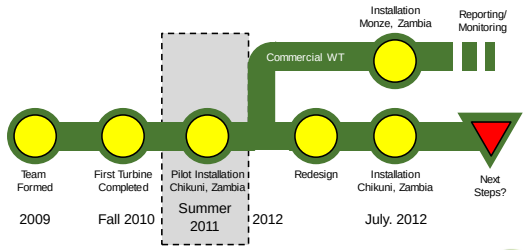


Timeline





Timeline



Zambia 2011

Goals:

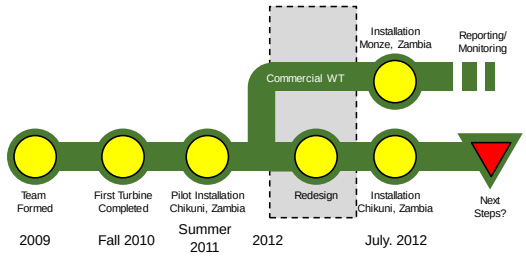
- Build part of the wind turbine on location
- Find a solution for the tower
- Field test
- Evaluate the conditions for wind turbine installation

Zambia 2011

Lessons Learned:

- Feasible to build blades and find tower solutions on location
- Most components can be found locally, except for magnets
- Generator oversized
- Too expensive
- Security considerations

Timeline

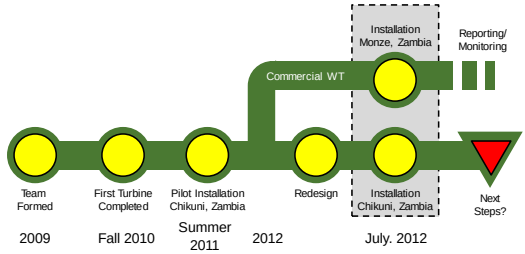


Two Approaches

Locally-Sourced

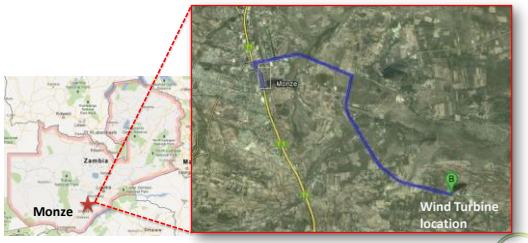
Commercially Purchased

Timeline



LOCATION

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



NGO PARTNER: Diocese of Monze

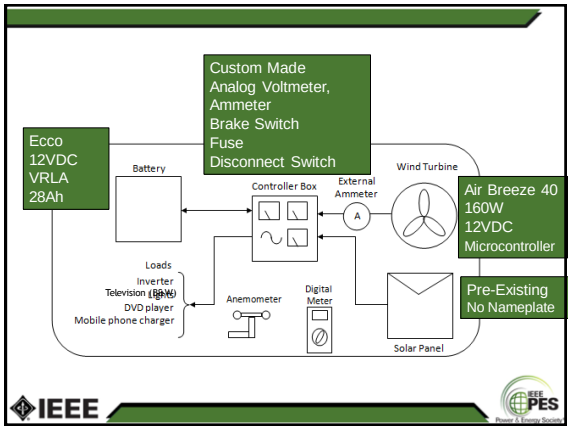
- Office of Development Promotion
  - water, agriculture and animal husbandry
- Focus on Appropriate Technology
- Project support
  - Facilities: Rural Engineering Center
  - Operator identification
  - Project "backstop"

OPERATOR BIOGRAPHY

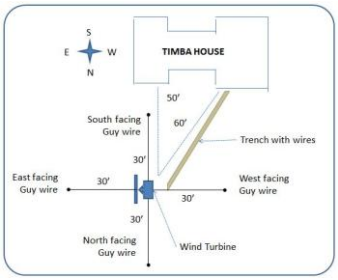
- Mr. George Timba
- Age 42, Family of 11
- Farmer, Small electrical system
  - Yr Income 13.9m ZKW = ~$2,800 USD
- Small cell phone, 12V battery charging business
  - Yr Income 2.8m ZKW = $560

Micro Wind Power

TECHNOLOGY INSTALLATION TRAINING REPORTING



Physical Layout



INSTALLATION

- Most materials locally sourced
- Three people, three days
- Competencies
  - Basic electrical
  - Basic mechanical
  - Basic civil

Major Component Costs

Component	Cost (US Equivalent)	In Monze?
Wind Turbine	US$649	N
Tower Yoke, guy wires	US$249	N
Conductors	US$252	Y
Tower Pipe	US114	Y
Battery	US$90	Y
Metering	US$50	N
Conduit	US$13	Y
Cement	US$13	Y
	US$1417	

TRAINING

- Turbine Operation
- DMM Use
- Load Energy Use
- Trouble-shooting
- Tower Raise/ Lower
- Wind Speed Measurement
- Battery Maintenance
- Reporting

Lessons Learned

- Wind turbine overdesigned for application
- Controller box needs work
- More education on battery care/maintenance
- More education on loads

REPORTING

- Objective:
  - Monitor Wind Turbine Condition
  - Record Wind Speed data
  - Record Wind Turbine charging current
  - Record battery voltage

REPORTING – how?

- Low(-ish) tech : Daily Log Book + Manually Submitted SMS 3 times / day

REPORTING – In process

- Using a Cheap $13 Cell Phone
- $1 SIM card + $.10 per SMS
- Total Yearly Cost: $125 USD
- Keeps us in constant contact

REPORTING – unusual reporting items

- Separate SMS if:
  - Turbine breaks for any reason
  - Tower buckles
  - Major battery problems
  - Lightning strikes
  - Other…
- Response:
  - First Line of Defence: **User Guide**
  - Second: contact via **Skype** to reporting mobile
  - Third: **NGO Support** (Father Bert is a retired EE prof)

REPORTING (pos vs. neg)

Strengths

- Easy and cheap to implement
- Limited training needed
- Direct line of contact with User (reasonable for pilot project)
- Primary (SMS) and backup (Log Book)

Weaknesses

- Limited # of measurements
- Limited data categories
- Training needed +
- Users make mistakes
- Not fully synchronized data: Wind speed/Wind current
- Snapshot, not running total
- Time Consuming?

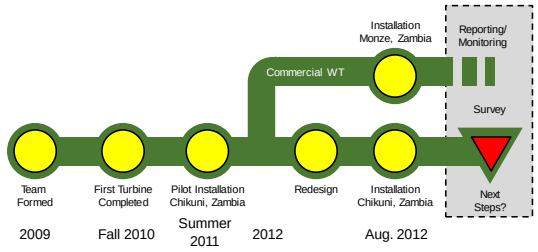
REPORTING – Improvements for next time

- Automation:
  - Integration with SMS technology
  - Integration with online database/analysis
- Process
  - More regular contact *IN-PERSON*
  - Incentivizing?

RISKS

- Technology: battery, turbine, tower failures
- Reporting: intermittent, erroneous, sustainability
- Wind Resource: significantly higher/lower than expected

Timeline



SURVEY

SURVEY(s)

1: Household (HH) Pilot Survey

- Personal/Demographic info
- HH Occupational data + income
- HH composition
- HH Energy Use
- HH Cell phone charging freq + cost
- HH 12V battery use
- HH Power Generation

2: Basic Market Survey

- Parts and components
- Prices and quality of batteries?
- Costs for 12V and cell phone charging?

SURVEY – HH Initial results

- 10 HH
- Costs for charging cell phones (avg $100/yr), 12V Bat. (avg $62/yr)
- Household Income (avg $2,313/yr)
- Incidence of PV (44%), 12V batteries (33%)

SURVEY – Basic Market Survey

- Question:
  - What is the cell phone and 12V battery charging business like in Monze?
- Cell Phones: 2000 ZKW/charge = $0.40
- 12 V bat: 3000 ZKW ($0.60) for 3 hours, 4000 ZKW ($0.80) for 6 hours.
- Source: Primarily grid power

Slides available at
www.drhenrylouie.com/Presentations.html

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