

Hybrid renewable microgrids: Clean power everywhere.

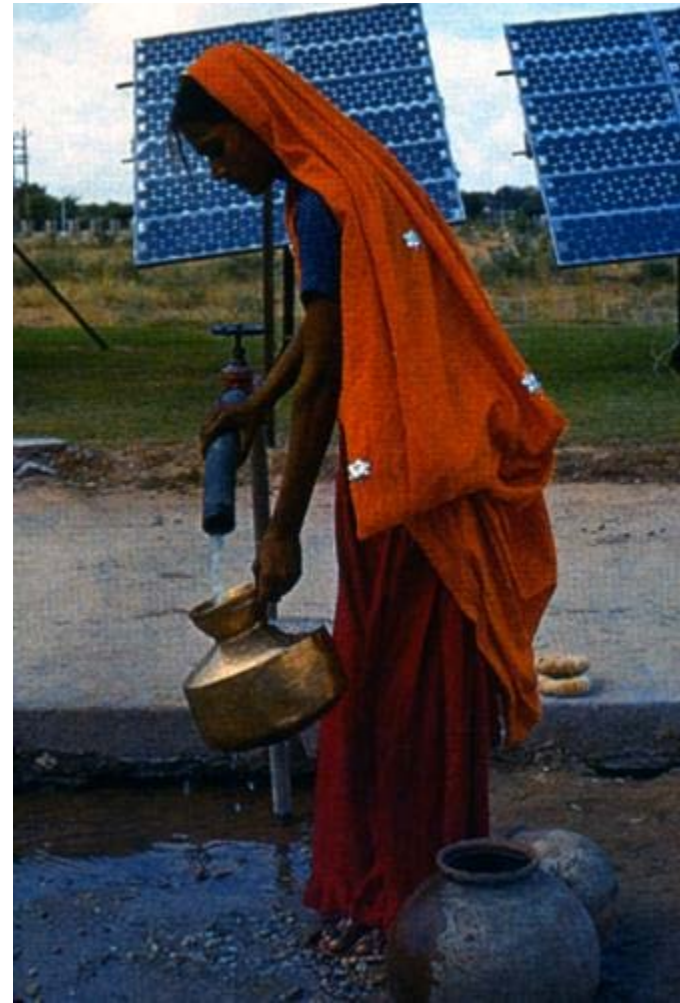


The Economics of Village Power

January 28, 2012
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ETHOS,
Seattle, Washington

Background on HOMER & Village Power

- 1992: NREL created the Village Power Program
 - The Hybrid Optimization Model created for internal use.
- 1998: Distribution over internet
- 2008: Original developers created HOMER Energy, LLC. with exclusive license
- 2012: 70,000 users in 193 countries



Lessons Learned

- Holistic approach
 - Local involvement
 - Support infrastructure
- Technical
 - Simplicity and robustness
 - Remote monitoring
 - Hybrid systems
- Economic
 - Tariffs and subsidies

Holistic approach

- Health
 - Cooking
 - Water
 - Clinics
- Public safety
- Regional support infrastructure
- Development
 - Communication
 - Education
 - Productive uses
- Lighting
- Local involvement

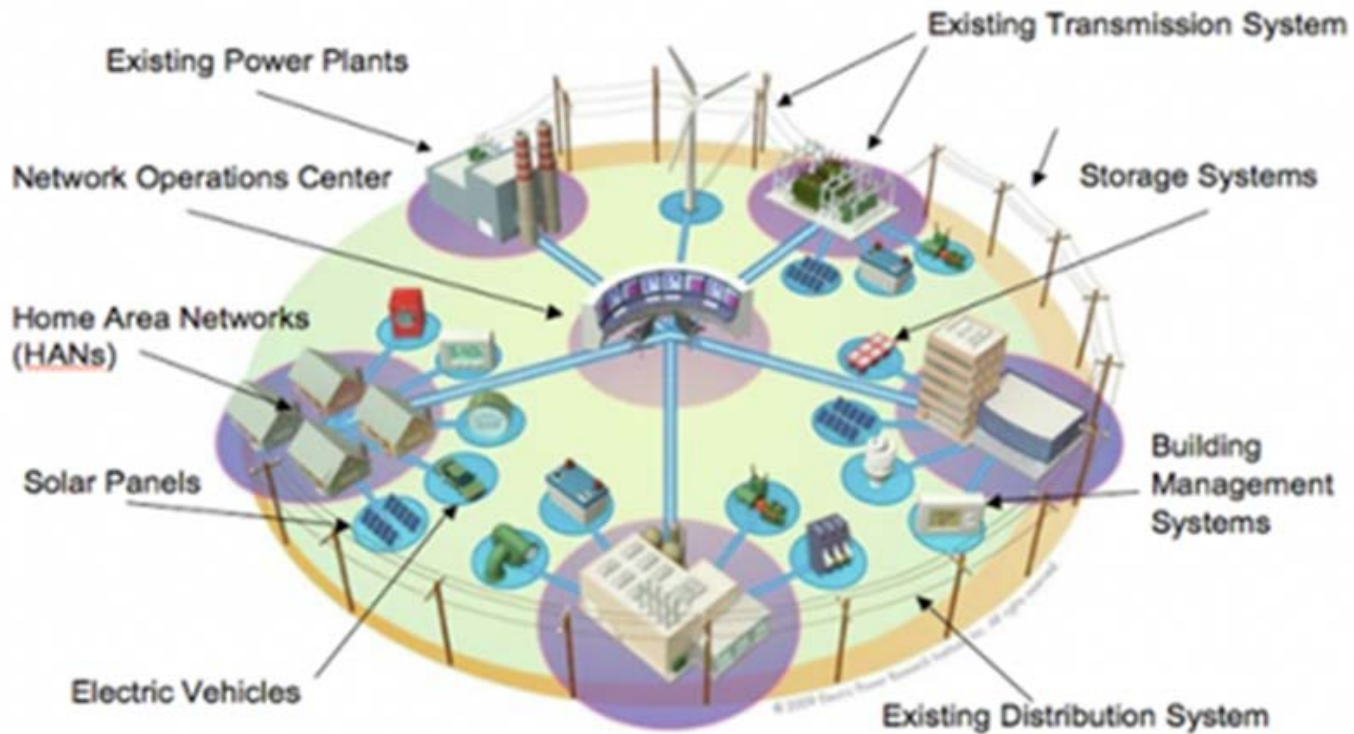
Telecomm as the killer app

- Anchor tenant
- Provides support infrastructure
- Requires reliable power
- Millions of small diesels



What is a microgrid?

- Local power systems that stand on their own



- Remote microgrids – Villages & Islands
- Connected microgrids - Military bases & Campuses

Too Many Choices

Solar

Wind

Hydro

Geothermal

Biomass

New Storage Techs.

Electric
Vehicles



Fuel Cells

Micro-turbines

Micro-grids

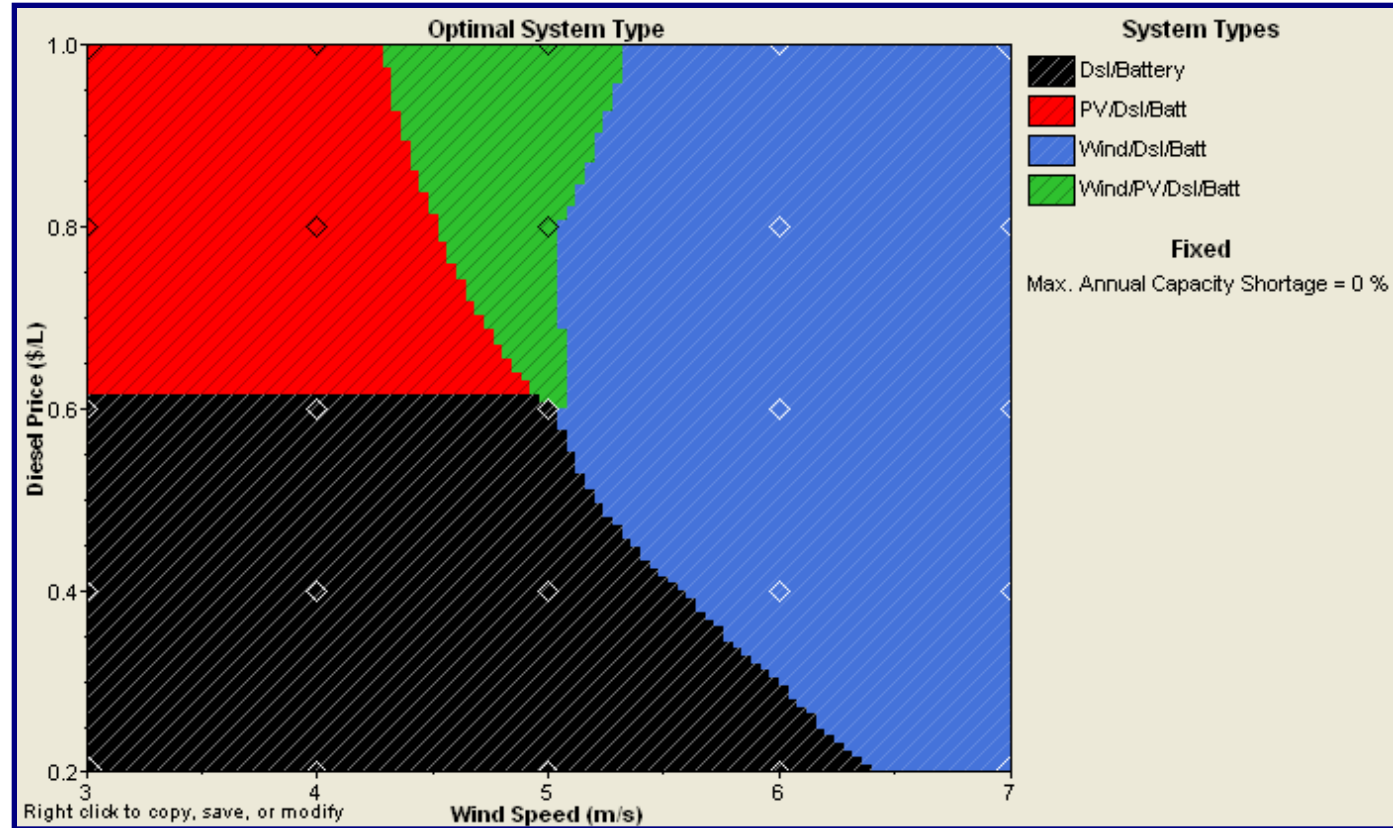
Demand
Response

Load Management

Smart grids

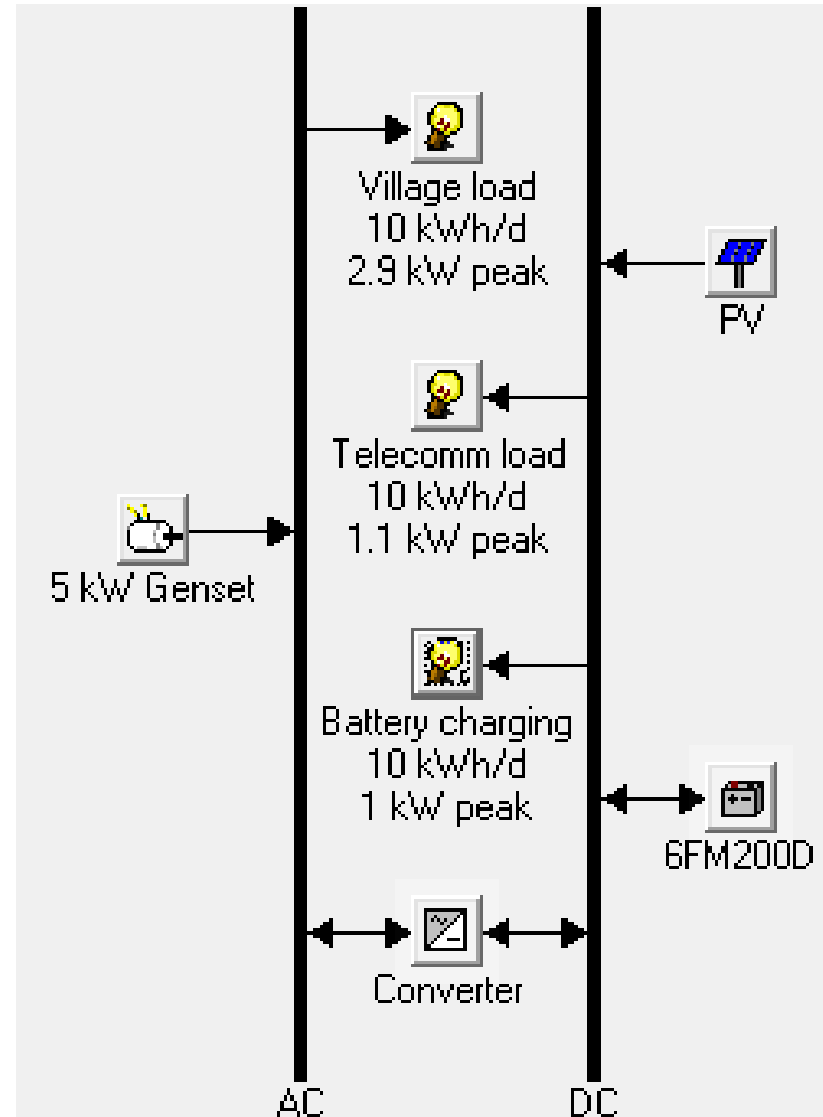
Optimal System Design

- What kind of system is best under which conditions?



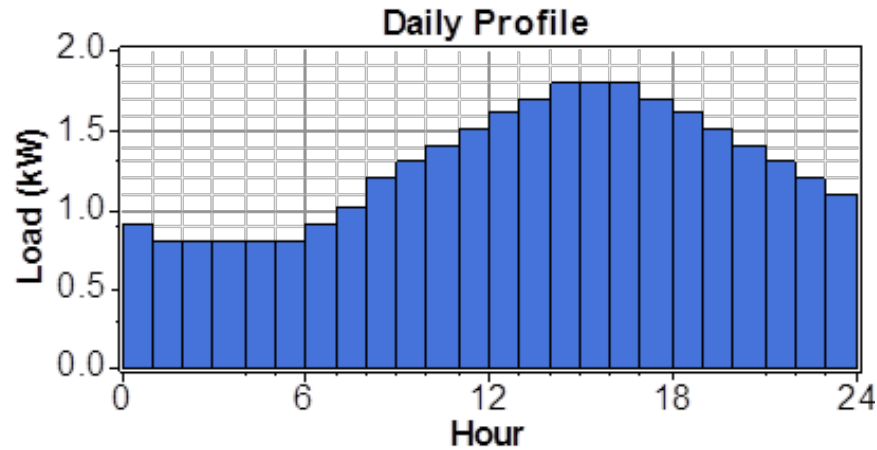
Example analysis

- Primary telecomm load
- Small AC distribution system
- Deferrable battery charging

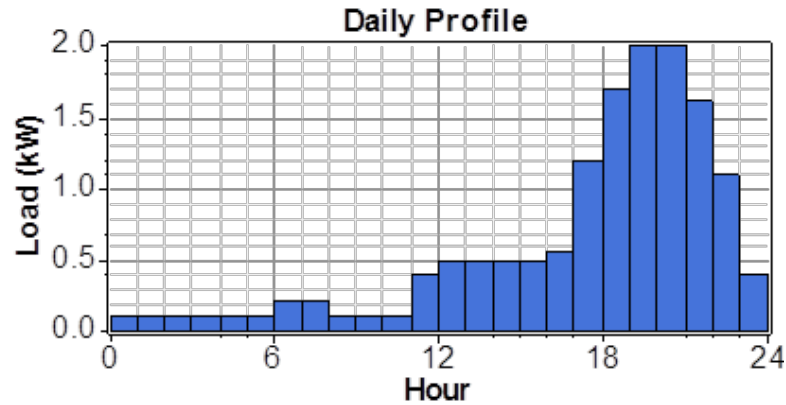


Load diversity

Telecomm load



Village load



Battery charging can be done whenever there is excess energy

Each load = 10 kWh/day

Telecomm only
3 kW PV, 12 batteries
\$27,800

Telecomm and battery charging
5 kW PV, 12 batteries
\$37,800

Telecomm and village AC loads
6 kW PV, 36 batteries
\$52,400

All 3 loads
7 kW PV, 28 batteries
\$54,200

HOMER Summary Results

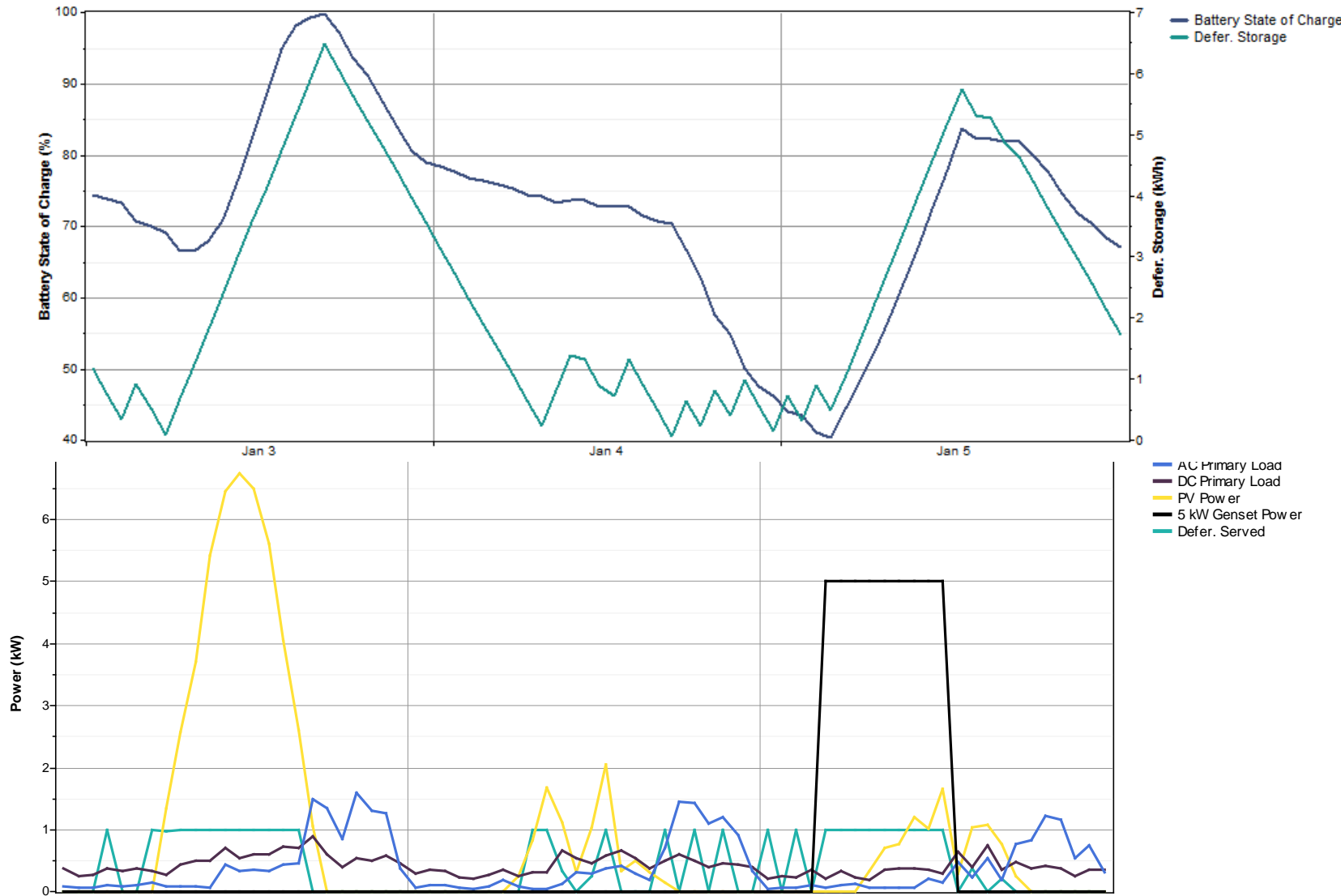
Village load (kWh/d)	Battery char (kWh/d)						PV (kW)	Gen5 (kW)	6FM200D	Conv. (kW)	Initial Capital	Operating Cost (\$/yr)	Total NPC	COE (\$/kWh)	Ren. Frac.	Diesel (L)	Gen5 (hrs)
10.000	10.000						7	5	28	5	\$ 54,200	3,491	\$ 98,821	0.706	0.87	475	291
10.000	0.000						6	5	36	5	\$ 52,400	2,330	\$ 82,183	0.881	0.99	19	12
0.000	10.000						5	5	12	5	\$ 37,800	1,665	\$ 59,086	0.634	0.92	202	127
0.000	0.000						3	5	12	5	\$ 27,800	1,046	\$ 41,167	0.882	0.98	25	15


Optimal system for each scenario

					PV (kW)	Gen5 (kW)	6FM200D	Conv. (kW)	Initial Capital	Operating Cost (\$/yr)	Total NPC	COE (\$/kWh)	Ren. Frac.	Diesel (L)	Gen5 (hrs)
					7	5	28	5	\$ 54,200	3,491	\$ 98,821	0.706	0.87	475	291
						5	4	5	\$ 9,600	12,274	\$ 166,509	1.190	0.00	4,795	3,644
						5		5	\$ 8,000	17,586	\$ 232,813	1.663	0.00	7,223	8,760

Scenario with all 3 loads

Detailed results





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Health Clinic Power System Design


This online software tool uses NREL's [HOMER®](#) optimization model to assist health care providers design appropriate power systems for their rural health clinics using combinations of diesel generators, utility power grids, batteries and photovoltaic arrays. Additional information: "Powering Health: Electrification Options for Rural Health Centers" [\(PDF, 660 KB\)](#)

Follow the numbered steps below to run a HOMER® analysis.

1. [Location and Time Zone](#) - Use the map to indicate your approximate location. [\[more info\]](#)
2. [Power Assumptions](#) - Override the default values for the cost and availability of the electric grid, any on-site power generation with local values if known. [\[more info\]](#)
3. [Financial Assumptions](#) - Enter the Real Interest rate. [\[more info\]](#)
4. [Electric Load Inputs](#) - Enter the type and number of electrical devices used in the health clinic and the time of day they are used. [\[more info\]](#)
5. [Run HOMER®](#) [\[more info\]](#)

1) Location and Time Zone

Click on the map below to mark your location



Solar Resource Data
Location (latitude, longitude)

2) Power Assumptions

Electric Grid (If available)

Grid on at (time)

for how many hours?

Electric Grid Price (\$/kWh)

On-site Generation

Type of Fuel

Cost of Diesel (\$/liter)

Cost of PV System (\$/kW)

Type of Battery

Cost of Batteries (\$/battery)

3) Financial Assumptions

Interest Rate

Interest Rate (percent per year)

Conclusion

- Essential community services require small amounts of electric power
- Every village is different
- Local involvement
- Regional support infrastructure