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DEVELOPING POWER BUSINESS PLAN: EMPOWERING THE BOTTOM OF THE PYRAMID

Scott Gregory Baron

DEVELOPING POWER BUSINESS PLAN: EMPOWERING THE BOTTOM OF THE PYRAMID

by

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Abstract

The purpose of this thesis is to develop a business model for a renewable energy company called Developing Power. This business model is a response to the need for a viable solution for effectively meeting the electricity requirements of large rural off-grid villages in developing countries. The research is presented in the form of a business plan followed by appendices that provide additional detailed support for the business model.

Developing Power designs and constructs hybrid power systems, which are a combination of energy technologies (often solar, wind, and diesel power) to achieve optimal performance at the lowest cost. Developing Power hybrid systems are 1/3 the cost of traditional grid extension and provide electricity at 1/5 the cost of what consumers are currently spending on inefficient forms of energy. The Developing Power business model relies on five steps to implement the use of hybrid systems: 1) Partner with non-governmental organizations to obtain access to local markets and to develop deal flow for the company, 2) Design optimal systems in a sophisticated software program called HOMER (Hybrid Optimization Model for Electric Renewables) and construct systems based on this optimal design, 3) Establish Energy Service Companies (ESCOs) using local labor to maintain and operate the hybrid power systems, 4) Implement a prepayment system based on smart cards and electricity meters to collect payment and manage system use, and 5) Sell the complete package system to a range of potential owners, the most likely being a regional or local utility.

The key finding of this research is that by incorporating important lessons learned from previous rural electrification projects with the innovative use of hybrid power optimization design and prepayment systems based on smart cards, the Developing Power business model has the potential to be a scalable solution for 30 million people that lack electricity. In addition to earning a financial return, Developing Power expects to provide $1.5 of social and environmental benefits for every $1 invested in the business.

Acknowledgements

I would like to thank my advisors, Greg Keoleian and Marc Ross for supporting my enthusiasm for undertaking a non-traditional thesis. I also used non-university assistance from inspirational friends and colleagues that I would like to thank. Todd Bartholf, Director of Renewable Energy and CH2M Hill, provided much of the original idea creation through a course at Solar Energy International and dedicated many hours on the phone. Sanjay Wagle at Expansion Capital provided the guidance and encouragement I needed to win the Social Return on Investment award at the National Social Venture Competition. Lastly, Paul Kirsch at the Zell-Lurie Institute for Entrepreneurial Studies pushed me to take this idea from a concept to a complete business plan; if it was not for him, I would not have been able to make the progress I did.

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Introduction

1. Research Scope and Objectives

The original intent of this research was to document lessons learned from prior renewable energy projects at the bottom of the pyramid. The main conclusion reached at the early stages in my research was that traditional developmental aid projects relying mainly on “give-away” programs have not been sustainable. But more importantly, projects that incorporated cost-recovery mechanisms or that relied on private investment were generally able to reach more consumers with higher quality service. Certain business models proved to be more effective than others in different social, economic, and political climates, but no business studied has yet reached a significantly large scale. Therefore, I adapted my research to focus on answering the question of how to reach scale in meeting the energy needs of the two billion people that lack modern forms of energy. The main result was the creation of an entirely new business model targeting the segment of the market requiring 24-hour electricity for productive uses in remote villages. The resulting business is called Developing Power with the name implying both developing new sources of electrical power and also developing human empowerment through access to electricity.

The business plan is organized and presented in the same general structure as traditional ventures seeking private investment. In order to test the business model, I competed in several business plan competitions with this plan between 2002 and 2004. While focused on competitions with a social component, I also competed directly against high-growth ventures in developed markets. Specifically, I entered seven competitions and either won awards or advanced as a finalist in five of the seven competitions, indicating that the business plan is viable in the investment community. Notable honors include winner of the Best Social Return on Investment at the National Social Venture Competition, Best Social Entrepreneur at the New Ventures Competition, finalist at the Wake Forest Elevator Pitch Competition, finalist at the Michigan Pryor-Hale Competition, second-place at the Michigan Future-Tech Quick Pitch, and medium-growth finalist at the Global Social Venture Competition (results pending).

2. Organization and Overview of Business Plan

The business plan first documents the market opportunity and the potential market size, showing that rural people are already spending a significant proportion of their income on inferior forms of energy and are able to afford upgraded services. Second, the business model is presented, which is separated into the economic value propositions and the business model execution. The economic value propositions are that Developing Power can build systems for 1/3 the cost of traditional grid extension and for 1/5 the cost of what is currently being spent on energy in rural areas. The business model execution relies on 5 steps: 1) partner with non-governmental organizations to gain market access, 2) design and construct optimal hybrid systems in sophisticated a software program called HOMER, 3) establish Energy Service Company to operate and maintain systems, 4) implement prepayment collection systems, and 5) sell systems to a range of potential owners. Third, the strategy for entering the market is outlined, which demonstrates the initial partnership building efforts undertaken so far. Based on the relationships established through these partners, Bahia, Brazil is identified as the most viable market for undertaking an initial pilot project. Fourth, competitive threats and alternative business models are presented. Fifth, the financial projections are discussed, showing a 5X return (31% IRR) to first round equity investors six years from initial investment. Sixth, the risks of the business are described. Seventh, a social return on investment analysis is presented; the main result is that the company returns $1.5 of benefits for every $1 invested. Lastly, qualifications of the management team and the board of advisors are described.

Supporting the business plan are seven appendices that provide more detail on various themes represented in the business plan. Appendix 1 shows the financial projections, which include a balance sheet, income statement, and cash flow statement. Appendix 2 includes two letters of interest from potential investors, showing the viability of the concept and the potential for partnerships. Appendix 3 further details organizations working in the field of rural electrification. Appendix 4 shows the main calculations used in the HOMER hybrid system-modeling program to determine the lowest cost system. Appendix 5 summarizes the recent research regarding the cost trends for renewable energy technologies. Appendix 6 documents how tremendous growth in microfinance is providing a basis for growth in rural electrification. Appendix 7 provides a detailed discussion on how carbon trading might be integrated with rural electrification projects as an additional source of revenue.

Following the appendices are my conclusions including key findings and recommendations for future research, a bibliography, and the presentation slides used in business plan competitions for pitching Developing Power to potential investors.

DEVELOPING POWER

Empowering the Bottom of the Pyramid

Business Plan

Business Plan Executive Summary

Empowering the Bottom of the Pyramid
www.developingpower.com

Contact Person
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Guiding Principle

"New business models are needed to reach the bottom of the pyramid"—C.K. Prahalad

The Market Opportunity

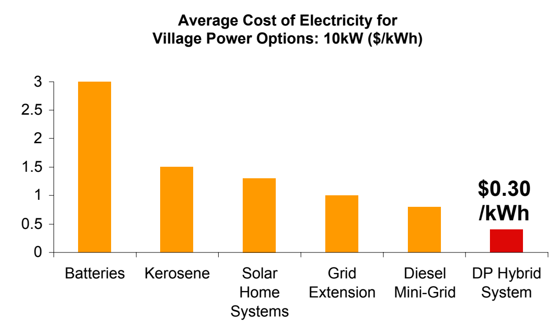
Approximately one-third of the world does not have access to electricity (1.7 billion people). The poor are spending a disproportionate share of their income on expensive, dirty, and unreliable forms of energy. Meeting the growing demand for electricity in rural markets of developing countries represents an estimated multi-billion dollar potential market.

Business Description

Developing Power specializes in the design and construction of distributed generation microgrids in areas of developing countries beyond the reach of a centralized power grid. The focus is on renewable energy based hybrid systems to achieve the most cost-effective and sustainable solution for large villages.

Business Model

Developing Power can electrify remote villages with the same or higher quality power of grid extension projects for approximately **1/3 the cost**, and **1/5 the cost** of what is currently being spent on inefficient forms of energy in rural villages.



Source: NREL, "Overview of Lessons Learned", 2002

Developing Power Business Model

1) Identify viable villages and deal flow though network of local partners
2) Design optimal power systems using sophisticated software program; construct microgrid
3) Establish local Energy Service Company to provide long-term maintenance and operation
4) Implement pre-payment collection system
5) Sale of system to range of potential owners

The business strategy is to sell projects to a range of potential owners for long-term operation. Local utilities are the target customer as they are looking for better ways to electrify rural communities (often under government mandate), but have limited or no expertise in distributed renewable energy solutions.

Target Markets

The target markets are regions where concession utilities (utilities that have bid for the right to service a determined territory of a region) are looking for alternative solutions to expensive grid extension. Bahia, Brazil represents a viable initial target market for proving the concept. Developing Power is currently working with E+Co to form a local partnership in Bahia to implement a pilot project.

Management Team

The founder, Scott Baron is graduating in May 2004 from the University of Michigan with an MS from the School of Natural Resources and Environment and an MBA from the Michigan Business School. Scott has five years experience in the energy industry and is a graduate from Solar Energy International. Recent experience includes helping start the Chicago Climate Exchange, a voluntary carbon trading program, and **modeling the Brazilian wind energy market for GE Wind Energy**. His partner, Mary Catherine Smith, is on the board of a cultural NGO in Brazil and has extensive contacts throughout the country. The company is currently searching for a Chief Engineering Officer.

Financial Projections

We are seeking to raise $25,000 to fund a partnership study in Brazil. After the initial partnership study the company is asking for $500,000 in equity capital over 3 years to electrify 25 large villages in 5 years. The expected return is 5X to first round equity investors six years from initial investment (31% IRR).

Social Return on Investment

There are measurable improvements in education and earning potential, productivity, and health from access to electricity. It is estimated that for every $1 invested in Developing Power projects, there is $1.5 in social and environmental benefits.

1. The Market Opportunity

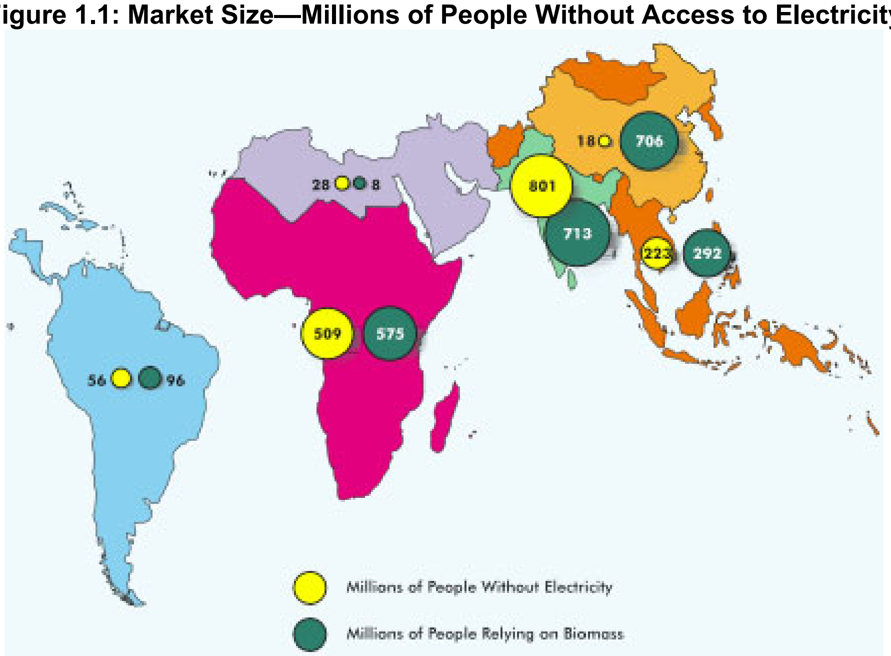
Approximately 1.7 billion people, or 400 million households, worldwide do not have access to electricity (WEO 2002, IEO 2002). Access to modern forms of energy are critical for improving lives and breaking the cycles of poverty, consequently rural electrification has been a top priority for world governments, multi-lateral development organizations, and non-governmental organizations (NGOs) for over 50 years. However, the number of people without access to electricity has remained approximately the same despite these efforts, as electrification rates have not kept pace with population growth and demand.

Developing Power capitalizes on this opportunity by meeting the needs of the growing segment of villages requiring 24-hour electricity solutions. This segment generally represents villages that have medium incomes (through agriculture or livestock), are further than 20-30 kilometers from a power grid, and are currently spending large portions of their income on inefficient and expensive forms of energy. Evidence abounds that this segment can afford and is willing to pay for upgraded and reliable energy services that allow for significant increases in productivity. Through a combination of sophisticated system design, partnership strategies, and pre-payment metering, Developing Power can construct systems for **1/3 the cost** of traditional grid extension and provides power for **1/5 the cost** of what is currently being spent on inefficient forms of energy in rural villages.

The target market is rural Bahia, Brazil, which contains an estimated 223 remote villages with over 40 households that are further than 30 kilometers from the grid (Developing Power will electrify 25 villages in 5 years). Brazil is the immediate focus because the government has recently enacted favorable legislation aimed at "universal electrification" which encourages private investment, rural energy delivery, and renewable energy. Bahia has the largest unelectrified population in Brazil and also has the most abundant renewable resources compared to any other state (wind and solar). Other potential markets include Nicaragua, Afghanistan, and India. We have a good understanding of the energy markets in these countries and opportunities will be considered as they become available.

The G8 Renewable Energy Task Force predicts that of the 1.7 billion people without access to electricity, approximately **300 million people** is a reasonable estimate of the number that can be provided with clean energy under appropriate social and economic conditions. A preliminary analysis indicates that large remote villages represents about 10% of this population, suggesting **30 million people** that fit the criteria of the Developing Power model.

Figure 1.1: Market Size—Millions of People Without Access to Electricity



Source: International Energy Agency. 2002. World Energy Outlook.

1.1 Potential Market Size

The U.S. Department of Energy projects that the world's total energy consumption will rise by 59% between 1999 and 2020, from 382 to 607 quadrillion BTUs. Most of the growth will occur in the rapidly developing parts of the world, including unelectrified areas surrounding urban centers, led by rapidly developing parts of Asia and Central and South America (International Energy Organization 2002). According to some estimates, developing countries (in this plan "developing countries" are considered non-Organization of Economic Co-operation and Development countries) will have to double their current generation capacity (1.5 million megawatts) by 2020 to meet this growing demand. And on average, approximately **25% of the population in developing countries** still does not have access to electricity. Table 1.1 lists various investment and growth predictions for investments in electricity and renewable energy in order to extend electricity services to unelectrified populations in developing countries.

Table 1.1: Summary of Renewable Energy Investment Predictions in Developing Countries

Prediction	Source
Rural market worth $2.5 billion by 2005	Strategies Unlimited
$30 billion per year investment (500 kWh per person/year)	World Energy Council
Over $1.7 trillion investment by 2020	World Energy Outlook, International Energy Outlook
5 million megawatts in four decades—1% increase in capacity represents a $50 billion market (or $5 trillion total)	The World Bank
Reported investment commitments of $10-15 billion for renewable energy in next 2-5 years (by 2006)	G8 Renewable Energy Task Force

Meeting these estimates **cannot take place under "business as usual" scenarios**. As demonstrated in the path-breaking book *Small is Profitable: The Hidden Economic Benefits of Making Electrical Resources the Right Size* produced by the Rocky Mountain Institute (2003), environmental risks and cost overruns of large fossil fuel plants makes them highly unappealing to investors. This trend is playing out in the United States and the dominant logic is that the developing world can take the lead in disseminating distributed generation technologies at a far lower cost. However, local utilities and governments in developing countries have little experience with these technologies; the dominant logic is grid extension despite its inefficiencies.

The World Resources Institute, an environmental think tank, states in its *Tomorrow's Markets: Global Trends and Their Implications for Business*, "[two billion people without access to modern forms of energy] represents a **huge market for dispersed energy systems** such as photovoltaic generators, small wind turbines, hydrogen fuel cells, and biomass generators that meet rural power needs without the infrastructure of [national] power grids, pipelines, and power plants" (2002).

In addition to a large potential market, developing countries are deregulating their power markets and opening up to privatization. The past decade has seen a wave of privatization of infrastructure activities in developing countries; between 1990 and 1999, **seventy-six developing countries** introduced private participation in energy. These countries awarded the private sector more than 700 energy projects, or almost $187 billion (ESMAP 2002). While private sources provided only one third of the necessary energy financing in the late 1980's, they account for over 80% in today's larger market (World Bank 1996).

1.2 Ability and Willingness to Pay for Electricity

A common misconception is that poor people in developing countries cannot afford many goods and services. As overwhelmingly disproved by Peruvian Economist Hernando DeSoto and preeminent strategist C.K. Prahalad in their recent works, people are willing to spend significant proportions of their money on things that they can get now that improve the quality of their lives. The poor are already spending a disproportionate share of their income on goods and services that richer people get more cheaply. James Wolfensohn, president of the World Bank summarizes these conclusions:

> In the Voices of the Poor study, where we interviewed 60,000 people in 60 countries, we asked them what was the number one thing they wanted. They said technology and information, they

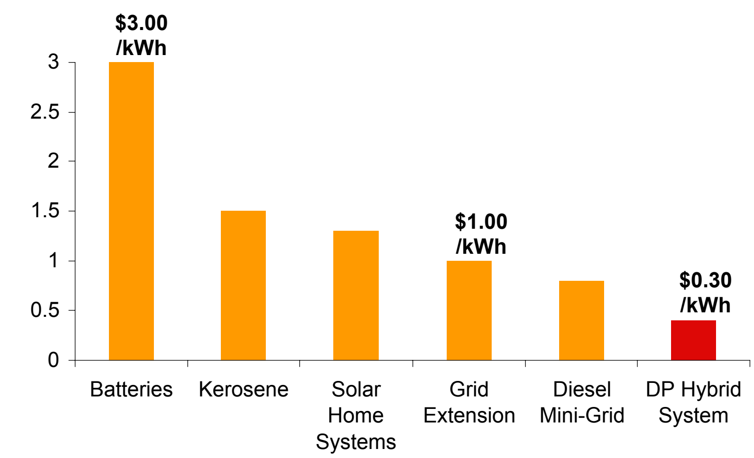
didn't say food, they didn't say charity. Poor people know as well as anybody else that what keeps them poor is lack of competitiveness and lack of knowledge (2000).

Electricity is the foundation for improving standards of living by allowing the access to technology and acquiring information. However, in many areas of developing countries, promised grid access is never delivered, resulting in hundreds of millions of people spending roughly **$20 billion each year** on ad hoc solutions for energy like kerosene lamps, candles, open fires, and batteries (World Development Report 1999). Approximately 10% of unelectrified households on a global basis use car batteries for electricity, which cost about $3/kWh to operate (compared to $0.10/kWh for grid electricity in the United States—Solar Energy International 2002). However, these sources are sometimes the only energy options available, given that only about 5 percent of rural populations in the majority of the world's poorer countries are connected to the national grid (Anderson et. al. 1999).

With the cost of grid extension typically in the range of $8,000 to $10,000 a kilometer, **electric utilities cannot afford the cost to extend transmission lines from the national grid to rural communities (further than 30 km on average)**. Unelectrified villages often take matters in their own hands and buy a diesel generator and install a local microgrid. However, these systems are often not properly built, cause considerable pollution and noise, are located far from easily accessible and inexpensive sources of diesel fuel, and only provide electricity for 4-6 hours per day. Solar Home Systems (SHSs)—small photovoltaic panels and a battery connected to individual households—are effective for meeting small loads, but are not suitable for more productive uses of energy typically required in larger villages.

Compared to these options, **hybrid renewable energy systems are an ideal source of energy for large village scale power**. A solar-wind-diesel system is a preferred combination because when the wind is blowing, the sun is typically not shining, and back-up diesel power can meet demand when neither of the resources is available. The synergistic relationship between technologies and resources, as well as economies of scale, allow hybrid systems to produce the lowest cost of energy compared to all other remote power options for larger villages (see Figure 1.2).

Figure 1.2: Average Cost of Electricity for Village Power Options: 10kW ($/kWh)



Source: National Renewable Energy Laboratory, "Overview of Lessons Learned", 2002

Table 1.2 illustrates that on average, people spend between **$7 and $25 per month on energy**. These expenditures are generally for inferior forms of energy like candles, kerosene, batteries, and dung and represent between **10-30% of one's income.** While cost would appear to be the main driving concern of rural people, previous projects indicate that **quality and reliability are the most valued attributes of an energy system**. What people are willing to pay for electricity that is reliable, safe, and of high quality is often higher than what is currently spent on current energy services (ESMAP 2000, World Bank 1996). As stated in the 2000 ESMAP Energy and Development Report, "evidence abounds that consumers are willing to pay often extraordinary high prices for reliable and predictable energy."

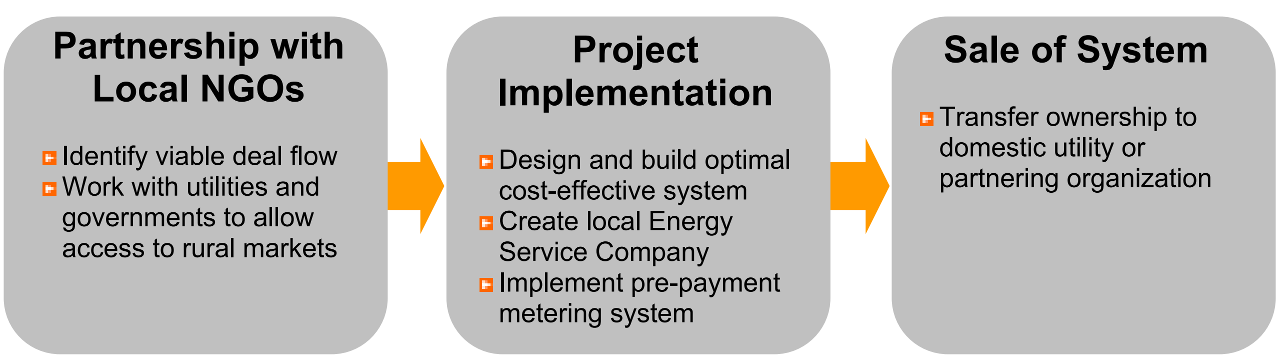
Table 1.2: Estimates of Money Spent on Energy

Number	Study	Region of the World	Amount Spent on Energy
#1	Solar Electric Light Fund	World average	$10 per month per person
#2	Dan Kammen, Cal Berkeley	Africa	$5-$10 per month per household on lights exclusively (New York Times)
#3	Michael Phillips and Brooks Browne	World average	$8-$12 spent per person on energy per month, willing to spend more for higher quality energy
#4	Soluz, Inc,	Dominican Republic	Customers spending $6-$25 per month on solar home systems
#5	Community Power Corporation	Indonesia	$10-$12 per month per person on hybrid power
#6	Douglas Barnes, World Bank	World average	The poorest 20% of households spend $7-$11 on energy per person; representing 15-22% of their income

2. Business Model
Developing Power designs and constructs cost-effective and clean hybrid microgrid power systems based on renewable energy. Hybrid systems are a combination of technologies (such as wind and solar) to provide high-quality electrical power (usually 24-hour). Microgrids are isolated grid networks, usually not connected to a national grid. Hybrid microgrids represent a **proven solution** for providing village power, but have yet to be widely used (only approximately 10,000 households in the developing world are being served by hybrid microgrids—Martinot et al. 2002). Hybrid systems have been used successfully in Mexico (San Juanico), Indonesia (Community Power Corporation), and Brazil (NREL), for example, and have proven to be a reliable and effective power source. Similar to hybrid vehicles, hybrid microgrids are a recent innovation and have not been widely replicated.

The advantages of hybrid systems compared to other available energy alternatives are 1) they are lower cost, 2) the energy is higher quality, and 3) they are reliable—the most important considerations for rural customers. Typical applications for microgrid power include lighting for extended operating hours in local stores and home businesses, water pumping for irrigation on farms, power for machinery such as power saws and grinders, ice-making for fisherman, and electric fences for containing cattle. Social improvements from 24-hour electricity include refrigeration of foods and vaccines, convenience, better educational opportunities through lighting and media, communication at community centers, and street lighting.

The Developing Power model is to: 1) **Partner** with NGOs to develop deal flow and to identify villages for electrification, 2) **Implement projects** by designing and constructing optimal systems, establishing Energy Service Companies, and installing pre-payment meters, and 3) **Sell systems** to a range of potential owners. This model is similar to InterGen or AES, global energy power generation firms that build large power plants in developing countries. The main difference is that Developing Power operates on a much smaller scale and specializes in **distributed generation solutions**.



The Developing Power model is based on considerable research and experience from what works and what does not work in rural electrification. The following table summarizes the main conclusions:

Table 2.1 Lessons Learned from Rural Electrification Projects in the Last 10 Years

1. Commercial sustainability must drive design; the system must be designed to what can be afforded.
2. There must be a fee for all electricity usage otherwise there is free-riding and overuse.
3. Productive use of power must be given high priority—income generation is critical for success.
4. The private Energy Service Company (ESCO) model for operation and maintenance is needed to ensure long-term sustainability.
5. Pre-payment meters are a must to ensure effective, low cost, receipt of customer payments.
6. Community participation is paramount in developing successful projects.
7. Local training, including operating manuals in the local language, and regional O&M capability are critical for sustained operation.
8. Village leaders and country governments must be strong supporters of the project.
9. Systems should be robust and simple to operate; simplicity is often more important to effectiveness than lower cost or higher possible efficiency.
10. An integrated approach that addresses the characterization of the rural situation, policy issues, financing, institutional delivery options, local/regional/national capacity building, characterization of renewable resources, and the capacitive analysis of options, through the development of a sizeable, regional pilot is the key to developing a sustainable rural electrification program involving renewables.

Sources include: Personal conversations with National Renewable Energy Laboratory staff and Robb Walt from Community Power Corporation; Solar Electric Light Fund, World Energy Assessment (2000)

2.1 Business Model Economics

The Developing Power business model is supported by two main economic value propositions, one to the buyer of Developing Power systems and the other to the end customers of the energy.

Economic Value Proposition #1: Benefits to Owners

Value Proposition	Result
Developing Power provides lower cost electricity delivery to rural communities compared to traditional grid extension.	**1/3 the cost** of traditional grid extension to remote villages

Economic Value Proposition #2: Benefits to Consumers

Value Proposition	Result
Developing Power provides lower cost and higher quality energy to rural unelectrified villages.	**1/5 the cost** of what is currently being spent on energy in rural communities

These propositions are supported by the economics for one example village in Bahia, Brazil:

Table 2.2 Assumptions for Example Village in Bahia, Brazil

Measure	Assumption	Source
Number of people in village	500	500 people is an average size village
Average expected electricity consumption	500 kWh/year/person	Average level of electricity needed to increase productivity (EPRI estimate)
Expected system size	100 kW	Expected capacity needed to meet peak loads given electricity demand profile
Downtime of the system (% of time it is not providing electricity)	0%	Developing Power provides 24-hour electricity for productive use; can specify lower % in model
Average wind speed	7.26 m/s	Taken from actual wind site in Brazil (GE Wind Energy)
Average solar radiation	4.9 kWh/m^2/day	Average for 12 degree latitude (Bahia)
Expected diesel fuel costs	0.4 $/L	Current cost of diesel in rural Bahia

2.1.1 System Design for Prototype Village

To further demonstrate the economic value propositions, an example system for a typical rural village in Bahia, Brazil (target market) should be designed. Using the assumptions from Table 2.2, Developing Power can model the optimal cost-effective solution to meet the energy needs of this village. Using a sophisticated software program called HOMER (Hybrid Optimization Model for Distributed Generation) developed by the National Renewable Energy Laboratory (NREL), Developing Power can determine which technologies are appropriate, the cost of energy for the system, and a host of other operational outputs. The model works by simulating multiple combinations of technologies to determine the lowest cost system to meet the expected electricity demand given the resource availability constraints in the village. While the program is publicly available, a limited number of people worldwide are known to have expertise in using it (based on conversation with NREL staff).

The three main parameters in the model include:

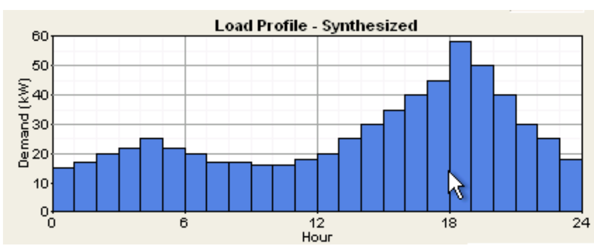
1. Electricity demand (load), which is based on expected kWh usage per person.
2. Resource availability, which is a based on the measurable wind and solar availability.
3. Input costs, which include capital costs of all equipment, O&M expenses, fuel costs, interest rate, operational life, and a range of other input variables.

Parameter #1: Load

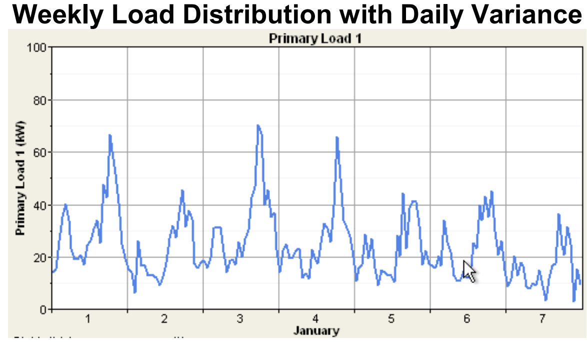
The load is expected to peak at night and sub-peak in the morning, following the average distribution of electricity usage in both developed and developing countries. The model uses these hourly averages and adds variability by day and season according to selected variance options (model currently assumes 15% daily variability and 20% hourly variability).

Figure 2.1 Expected Load Distributions

Daily Load Distribution



Weekly Load Distribution with Daily Variance

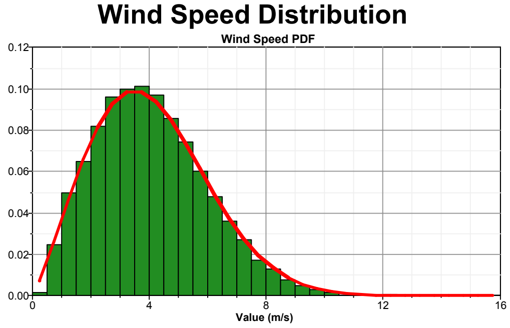


Parameter #2: Resource Availability

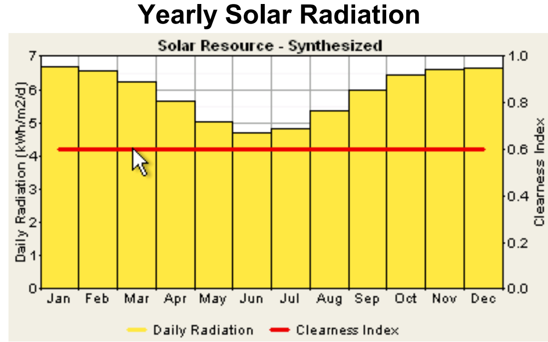
The second major parameter driving system design is the resource availability. Solar radiation is fairly well documented by latitude and approximate location; the average for Bahia, Brazil is used in this model. Wind turbine output is more sensitive to specific wind regimes and can be measured through the use of an anemometer. The wind speeds used in this example are from an actual site in Brazil (source: GE Wind Energy).

Figure 2.2 Sample Wind and Solar Distributions

Wind Speed Distribution



Yearly Solar Radiation

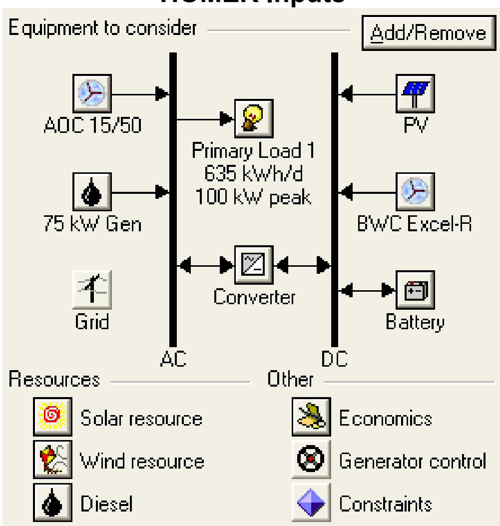


Parameter #3: Input Costs
The user of HOMER selects what technologies and costs to enter into the model. Based on these costs, the resources availability, and the expected load, HOMER runs simulations to determine the lowest cost system to meet the user's specifications. Because wind and solar energy are available in Bahia, wind turbines and photovoltaics are modeled in addition to diesel power, which is important for providing power when the renewable sources are not available. Batteries are also used to store excess energy.

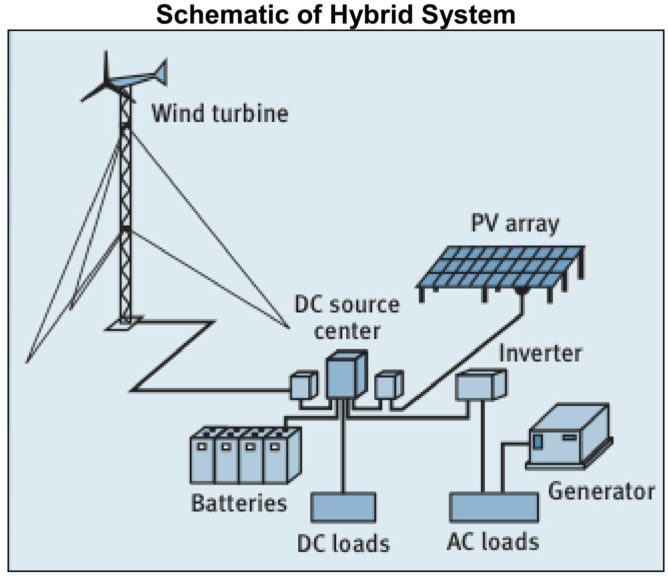
To support the AC infrastructure, a converter is needed to turn the DC loads from batteries, smaller wind turbines, and the solar panels into AC power. HOMER uses base case cost estimates to determine the **optimal number of technologies** in the system design (i.e. user enters cost data for 1 wind turbine and the model runs simulations for multiple turbine configurations) Figure 2.3 shows the main input screen in the HOMER model and the rough schematic of the system.

Figure 2.3 HOMER Inputs and Schematic

HOMER Inputs



Schematic of Hybrid System



The costs used to model the system for the example village include all necessary generation equipment and hardware, storage and conversion devices, mounting systems and towers for wind turbines, microgrid upgrades (poles, wires), pre-payment systems, and yearly maintenance costs.

Table 2.3: Initial Input Capital Costs in Model[1]

Technology	Capital Cost	Replacement Cost	O&M Cost[2]	Expected Lifetime	Source
Atlantic Orient 15/50 Wind Turbine	$110,000	$100,000	$3,000/yr	20 years	NREL
Bergey 7.5 kW Wind Turbine	$28,040	$27,000	$800/yr	20 years	Bergey Wind
Photovoltaic Panels (base case: 2.64 kW)	$19,030	$15,000	-	20 years	Bergey Wind
75 kW Diesel Generator	$21,000	$15,000	$0.5/hr O&M $0.4/L Fuel	Model determines	NREL
11 kW Converter	$8,030	$8,000	-	15 years	Bergey Wind
Rolls/Surrette Batteries (9,645 kWh)	$1,100	$1,000	$10/year	Model determines	NREL
Microgrid Upgrade	$20,000	-	-	-	Estimate

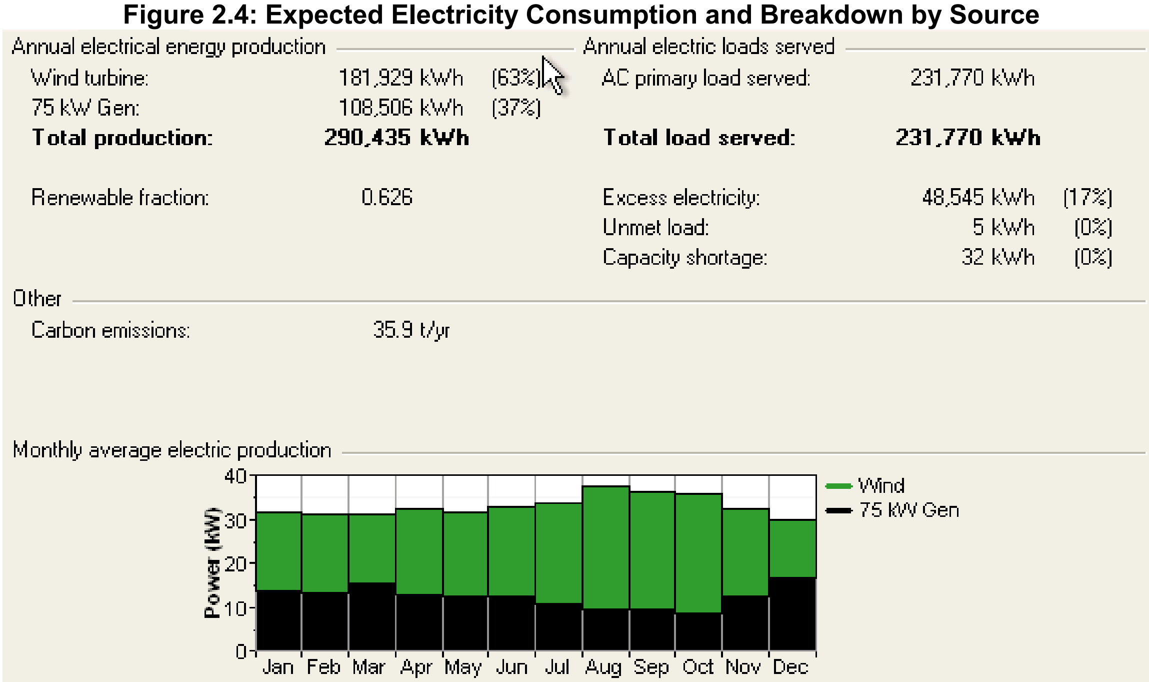
Pre-payment System	$20,000	-	-	-	Estimate
Yearly O&M Costs (wages, replacement parts)	$10,000	-	-	-	Estimate

1 HOMER uses this data to determine the optimal combination and number of technologies; these figures may not represent the costs for the final design
2 Includes premium for rural locations; difficulty of access and lack of readily available parts

Based on these input costs, the resource availability for Bahia, and the expected electricity load for a 500 person village (consuming 500 kWh/year/person), the HOMER optimization result for this example village is: 1—AOC 12/50 Wind Turbine, 1—75 kW Diesel Generator (load following), 24—Rolls/Surrette 6CS25P Batteries, and 1—20 kW Inverter.

The Bergey 7.5kW turbine and photovoltaic array were not chosen because their costs were not justified with this particular wind and solar regime. Solar will likely still be a viable technology in Developing Power projects in areas where the price of diesel fuel is high and specific local resources are abundant. Renewables still make up the majority of the power production and the model predicts that wind alone will satisfy **63% of the total energy needs** of this village.

Figure 2.4: Expected Electricity Consumption and Breakdown by Source



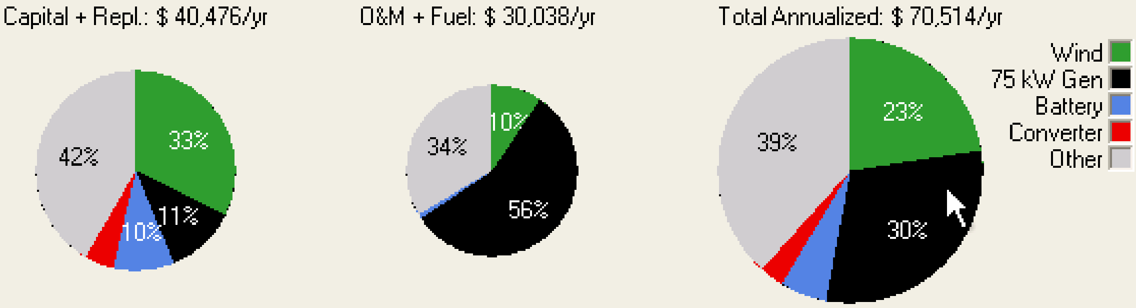
The total costs for the example village are presented in Figure 2.5. The total capital costs for a system meeting the 24-hour electricity needs for a village of about 500 people consuming 500 kWh/year/person is about $300,000 ($312,000 in this model). These costs include a $100,000 development fee for Developing Power to design and construct the system. The levelized cost of energy (COE)—the cost per kWh needed to recover capital costs and to cover operating expenses—is 0.30 $/kWh (0.304 $/kWh in this model).

Figure 2.5: Optimal System Design and Relative Costs for Sample Village[1]

System Architecture: 1 AOC 15/50; 75 kW 75 kW Gen; 24 Surrette 6CS25P; 20 kW Inverter; 20 kW Rectifier; Load Following

Total NPC: $ 588,236
Levelized COE: $ 0.304/kWh

Cost | Electrical | 75 kW Gen | Battery | Grid | Hourly Data



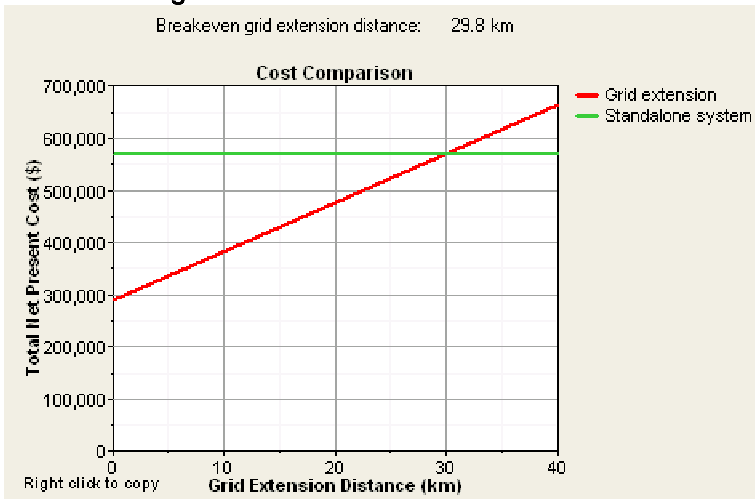
Component	Initial Capital ($)	Annualized Capital ($/yr)	Annualized Replacement ($/yr)	Annual O&M ($/yr)	Annual Fuel ($/yr)	Total Annualized ($/yr)
AOC 15/50	110,000	13,186	0	3,000	0	16,186
75 kW Gen	21,000	2,517	2,020	1,883	14,915	21,335
Battery	26,400	3,165	818	240	0	4,223
Converter	14,600	1,750	237	0	0	1,987
Other	140,000	16,782	0	10,001	0	26,783
Totals	312,000	37,401	3,075	15,123	14,915	70,514

1 Assuming a discount rate of 10.3% (WACC in financial statements) and a 10 year life of system

2.1.2 Economic Value Proposition #1: Benefits to Owners

Developing Power will sell an average 100 kW system for $300,000. In order for a utility to pay this price, the net present cost of the microgrid system has to be less than the cost to extend grid power lines. The cost of extending grid lines is a function of distance of the village to the grid. Based on a cost of grid extension of $8,000/km (the lower estimate of the commonly cited $8,000-$10,000 range, including yearly maintenance fess of about $160/km) and the 100 kW system modeled, **Developing Power can electrify a rural village for cheaper than the grid for distances greater than 30 km (18.6 miles).**

Figure 2.6: Grid Breakeven Distance



In addition to providing a lower-cost alternative to grid power for villages further than 30 km from the grid, Developing Power also establishes a **new profit center** for the utility (owner). The utility can chose to charge more than 0.30 $/kWh for the electricity it produces. They may also chose to take advantage of government subsidy programs for rural energy delivery (charging customers less, but earning same return).

- Assuming the utility charges 0.35 $/kWh for electricity, representing a 15% profit margin, the expected yearly revenue from the system operation is [231,770 kWh consumed * 0.35 $/kWh] = $81,200.
- 231,770/500 people = 463 kWh/year/person, which is reasonable energy consumption to expect for most rural customers. About 500 kWh/year/person is what is needed to be productive with electricity—electricity for running appliances and machines [corresponds to estimates].
- $81,200/500 people in the village= $162/year/person = $13/month/person [corresponds to data in Table 1.2 on page 5].
- The average per capita income in rural Bahia is about $3,000 for medium sized rural villages (mostly farmers). $162 per year represents 5% of yearly income, which is reasonable given that most estimates suggest people are willing to pay between 10-30% of their income on energy, which includes fuels for cooking [corresponds to Table 1.2, line #6 on page 5].

The economics and value proposition is further supported with an example of a **village 50 km from a centralized power grid** (Table 2.4). As this example shows, there is no incentive for utilities to electrify rural villages (of this size) with grid power when further than 30 km from the grid, and they generally do not. However, the system provided by Developing Power results in a new profit center for the utility and is affordable by the village community.

These results suggest two conclusions:

1. A utility that is required to electrify rural villages under concession contract would be willing to pay up to $548,600 for a Developing Power system (100 kW, given assumptions). The expected cost to the utility for a 100 kW system from Developing Power is $300,000, **saving them approximately $250,000**. Developing Power only charges $300,000 in order to keep the levelized cost of energy low enough for the system to be affordable (COE = $0.30/kWh). Charging $0.35/kWh, the utility can still earn a 15% return on investment from the operation of the system.
2. Because a new profit center is created, utilities may not be the only potential owners. Providing a 15% return, these systems are likely to be attractive investments to microfinance institutions and partnering NGOs that might be interested in long-term ownership.

Table 2.4: Economics for a Village 50 km Distance from the Grid

	Grid	Developing Power Microgrid
Net Present Cost of Grid Extension and Microgrid	($750,000)	($588,000)[2]
Net Present Revenue (assuming 20 year analysis, 10.3% discount rate)	0.15 $/kWh[1] * 231,770 = $34,765 PV = $290,100	0.35 $/kWh * 231,770 = $81,200 PV = $676,700
Net Present Value	($459,900)	$88,700
Cost per Person	$1,500	$1,175
	Economic Benefit = $548,600	

1 Cost of grid electricity is $0.15/kWh to consumers
2 Includes all capital, operating costs, and fee to Developing Power

2.1.3 Economic Value Proposition #2: Benefits to Consumers

It costs the utility upwards of $0.50 $/kWh to provide power to remote sites, and they are often limited by law what they can charge to customers for grid power (average about 0.15 $/kWh). However, because the grid rarely gets extended to remote sites (illustrated above), people turn to other forms of energy. These forms are on average **five times more expensive** than high-quality power from Developing Power microgrids.

The following table shows the costs from different sources to achieve the same total kWhs as the system in the example village described above.

Table 2.5: Energy Expenditures for Commonly Used Energy Sources to Obtain 460 kWh/year/person: Same as Microgrid System (see Table 1.2 on page 5)

Energy Source	Cost	Total Cost per Person per Month	Power Quality
Batteries	3.0 $/kWh	$160	Poor
Kerosene	1.5 $/kWh	$80	Poor: limited to lighting, health risks
Solar Home Systems	1.3 $/kWh	$50	Medium: not capable for larger uses of electricity
Diesel Microgrid	0.80 $/kWh	$30	Medium: intermittent, usually only operating 4-6 hours per day
Developing Power Hybrid System	**0.35 $/kWh**	**$13**	**High: 24-hour electricity**

2.2 Business Model Execution

In order to execute the above economic value propositions, Developing Power will follow the following steps:

1. Partner with NGOs to obtain access to local markets and to develop deal flow.
2. Use HOMER to design optimal low-cost systems; construct systems based on optimal design.
3. Establish an Energy Service Company using local labor to maintain and operate the system.
4. Establish a pre-payment metering system for collecting payment and managing electricity use.
5. Sell complete system to a range of potential owners (these contracts will be signed prior to project engagement).

2.2.1 Partnerships

The first step in the business strategy is to identify a deal flow of viable villages to electrify. The goal is to partner with an in-country organization that knows the local environment and has connections with key government and industry representatives.

The role of this local partner will be to:

- Work with government officials and local utilities to grant access to rural markets;
- Identify the approximate electrical demand and willingness to pay for electricity in the rural villages;
- Continue to develop deal flow for Developing Power.

The expectation is to find local partners that have social missions for electrifying rural areas or improving development in isolated regions. Many organizations around the world exist with these missions, but it is imperative to find a credible and reliable local partner that understands energy. Based on initial progress working with potential partners including Winrock International and E+Co (and their partners), these expectations seem realistic in Brazil and elsewhere (see section 3.1 Strategic Partnerships). In particular, E+Co has already established partnerships with both Instituto de Desenvolvimeinto Susentavel Energies Renovaveis (IDER) and Instituto Eco-Engenho (IEE), organizations specializing in renewable energy with a mission to assist in bringing new technologies to rural areas in Brazil. Through our special relationship with E+Co, Developing Power will have access to these local partner resources. There are 22 NGOs with similar missions in all of Brazil (Winrock 2002).

In exchange for partnering with Developing Power, equity stakes in the company will be considered as compensation. Developing Power is asking for $25,000 to further research potential partners in Bahia, Brazil and to develop a local partnership implementation manual.

2.2.2 Hybrid System Design and Construction

As previously described, Developing Power will use the HOMER model to determine the most cost-effective optimal solution for each particular village. In order to provide the most accurate information into the model, resource tests and end-use surveys will need to be conducted to correctly model the system. As part of the partnership study (asking for $25,000), Developing Power will further research how the capabilities of local partners can assist in completing these assessments if needed. While expensive and precise measurements are possible, it is not expected that Developing Power will invest heavily into resource measurement in order to keep the system costs down. Since the model has the flexibility to add statistical variation to account for lack of precise data, most of the resource variability is accounted for in the design.

The construction of the system will mainly use local labor with equipment shipped from the United States. There are multiple vendors in the U.S. and U.S. equipment would qualify the company to take advantage of favorable financing from the EX-IM Bank (see Section 5). Diesel generators, wiring, poles, and basic power equipment will probably be sourced locally to reduce costs. In most cases, it is expected that diesel microgrids will already be installed, but the system will need to be upgraded (built into cost projections for example village). **The expected time from sale of project to completion is 2 years.** The financial model assumes that 60% of the construction will occur in the first year and 40% will occur in the second.

2.2.3 Energy Service Company

Developing Power will establish an Energy Service Company (ESCO) in each rural village. ESCOs are responsible for maintaining and operating the microgrid power system. Responsibilities include: monitoring and supplying diesel fuels, starting diesel generators, lubricating wind turbines, maintaining batteries, and general troubleshooting. The expectation is to train local technicians such as radio repairmen or local mechanics that are already familiar with basic operation of mechanical equipment. There is ample evidence that finding willing and capable employees will not be a limitation for the business model (based conversations with NREL and own experiences in rural villages). The ESCO model has worked successfully for hybrid systems in multiple rural environments including in Indonesia, Mexico, and India. The expectation is that local NGO partners involved in improving economic development and rural employment will assist with funding training expenses in order to support the creation of the new jobs associated with the ESCO.

Developing Power will deliver functioning and established ESCOs to the eventual owner of the system. As part of the partnership identification study, Developing Power will attempt to further define the role of ESCOs and how potential partners can support ESCO creation.

2.2.4 Payment Collection

A central component of the Developing Power model is the use of a system of smart cards and meters to manage and collect payment for electricity service. According to Rob Walt at Community Power Corporation, “having used a pre-payment system in Indonesia, I cannot imagine doing any future rural electrification project without pre-payment and electricity meters.” Failures of previous rural electrification projects to adequately incorporate cost-recovery mechanisms and payment for service have led to three main conclusions:

- Pre-payment reduces collection risk for the owner of the system.

- Payment flexibility is highly desired in the developing world, and pre-payment systems allow users to pay when money is available.

- Pre-payment and electricity meters are needed to manage electricity load.

Developing Power will use smart cards to hold payment information. Smart cards are plastic cards with a built-in microprocessor designed to digitally record information. When run through a device such as an electricity meter, an electronic reader on the smart card transfers information on the card to the device. Both the smart cards and related meters are difficult to tamper with and come with tamper-resistant safeguards (device shuts down when cover is removed). In 2001, 685 million smart cards were shipped for consumer use globally, and are being used in a variety of pre-pay scenarios including toll-ways and gas stations (Schwartz 2002). Smart cards cost approximately $4 each according to recent estimates. The entire pre-payment system for a village of 500 people is expected to cost about $20,000 including cards, meters, and charging devices.

For Developing Power systems, each electricity customer will own a smart card, which can be “charged” with electricity pre-payment. When the card is swiped through the meter in the household, the electricity units (kilowatt-hours) are then displayed on the meter and exhausted as electricity is used. When there are a limited number of electricity units left, the meter will flash a small light, indicating that the consumer needs to add more units to the smart card. When all the units are exhausted, the meter will stop electricity from being delivered to the customer. Developing Power is currently working with Motorola to supply the modules that will be used in projects.

Three means for pre-payment collection will be considered. All three methods will use a personal digital assistant (PDA) device to “charge” the smart card with electricity units (see Figure 2.4.3). Method 1 is for microfinance agents that serve the community with financial services to operate the PDA and charge smart cards in exchange for payment. Microfinance Institutions (MFIs) are one of the fastest growing industries serving rural markets with financial solutions. Many MFIs are starting to use PDAs and smart cards to manage loans (i.e. SKS India and Prodem). Communication with leading MFIs indicates that adding electricity payment collections as an additional financial service of MFIs is a practical and desirable option (conversations from the Microcredit Summit 2002). The risk of this method is that community members might not have the necessary access to MFI agents to charge the smart cards when it is convenient, depending on the local presence of the MFI.

Method 2 is for the ESCO to manage the payment collection. In addition to maintaining the electrical system, the ESCO staff would also be responsible for charging the smart cards at the ESCO office.

Figure 2.4.1 Pre-Payment Meter

Figure 2.4.2 Smart Card

Figure 2.4.3 Smart Card Reader

Method 3 is for a local storeowner or entrepreneur in the community to use the PDA to charge smart cards. This method is desirable because it maximizes the flexibility of payment for community members. For each method, the data in the PDA will be downloaded into a computer and managed in a database. Table 2.4.1 shows the benefits and drawbacks of the three methods under consideration. The method ultimately used will be determined based on which method is deemed most viable in the feasibility analysis and given the specific needs of the community.

Table 2.4.1: Methods for Payment Collection

Method/Benefits	MFI	ESCO	Storeowner
Payment Flexibility	Low	Medium	High
Control of Cash	High	High	Low
Control of Database	High	High	Low

The long-term objective is for the smart cards used for electricity pre-payment to also be used for pre-payment for other services such as clean water, telephone access, and Internet use. It is possible that smart cards and palm PDAs can be programmed to charge access to these other services if available. Through partnering with MFIs and microenterprise development organizations, these options will be explored once the electricity system is fully implemented.

2.2.5 Sale of System

The sales strategy is to make long-term operation of Developing Power systems appealing to a range of potential owners in order to reduce risk for investors. Possible owners are utilities (especially in concession territories), microfinance institutions, partnering non-governmental organizations, and community members. The preferred approach is to sell systems to a utility in a concession area. Concessions are bid contracts to serve electricity to an entire region within a certain period of time. These utilities are looking for cheaper ways to electrify mandated territories. According to Winrock International’s Brazil office, “In general, this unattended potential consumer market [in Brazil] is spread over isolated and sparsely inhabited areas, presenting little attraction as business opportunities for concessionaries. If the traditional means of electrification were to be carried out, that is, by extension of the grid, the investment required to attend these localities would be enormous compared to the revenue that would be generated by the tariffs on their consumption."

The strategy is to contract with the utility **prior to project execution** for an agreed upon price. Conversations with NREL indicate that this strategy is viable if the economics can be justified (as shown previously). In Brazil for example, recent laws (2003) give incentives for renewable energy and rural electrification. According to the law, "producers of small hydropower, wind, biomass and solar may commercialize energy directly with a consumer or consumer group, whose load is equal or greater than 50 kW within the isolated systems," which is the case for most Developing Power systems.

A second sales strategy is to sell the project to a partnering organization. The most likely candidate is a partnering microfinance organization. As MFIs grow their portfolios and look for new areas of growth, they are likely to consider acquiring assets related to their areas of expertise. In this case, it would be a logical and easy transition for a MFI that is already collecting payment to buy out Developing Power's stake through an LBO. Multiple microfinance institution representatives that we have talked with have confirmed this strategy. Tom Miller, a board member for Parwaz—a microfinance company operating in Afghanistan—has already demonstrated interest in linking Developing Power with Parwaz in rural areas of the country and Developing Power is currently working to collect preliminary modeling data (see Appendix 2 for a letter of interest).

Other ownership options include partnering NGOs and community members. It is expected that a limited number will be able to afford the large capital expenditure of a system. However, in Brazil, a new law established in April 2002 to promote universal electrification requires concessionary utilities to fully refund rural customers for the cost of installing their own systems if the utility does not provide service in a pre-determined timeframe.

The expected development fee for the design and construction of a typical microgrid is $100,000 (assuming an average size of 100 kW per project as in example discussed in section 2.1.1).

3. Market Entry

3.1 Strategic Partnerships

In order to effectively enter the market with a pilot project, Developing Power has spent that past two years building relationships and partnerships with key organizations supporting rural electrification on a global basis. We are seeking $25,000 to fund continued development of relationships with local partners and $400,000 in grants to implement a pilot in order to prove the concept viability. Developing Power has made considerable contacts in the industry; Table 3.1 summarizes our current relationships with the main potential partners:

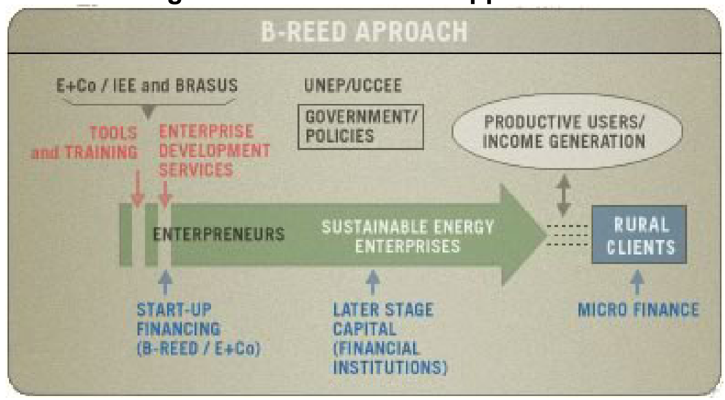
Table 3.1 Summaries of Main Initial Partnership Building Efforts

Potential Partner	Partner Description	Status of Relationship
E+Co	E+Co is the premier rural energy investment company in the world. E+Co assists in getting businesses off the ground with early stage risk capital to the entrepreneur and has funded over 70 energy projects in more than 20 countries (mainly Central America, Africa, Asia).	Through the University of Michigan, we have worked with E+Co for the past year writing a case study on the company; the study will appear in the forthcoming book "Innovations at the Bottom of the Pyramid" by C.K. Prahalad. E+Co has expressed interest in providing a $150,000 loan as part of their B-REED Program in Brazil (see Appendix 2).
Solar Development Group (SDG)	SDG provides business development support and investment to companies with high growth and profit potential that provide photovoltaic (PV) and other energy sources to off grid rural areas in developing countries.	SDG has indicated initial interest in making an investment in Developing Power based on the business plan (see Appendix 2).
Winrock International	Winrock International is a nonprofit organization that works with people around the world to increase economic opportunity, sustain natural resources, and protect the environment.	Developing Power's key advisor Todd Bartholf is a former Senior Program Officer for Winrock and has access to a large base of contacts. Specifically, Developing Power has been working with the Winrock Office in Bahia, for the initial pilot project.
Baixo Santa do Alto Glória (BSAG)	BSAG is a not-for-profit NGO which supports cultural, educational, and community development in Brazil.	Mary Catherine Smith is a partner in Developing Power and has a large contact base in Brazil through over 27 years living and traveling in Brazil.
Instituto de Desenvolvimeinto Susentavel Energies Renovaveis (IDER)	IDER is an E+Co local partner working in the northeast of Brazil to promote integrated sustainable development using renewable energy resources.	We have only had initial dialogues to understand the basic capabilities of the local partner.
Energy and Security	Energy and Security works towards the commercialization of renewable energy technologies in over 60 countries worldwide.	We have had various conversations with the founder Judy Siegel, who has over 25 years experience in the field. She is interested in working with Developing Power to implement a pilot in India.
Parwaz	Parwaz empowers entrepreneurs in Afghanistan to rise from poverty by enabling them to build viable businesses, increase their income, and to become economic change agents.	Parwaz is developing a socially responsible microlending investment fund and has expressed initial interest in working with Developing Power to implement a pilot project in Afghanistan (see Appendix 2).
National Renewable Energy Laboratory (NREL)	NREL is a governmental agency focused on the development and deployment of renewable energy technologies.	NREL's current capacity with Developing Power is to assist with model development in HOMER. NREL is active in Brazil and there may be the potential for future joint-development of projects based in initial conversations.

The B-REED Program

The B-REED Program, or the Desenvolvimento de Empresas de Energia Rural no Brasil, is a rural energy development program targeted for the northeast of Brazil and supported by E+Co and the United Nations Environment Program (UNEP). B-REED provides assistance to entrepreneurs to build successful businesses that supply clean energy technologies and services to rural Brazilian customers. B-REED's services include training, hands-on business development assistance and, for promising businesses, early-stage investment and assistance in securing financing. **Developing Power's pilot project would fall under this program.**

Figure 3.1: The B-REED Approach



3.2 Pilot Project in Bahia, Brazil

To implement the proposed business model, Developing Power is targeting the northeastern state of Bahia, Brazil. Compared to other markets globally, Brazil represents a unique opportunity given the country's recent dedication to "universal electrification." The Government of Brazil considers universal access to safe, affordable energy a central component in its fight against inequality and rural poverty and has announced a **goal to electrify the entire country by 2005**. Driving this reform is an electricity crisis in 2001 when a drought year severely limited the country's hydroelectric capacity (90% hydroelectric) and a financial crisis that halted private investment in energy. To support rural electrification, electricity reform laws of 2002 are opening up the market for serving off-grid areas by 1) allowing private companies to operate in concession areas (called "permissions"), and 2) giving financial subsidies for the use of renewable energy technologies (PROINFA legislation—source: Winrock Trade Guide on Renewable Energy in Brazil, 2002).

About 59% of all rural households in Bahia are not connected to the grid, or about 635,000 households in 17,500 villages (ESMAP 2000). At current grid extension rates of 10,000 households per year, to electrify all 635,000 households would take 63 years and the costs would be astronomical. It is estimated that of the 17,500 villages without access to the grid, about 15,111 have some sort of electrical supply (diesel microgrids or batteries) and about 2,389 villages have no electricity (ESMAP 2000). Developing Power is targeting larger villages (>40 households) that are at least 30 km from the grid. Based on data from the World Bank, it is estimated that 223 villages meet this criteria in Bahia (see Table 3.2). Developing Power expects to upgrade existing power systems with renewable energy to provide 24-hour electricity to 25 of these 223 villages in 5 years.

Table 3.2: Unelectrified Village Size and Grid Distance Distribution in Bahia Brazil

Village Size \ Distance to Grid	< 5 km	5-15 km	15-30 km	> 30 km	Total # of households
< 20 households	5,431	1,810	905	905	9,051
20-40 households	2,304	768	384	384	3,839
40-100 households	759	253	127	**127**	1,265
> 100 households	573	191	96	**96**	955
Total # of households	9,067	3,022	1,511	1,511	15,111

The average income in Developing Power's target villages is about $3,000 per person. Expected customers are farmers and livestock owners that are looking for electrical power for irrigation, electric fencing, running machinery, and operating various appliances. The average expenditure for current forms of energy (kerosene, diesel, batteries) in Bahia is $10-$15 per month per person. Initial research in Brazil and previous studies indicate that they would be willing to spend more for higher-quality electricity from a hybrid system. It is also expected that a pre-payment system for electricity will not be a foreign concept given that **75% of rural telephony is through pre-pay**.

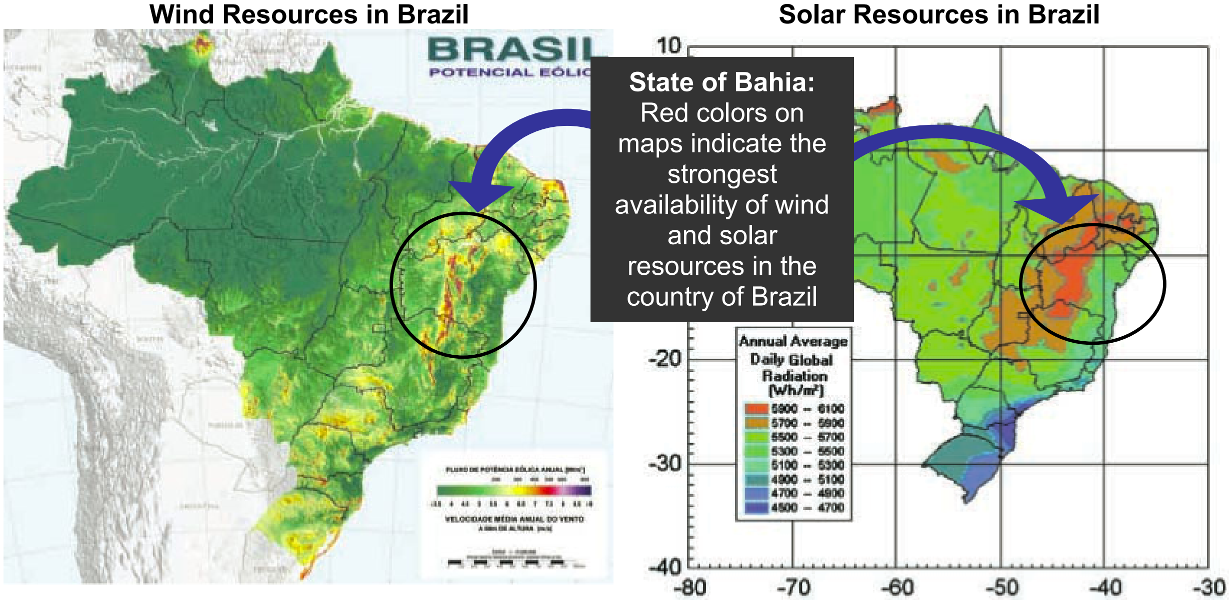
The target region of Bahia is the western part of the state because:

1) Most of the unelectrified villages are in the western region
2) The best solar and wind resources **in Brazil** are found in the western region of Brazil.

We are working with E+Co and its local partners to identify specific villages in this region. As part of the partnership identification study, we will determine which partners in the region will be suitable for conducting initial data gathering and the extent of microfinance partners in the region.

Figure 3.2 Wind and Solar Resources in Brazil (Bahia has the best solar and wind in country)

Wind Resources in Brazil **Solar Resources in Brazil**



3.3 Electrification Plan

After the initial pilot project, the strategy is to complete 25 projects by year 5. Working with local partners, Developing Power expects to expand project development by about 3-5 projects per year. Projects will take approximately 2 years to complete. This estimate is conservative because short construction time is one of the distinguishing characteristics of distributed generation because the smaller sizes and simplicity of system design are less prone to construction risks. Most large wind projects are installed in 3-5 months for example. However, the conservative two year estimate takes into account potential delays associated with working in rural conditions.

The expectation is to start with three executives and bring on 2-3 people into the company by year 5. Currently, the company is seeking a Chief Engineering Officer to specialize in system design and equipment procurement.

Table 3.3: Expected Timeline for Project Development

	Year 1	Year 2	Year 3	Year 4	Year 5
Number of projects undertaken	1	2	4	7	11
Cumulative number of projects completed	1	3	7	14	25

4. Competition
Although hybrid systems are a relatively new concept, there could be imitation and competitive threats in the rural electrification market. Potential threats could include 1) rural electrification companies (section 4.1), 2) non-governmental organizations and governmental agencies (section 4.2), and 3) governments and domestic utilities (also our customers—section 4.3).

4.1 Rural Electrification Companies
There are relatively few companies based in the United States and internationally that are dedicated to rural electrification in developing countries. In most cases, each company operates in a specific country or region and only achieves modest penetration. These companies can be categorized into four groups with different business models (Table 4.1).

Table 4.1: Rural Energy Business Models

Business Model	Affordability	Down Payment /Connection Fee	System Ownership
Cash sales of equipment	Low	Full cost at purchase	User
Credit sales of equipment	Low	High	User
Lease-to-own	Moderate	Moderate	User (at end of lease)
ESCO	High	Low	ESCO

Source: Solar Energy International (2002), Fraunhofer ISE/ISES Rural Energy Supply Models RESuM

Table 4.2: Rural Electrification Companies

Company	Model	Technology	Region of Focus	Penetration
Soluz, Inc.	Mainly fee-for-service rental, and also cash and credit sales	PV-Solar Home Systems	Dominican Republic and Honduras	6,000 households
Solar Electric Light Company	Mainly fee-for-service rental, and also cash and credit sales	PV-Solar Home Systems	India, Vietnam, Sri Lanka	15,000 households
Community Power Corporation	ESCO	Biomass, wind, hybrid systems	Asia, Philippines, USA	Approximately 2,000 households
Lotus Energy	Cash and credit sales	Mainly PV	Nepal	Approximately 10,000 households
Grameen Shakti	Cash and credit sales	Mainly PV	Bangladesh	6,000 households

4.2 Non-Governmental Organizations and Governmental Agencies
Rural electrification has been a high priority for non-governmental organizations, development assistance organizations, and government agencies (developed countries) for a long time. In contrast to rural electrification companies, these entities are generally global in scope and emphasize the social benefits of electricity and renewable energy. Significant entrance into the market by NGOs offering “free” or highly subsidized systems can ruin the market if utilities or governments feel NGOs are working on the problem.

The main non-profit organizations and government agencies that have historically supported rural electrification projects in developing countries include: Solar Electric Light Fund, Winrock International, Energy Sector Management Assistance Programme (World Bank/UNDP), Intermediate Technology Development Group, National Renewable Energy Laboratory, Sandia National Laboratory, and USAID. Developing Power has established relationships with many people at these organizations over the past three years and most organizations are fully supporting private sector involvement in rural electrification.

4.3 Governments and Domestic Utilities
The main suppliers of electricity to rural areas of developing countries are domestic governments and utilities. They can be considered both a competitor and a customer. Currently, the grid extension rates are far below the level of people demanding electricity, leaving a large population to be served by Developing Power projects. To the extent that utilities learn how to service rural communities with distributed generation, there could be a potential to erode Developing Power's competitive advantage. However, as Developing Power grows, the expectation is to expand into new markets to replicate the model, reducing this risk.

5. Financial Analysis
The financial model is based on the assumption of selling systems averaging 100 kW in size. As presented in the example in Section 2, each 100 kW system would provide revenue of about $300,000 with capital expenditures of $200,000. This represents an **average size village** but we will target the largest villages possible to take advantage of economies of scale. However, if the company is unable to start with larger villages, the expectation is that a greater number of smaller projects will be undertaken. Therefore, we believe that these projects represent a slightly conservative picture with more potential upside for investors.

Developing Power is looking to fund the first project through a grant of $400,000. Subsequent projects will be leveraged at approximately 80% debt. Debt is expected to come from various sources, but the most likely candidate is the U.S. EX-IM Bank. Based on relationships we established with the EX-IM bank through GE Wind Energy, we know that **EX-IM is very interested in financing renewable energy projects in Brazil (at favorable rates of 6%).** They are willing to finance 80% of the project given that 80% of the sourcing is from the United States, which is the case for Developing Power projects.

Table 5.1: Sources of Funds from Year 1 through Year 6

Year	Grant Financing	Debt Financing	Equity Financing	Potential Sources
Year 0	$25,000			**Grants:** Business plan competitions, corporate philanthropy
Year 1	$400,000			**Grants:** USAID, GEF, SDF
Year 2		$300,000	$200,000	**Debt:** EX-IM, E+Co (B-REED) **Equity:** Angel Investor
Year 3		$400,000	$200,000	**Debt:** EX-IM, E+Co (B-REED) **Equity:** Angel Investor
Year 4		$600,000	$100,000	**Debt:** EX-IM, E+Co (B-REED) **Equity:** Angel Investors, EEAF, SDG
Year 5		$400,000		**Debt:** EX-IM, BNB, BNDES **Equity:** Angel Investors, EEAF, SDG
Year 6		$200,000		**Debt:** EX-IM, BNB, BNDES **Equity:** Angel Investors, EEAF, IFC
Total	**$425,000**	**$1,900,000**	**$500,000**	**Total: $2,825,000**

Grants: The company projects to utilize public grant money to fund a feasibility study, to fully fund a pilot project, and to subsidize initial market entry in Year 1.

Developing Power is targeting multiple sources of funding for the initial pilot project including:

- Corporate Foundations: There is a large amount of grant money available from corporations looking to support various philanthropic missions. Specifically, we are targeting electric utilities including American Electric Power and DTE, which would be interested in supporting projects with renewable energy that reduce greenhouse gasses.

- U.S. Trade and Development Agency: USTDA supports projects that both foster U.S. exports and support development work in developing countries. USTDA has historically been a large supporter of renewable energy projects in the developing world.
- Global Environment Facility: in the process of applying for a $50,000 grant from the Small Grant Programme.

Debt:
The expected sources of debt include:

- The Export-Import Bank (Ex-Im): Ex-Im Bank provides a level playing field for U.S. exporters by countering the export credit subsidies of other governments. It also provides financing to creditworthy private and sovereign foreign buyers when private financing is unavailable.
- E+Co: E+Co has indicated an interest in providing seed capital in the form of debt ($150,000) for Year 2 through the B-REED initiative (see Appendix 2); E+Co has also suggested that debt would be available in Year 3 and is conditional on the previous year's success;
- Banco do Nordeste (BNB): BNB is the development bank of the Northeast of Brazil, providing support for infrastructure and social development projects. BNB has a specific credit line (Nordeste Energia) for the purpose of energy infrastructure for productive uses and energy efficiency;
- BNDES: BNDES is the national developmental bank of Brazil, with an annual budget of approximately R$25 billion. BNDES is the only true source of long-term capital in Brazil, providing commercial loans in local currency with tenors of up to about 10 years, and maximum grace periods of approximately 2-3 years.

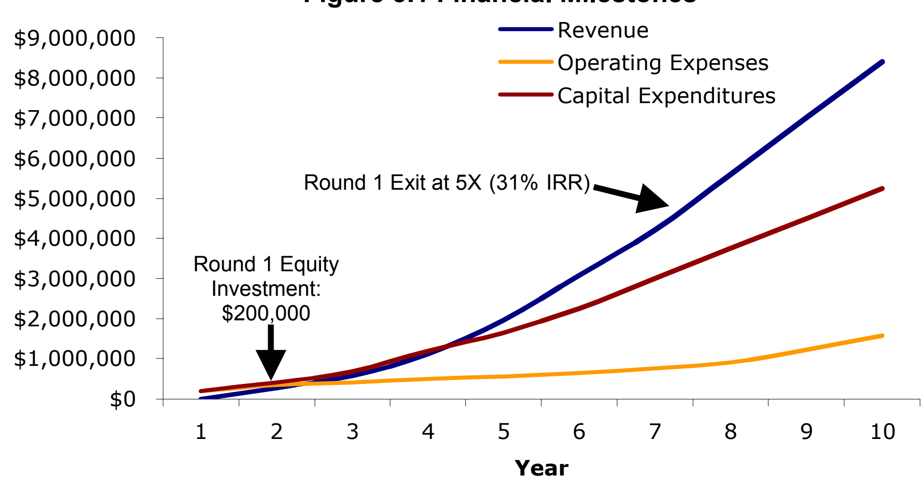
Equity: Equity is required to expand project development. The first equity investment is scheduled for Year 2 and continued investments are predicted to continue through Year 4.

The expected sources of equity include:

- Angel investors: There are a select group of private angel investors that have indicated interest in investing in Developing Power.
- Environmental Enterprise Assistance Fund (EEAF): EEAF is an investment fund for renewable energy projects. The financing available varies between US$100 thousand and US$750 thousand in loans, stock shares, or both.
- Solar Development Group (SDG): A branch of EEAF, the Solar Development Group provides growth capital, in the range of US$100,000 to US$2,000,000.
- International Finance Corporation (IFC): The IFC invests in private ventures in developing countries by offering equity financing and loans without government warranties, in collaboration with investors. It finances up to 25% of a project's cost in several ways, depending on its needs.

The target return for equity investors is 5X in six years, representing a 31% IRR. Figure 5.1 shows the expected revenue, operating expenses, capital expenditures, and return to equity investors.

Figure 5.1 Financial Milestones



6. Risks

The first risk is finding the right local partner to assist Developing Power in entering the market and contracting with COELBA, the electric utility in Bahia. In order to mitigate this risk, Developing Power is seeking $25,000 to conduct a complete feasibility study to determine the most appropriate local partner and to advance discussions with COELBA. This will give a good idea whether or not the assumed feasibility of Bahia as an initial target market is appropriate. E+Co is spearheading much of this effort through their office in Bahia and has already engaged in multiple rounds of discussions with government officials and utility representatives to facilitate market entry from private energy entrepreneurs in Brazil.

The second risk is insuring a smooth transition of projects to eventual owners. When Developing Power gives up control of the project, the next owner may not be as effective managers, threatening the credibility of the model. The hope is to establish a well-functioning ESCO that needs little outside assistance and to work closely with the eventual owners, utilities or microfinance institutions, in an overlapping way to ensure the sustainability of the project from both a financial and social perspective.

A third risk is that people's electricity use becomes highly unpredictable with higher quality power, making the system more susceptible to disruptions. Most of these variances are accounted for in the original model design however, so this problem is expected to be minimal. Other risks that exist related to the system model include unexpected changes in input prices, affecting the economic viability of the optimal system. For example, unexpected governmental subsidies for diesel fuel might make solar and wind technologies look less feasible than initially modeled.

A fourth risk is financial exchange. The time between a contract signing and the actual sale may be multiple years. To manage this risk, Developing Power will utilize hedge instruments when appropriate. However, the objective will be to sell projects as close as possible to completion of construction.

7. Social Impact Analysis

Just a small amount of electricity can change the lives of poor people. Because the basis of Developing Power's value proposition is breaking the cycles of poverty through electricity and capacity building, quantifying and continuing to measure the social and environmental impacts of Developing Power projects are a significant component of the organization.

The primary benefits from access to electricity include improved education, human health, communication and entertainment, comfort, protection, convenience, and productivity. Until recently, the magnitude of these benefits has not been well documented. The goal of this Social Impact Analysis is to develop a methodology for quantifying these benefits from access to electricity. This methodology will then be applied to estimate the benefits from Developing Power projects in Bahia, Brazil.

Developing Power expects to electrify **75,000 people in 10 years**. Because most of the studies used to estimate benefits are on the household level, we make the assumption that there are 5 people per average household, resulting in 15,000 households that will be served with energy in 10 years. In summary, this results in over **$24 million in social and environmental benefits**. For every $1 invested in a Developing Power project there is an average of $1.5 in social and environmental benefits.

7.1 Assumptions

- The benefits assessed in the analysis are grouped into education and earning potential, productivity, the environment, communications and entertainment, and human health. To avoid double-counting of the benefits from access to lower-cost lighting, it is assumed that lighting benefits are reflected in the above measures.
- The estimates presented are for villages that previously did not have electricity, where the benefits represent the incremental benefits of acquiring access to electricity compared to the baseline of kerosene and batteries.
- Many of the benefits are based on a groundbreaking study from the World Bank entitled, "*Rural Electrification and Development in the Philippines: Measuring the Social and Economic Benefits* (Barnes 2002), which quantifies the social benefits to households with electricity versus those without electricity,

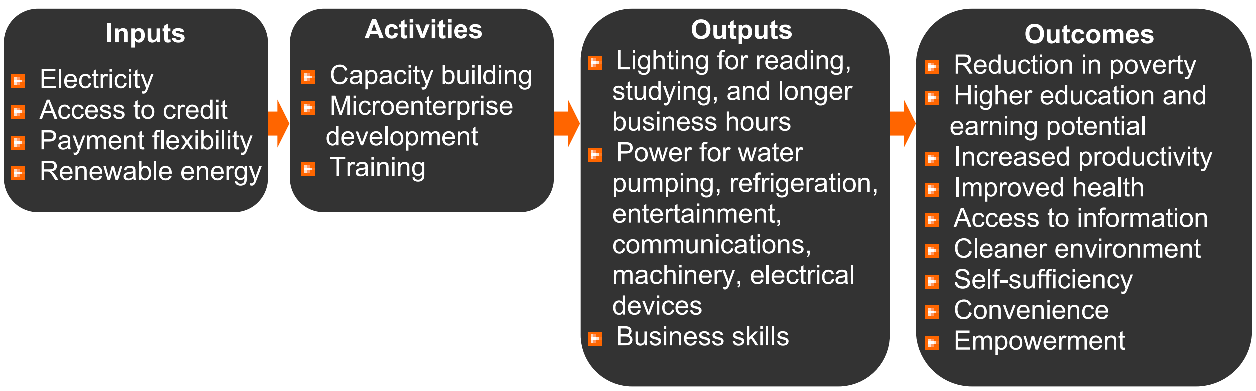
based on a survey of 2,000 households in the Philippines. In the Social Impact Analysis for Developing Power, average income is used as a proxy to adjust the benefits in the Philippines study to the potential benefits of electricity in Bahia, Brazil. The average monthly income in rural areas of Bahia, Brazil is $225, and the average monthly income of the households in the Philippines study is $177; therefore, the benefits presented in this analysis are scaled up 27% to better approximate the probable benefits in Bahia.

- The benefits are quantified for 10 years because the expectation is that the villages electrified through Developing Power will not likely receive grid connection over that time period.
- Social and environmental benefits are discounted at the weighted average cost of capital, reflecting the opportunity cost of the projects not being undertaken.

7.2 Social Benefits

Electricity in rural villages is used for various applications, the foremost being to power electric light bulbs for illumination. The intermediate outputs from the use of electricity are improved services, which are predicted to result in the intended social benefits of the electricity system, such as improved education and productivity. Figure 7.1 shows the relationship between electricity access and the services it can provide to increase social welfare.

Figure 7.1: Potential Outcomes of Improved Energy Services in Alleviating Poverty



7.3 Education and Earning Potential

One of the most effective ways to improve education and earning potential is to utilize electric light to increase the ability to study or read at night. In the Philippines study, households with electricity believe that their children study more during the evening hours than do households without electricity, and 97.7% of all households either agreed or strongly agreed with the statement, “having electricity is important for children’s education.” Surprisingly, more than 70% of the surveyed households with electricity also expect their children to attain a college education.

The dominant source of lighting in the developing world is a kerosene lamp, which provides one-tenth to one-fiftieth of the light from a light bulb. Of the 2,000 households surveyed, 91% believed that reading was easier with electric light compared to kerosene.

After controlling for factors such as income, housing type, and price of energy, the Philippines study estimates that a child in an electrified household reads or studies *48 minutes longer per day* than a child in an unelectrified household. And electric light increased reading by adults an average of *15 minutes per day*. The study also indicates that members of electrified households attain about two years more formal education than their non-electrified counterparts.

The most direct benefit of a higher education is the ability to earn a greater income. In this analysis, the benefits are not expected to be fully realized until *five years* from the installation of the system, because the effects of increased education and earning potential do not accrue immediately. The actual timing of the benefits should be determined based on the specific age profiles of the households, but five years represents a realistic average. Scaling the benefits to Bahia, wage earners in households with electricity are estimated to earn between **$53 per month per household** more than their counterparts without electricity. The assumption is three wage earners per household.

7.4 Productivity

Approximately 20% to 30% of people in the developing world operate a business from their home, and the use of electricity for electric lighting and mechanical devices can significantly enhance the productivity of home businesses or microenterprises. The Philippines study indicates that with electricity, small businesses typically operate *two more hours per day* compared to businesses without electricity. Scaling the estimated benefits to Bahia, Brazil, a business in a non-electrified household could potentially increase its income by **$34 per month per household** with access to electricity.

Electricity also saves time spent on cooking, cleaning, collecting firewood, fetching drinking water, and various family chores. The Philippines study estimates that households save approximately one hour of time per day through the use of electricity. Assuming that the opportunity cost for time used for these purposes is income generation, the value of the time saved per household is approximately **$23 per month per household**.

7.5 Environment

The benefits to the environment from Developing Power projects are from two main sources: 1) reduction in CO_2 from the use of renewable energy, and 2) reduction in the improper disposal of batteries.

A Developing Power hybrid system can provide approximately 63% of the total generated power for a village from renewable energy. The other 37% of the power generated is from the diesel genset, which results in 8.41 tons carbon per year (from HOMER output). This is equivalent to 30.8 tons CO_2 (8.41*44/12 = 30.8). The average annual CO2 emissions from kerosene lighting in most rural households is 0.3 tons of CO2 per household (Nieuwenhout 2000). Assuming that the electrical system displaces all of the kerosene use in the village, then approximately 60 tons CO_2 from kerosene would be avoided (0.3*200 households). On net, a Developing Power system would then reduce CO_2 emissions in half from the baseline of kerosene, and would avoid a total of 30 tons CO_2 per year. There is a wide range of estimates for the marginal damage of a unit of CO_2, but most estimates fall between $3 and $7 per ton CO_2 per year (Tol 1996). Assuming $5 marginal damage per ton CO_2, a Developing Power project would **avoid $150 of environmental damages (climate change) per year**.

Approximately 10% of unelectrified areas of developing countries use car batteries to power small electrical appliances such as lights, television, and radio. Because this type of battery was not designed for small discharges, these activities reduce the useful life to about 1.5 years. Consequently, there are high rates of battery disposal, which often means dumping them in the local river. The assumption is that car batteries and improper disposal will be avoided with electricity from Developing Power; however, the discrete benefits to the environment need to be determined on a village-by-village basis.

7.6 Communications and Entertainment

People's desire for information is reflected through the high demand in the developing world for radio, television, and the Internet. Because there is already use of these devices in the developing world through batteries, which are extremely expensive on a kWh basis, it is possible to estimate the value of expanded and lower cost electricity from a hybrid system in place of batteries. Table 7.1 shows that households with electricity from a Developing Power hybrid system receive expected communications and entertainment benefits of **$5.56 per month per household,** through the use of cheaper electricity. These benefits are likely to be *underestimated* because they do not capture the excess consumer surplus under the demand curve that is expected from increased demand from cheaper access to electricity.

Table 7.1: Communications and Entertainment Benefits from Cheaper Electricity

Electrification Status	Hours of radio listening per month (10W radio)	Hours of TV viewing per month (50W TV)	Total cost per month (radio and TV)	Total benefits for having electricity
Household with electricity	60	30	$0.74[1]	**$5.56 per month per**

Household without electricity	60	30	$6.30[2]	**household**

1 Sum of radio and TV use assuming $0.35 per kWh; (60*0.01*0.60)+(30*0.05*0.60)=$0.74
2 Sum of ratio and TV use assuming $3 per kWh; (60*0.01*3)+(30*0.05*3)=$6.30

7.7 Human Health
The provision of electricity to rural villages in developing countries can result in multiple benefits to the health of community members. The main health benefits include 1) the avoidance of diseases or death from the ability to store vaccines through 24-hour refrigeration, 2) the ability to pump and purify water for drinking and use in medical clinics, 3) improved lighting and use of equipment (i.e. microscopes) in medical clinics, and 4) reduced incidents of injury from explosions of kerosene lanterns. Although some of the most important energy-related health benefits occur through improved cookstove design which reduces indoor fume inhalation, Developing Power does not specifically provide this option as part of the original business proposition of electricity service. There is the potential for households that are using these options to upgrade to small two-ring electric stoves, but it is unclear whether this option will be realized.

Measuring health benefits is difficult for rural villages in the developing world, and it does not appear that a thorough evaluation has been completed to estimate the discrete benefits from access to electricity. The Philippines study was also not able to estimate specific health benefits, although it noted marginal differences between the number of days missed from work and self-reported illnesses between electrified and unelectrified households. However, to capture some sense of the possible health benefits that might result from a Developing Power project, estimates are taken from a World Health Organization (WHO) study, *Addressing the Impact of Household Energy and Indoor Air Pollution on the Health of the Poor* (2002), which shows the predicted benefits from an improved cookstove program in Guatemala. Benefits from the WHO study are used as a proxy for the benefits to households from access to electricity. This assumption is supported by the statistic that there are about the same number of premature deaths from indoor air pollution as there are from unsafe drinking water, on a global basis. The expectation is that villages electrified by Developing Power will acquire water purification systems, but on average, they will not be operational until *three years* after the system is installed. Because income data was not presented in the study, the assumption is that the benefits achieved in Guatemala are the same as would be achieved in Bahia—approximately **$75 per household per month**. It should be noted that these estimates are a best approximation of the health benefits from access to electricity, and Developing Power will attempt to measure discrete benefits once power systems are in operation.

7.8 Qualitative Benefits
Other benefits of electricity, which are more difficult to quantify but result from rural electrification projects, include greater levels of comfort, protection, and convenience. Access to credit through microfinance institutions has also shown to improve knowledge of health and nutrition, empower women, and institute financial skills among customers. Whether realized within the home or in the community, these qualitative benefits may result in higher levels of confidence and peace and should not be disregarded. However, contingent valuation studies could not reveal a discrete willingness-to-pay for these benefits.

7.9 Evaluation of Social Benefits and Costs
Evaluation of the social impacts of Developing Power projects is grounded in traditional cost-benefit analysis (CBA) to calculate a Benefit-Cost Ratio and a Blended Value. The total benefits are defined as the incremental social and environmental benefits over the next best alternative: in this case, the benefits of having electricity from a reliable source (hybrid system) versus the use of kerosene and batteries for energy. The total costs are represented as the sum of the total operating expenses and capital costs to implement Developing Power projects (taken from the income statement). A ratio of the net present value of the social and environmental benefits to the net present value of the project costs determines a benefit-cost ratio. A value greater than one reflects a net increase in the overall benefits to society from undertaking the projects. The discount rate assumed in the analysis is 10.3%, or the weighted average cost of capital. The results from the estimated benefits indicate that for every $1 invested in a Developing Power project there are an average of $1.5 in social benefits.

Figure 7.2 Social Return on Investment

Social Return on Investment
(in $1,000 USD)

	Year 1	Year 2	Year 3	Year 4	Year 5
Number of Projects	1	2	4	7	11
Cumulative Number of Projects	1	3	7	14	25
Cumulative Number of People Served	100	300	700	1,400	2,500
Social and Environmental Benefits					
Education and earning potential	$0	$0	$0	$0	$127
Communication and entertainment	$7	$20	$47	$93	$167
Productivity in home businesses	$12	$37	$86	$171	$306
Productivity in households	$28	$83	$193	$386	$690
Human health benefits	$0	$0	$90	$270	$630
Environmental benefits	$0	$0	$1	$2	$4
Total Social and Environmental Benefits	$47	$140	$416	$921	$1,920
Operating and Capital Costs	$0	$0	$0	$0	$0
Total operating expenses	($198)	($334)	($405)	($508)	($609)
Capital expenditures	($120)	($320)	($640)	($1,160)	($1,786)
Total Operating and Capital Costs	($318)	($654)	($1,045)	($1,668)	($2,395)
Social Purpose Benefit Flow	($271)	($514)	($629)	($747)	($475)
Discount rate	10.29%				
NPV of Social and Environmental Benefits	**$24,628,180**				
NPV of Project Costs	**$16,186,343**				
Benefit-Cost Ratio	**1.5**				
Social Purpose Value	**$8,441,837**				

Blended Value, a metric developed by the Roberts Enterprise Development Fund, is also useful for comparing social and environmental performance to the financial performance of Developing Power. Blended Value is calculated as the Enterprise Value (based on free cash flows) plus the Social Purpose Value less the total long-term debt. Table 7.2 shows that Developing Power projects will result in over $15 million of Blended Value.

Table 7.2: Blended Value	
Enterprise Value	$8,580,672
Social Purpose Value	$8,441,837
Less: Long-Term Debt	$1,900,000
Blended Value	**$15,122,509**

8. Management Team and Organization

Scott Baron is the Founder and CEO of Developing Power. He is graduating in May 2004 from the University of Michigan with an MS from the School of Natural Resources and Environment and an MBA from the Michigan Business School. Scott has five years experience in the energy industry and has extensive experience with renewable energy and international development. Most recently, he interned with GE Wind Energy, where he developed a financial model for selling wind turbines in Brazil and therefore has considerable exposure to the Brazilian energy industry. This past year, Scott has worked closely with strategy guru C.K. Prahalad where he authored a chapter for Mr. Prahalad's forthcoming book The Fortune at the Bottom of the Pyramid. The chapter is focused on how innovative energy businesses are profitably serving rural communities, with particular focus on a company in Nicaragua. In addition to these experiences, Scott is a graduate of Solar Energy International's "Renewable Energy in the Developing World" course and has presented at Cuba's prestigious Renewable Energy Conference. Recently, he has developed a model for NextEnergy to evaluate the life-cycle performance of distributed generation technologies at a pilot microgrid in Detroit. His previous work on Developing Power won the company various awards last year including: best SROI at the National Social Venture Competition, best Social Entrepreneur at San Diego State's New Venture Competition, finalist at the Wake Forest Elevator Pitch Competition, and finalist at Michigan's Pryor-Hale Business Plan Competition.

Prior to attending the University of Michigan, Scott helped start the Chicago Climate Exchange (CCX), the world's first voluntary carbon trading program. The CCX has recently been featured in the Wall Street Journal, the New York Times, and the Economist. Scott has also worked for Stratus Consulting in Boulder, CO, designing analytical pricing tools for deregulated electric utilities and performing cost-benefit analysis on a variety of water quality projects. He graduated from Northwestern University with a degree in Environmental Policy and an honors degree in Economics.

Mary Catherine Smith is partnering with Developing Power to introduce the company to the NGO community in Brazil. Mary Catherine is fluent in Portuguese and has traveled in Brazil since 1977. She spent over a year in São Paulo and studying at the Universidade de São Paulo (USP) while working toward a degree in Brazilian Culture from the University of Michigan. Since then she has worked as a freelance translator and Brazilian culture consultant, spending as much time in Brazil as possible.

Currently a fundraiser for the Rackham Graduate School at the University of Michigan, Mary Catherine also hosts one of a handful of weekly Brazilian music radio shows in the U.S. She is a member of the Board of Directors of Baixo Santa do Alto Glória, a cultural NGO based in Rio de Janeiro. She has the distinction of being the only American Folhete, an associate of the roots samba group Folha Seca in Rio.

8.1 Board of Advisors

C.K. Prahalad is the Harvey C. Fruehauf Professor of Business Administration at the University of Michigan Business School. C.K. is a preeminent strategist and has most recently published an article in the Harvard Business Review in September 2002 entitled, "Serving the Poor, Profitably." Scott Baron of Developing Power has been working closely with Mr. Prahalad, and has contributed a chapter on rural energy in his forthcoming book "Innovations at the Bottom of the Pyramid."

Todd Bartholf has 20 years of experience with renewable energy in various domestic and developing countries contexts. Currently, he is the Director of Renewable Energy at CH2M Hill in Denver, CO. Todd is also the former Senior Program Officer at Winrock International, where he oversaw rural electrification project development around the world.

Gina Rodolico is E+Co's Corporate Secretary and its Program Manager for Brazil. She manages the newly launched United Nations Foundation supported Brazil Rural Energy Enterprise Development Initiative. Gina worked closely with Scott Baron from Developing Power to document rural energy innovations in Nicaragua.

Sanjay Wagle is a Principal and co-founder of Expansion Capital Partners, LP, a venture capital firm investing in expansion-stage companies in the areas of energy and environmental technology, industrial resource efficiency, and water. Sanjay served as the CFO of Sea Power & Associates, the grand prize winner of Haas Social Venture Competition in 2001.

Ian Baring-Gould is a world expert on hybrid system design with the Village Power Program at the National Renewable Energy Laboratory. He has designed systems in a number of countries in Latin America. His main capacity for Developing Power has been to evaluate system configurations in HOMER and to provide various input data from previous NREL projects.

Marc Ross is a professor of Physics and Energy at the University of Michigan.

9. Funding Request

Developing Power is seeking $25,000 for a partnership identification study and $400,000 to finance a complete pilot project in Bahia, Brazil. Proceeds from the Global Social Venture Competition will be used to fund a partnership identification study in Brazil. The intended outcomes of this study are: 1) to identify and specify a local partner in the western region of Bahia Brazil with the capabilities required to facilitate a pilot project, 2) to begin to measure specific village resources in multiple villages in western Bahia, and 3) to conduct specific willingness-to-pay surveys and electric load assessments in a select set of villages. The expected expenses for the study are as follows:

- Travel to Brazil from the United States for 1-2 people: $10,000
- Resource measurement equipment for initial surveying: $15,000

Appendix 1: Financial Statements

Income Statement
(in $1,000 USD)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Number of Projects	1	2	4	7	11	15	20	25	30	35
Cumulative Number of Projects	1	3	7	14	25	40	60	85	115	150
Cumulative Number of People Served	500	1,500	3,500	7,000	12,500	20,000	30,000	42,500	57,500	75,000
Revenue										
Project sales	$0	$300	$600	$1,200	$2,100	$3,300	$4,500	$6,000	$7,500	$9,000
Grant revnue	$400	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Revenue	$400	$300	$600	$1,200	$2,100	$3,300	$4,500	$6,000	$7,500	$9,000
Expenses										
Operating expenses	($198)	($334)	($405)	($508)	($609)	($754)	($899)	($1,134)	($1,568)	($2,051)
Net Operating Profit (EBITDA)	$202	($34)	$195	$692	$1,491	$2,546	$3,601	$4,866	$5,932	$6,949
Interest expense	$0	($18)	($41)	($73)	($91)	($95)	($85)	($75)	($64)	($52)
Depreciation	($12)	($32)	($64)	($116)	($179)	($241)	($324)	($414)	($504)	($594)
Taxes	-	-	-	-	-	-	-	-	-	-
Net income	$190	($84)	$90	$503	$1,221	$2,210	$3,192	$4,377	$5,365	$6,303

Balance Sheet
(in $1,000 USD)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Assets										
Cash	$82	$143	$203	$259	$133	$209	$312	($221)	$414	$1,164
Fixed assets	$120	$440	$1,080	$2,240	$4,026	$6,438	$9,678	$13,818	$18,858	$24,798
Accumulated depreciation	($12)	($44)	($108)	($224)	($403)	($644)	($968)	($1,382)	($1,886)	($2,480)
Net fixed assets	$108	$396	$972	$2,016	$3,623	$5,794	$8,710	$12,436	$16,972	$22,318
Total assets	$190	$539	$1,175	$2,275	$3,756	$6,003	$9,022	$12,215	$17,386	$23,482
Liabilities										
Long-term debt	$0	$233	$579	$1,076	$1,336	$1,372	$1,199	$1,016	$821	$615
Equity										
Equity	$0	$200	$400	$500	$500	$500	$500	$500	$500	$500
Cummulative year loss/gain prior years	$0	$190	$106	$197	$699	$1,920	$4,131	$7,323	$11,700	$17,065
Current year loss/gain	$190	($84)	$90	$503	$1,221	$2,210	$3,192	$4,377	$5,365	$6,303
Retained income	$190	$106	$197	$699	$1,920	$4,131	$7,323	$10,700	$16,065	$22,368
Total liabilities and equity	$190	$539	$1,175	$2,275	$3,756	$6,003	$9,022	$12,215	$17,386	$23,482

Assumptions:
• Taxes are assumed to be zero for the analysis; construction costs are over 2 years per project (60% in the first and 40% in the second)

Cash Flow Statement
(in $1,000 USD)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Number of Projects	1	2	4	7	11	15	20	25	30	35
Cumulative Number of Projects	1	3	7	14	25	40	60	85	115	150
Cumulative Number of People Served	500	1,500	3,500	7,000	12,500	20,000	30,000	42,500	57,500	75,000
Cash Flows from Operating Activities										
Revenue										
Project sales	$0	$300	$600	$1,200	$2,100	$3,300	$4,500	$6,000	$7,500	$9,000
Total Revenue	$0	$300	$600	$1,200	$2,100	$3,300	$4,500	$6,000	$7,500	$9,000
Operating Expenses										
Travel expenses	($15)	($23)	($40)	($63)	($75)	($105)	($123)	($160)	($270)	($360)
Wages	($150)	($200)	($230)	($276)	($331)	($397)	($477)	($596)	($775)	($1,008)
Miscellaneous expenses	($33)	($111)	($135)	($169)	($203)	($251)	($300)	($378)	($523)	($684)
Total operating expenses	($198)	($334)	($405)	($508)	($609)	($754)	($899)	($1,134)	($1,568)	($2,051)
Taxes	-	-	-	-	-	-	-	-	-	-
Net Cash Flow from Operating Activities	($198)	($34)	$195	$692	$1,491	$2,546	$3,601	$4,866	$5,932	$6,949
Cash Flows from Investing Activities										
Capital expenditures	($120)	($320)	($640)	($1,160)	($1,786)	($2,412)	($3,240)	($4,140)	($5,040)	($5,940)
Net Cash Flows from Investment Activities	($120)	($320)	($640)	($1,160)	($1,786)	($2,412)	($3,240)	($4,140)	($5,040)	($5,940)
Cash Flows from Financing										
Pilot grant income	$400	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt financing	$0	$256	$400	$600	$400	$200	$0	$0	$0	$0
Equity financing	$0	$200	$200	$100	$0	$0	$0	$0	$0	$0
Net Cash Flows from Financing Activities	$400	$456	$600	$700	$400	$200	$0	$0	$0	$0
Net Annual Cash Flow	$82	$102	$155	$232	$105	$334	$361	$726	$892	$1,009
Cummaltive Year-to-Year Cash Flow	$82	$184	$298	$436	$364	$467	$570	$1,037	$1,672	$2,422
Debt repayment (6% interest rate)	$0	($41)	($95)	($177)	($231)	($258)	($258)	($258)	($258)	($258)
Net Cash Available after Debt Repayment (working capital)	$82	$143	$203	$259	$133	$209	$312	$779	$1,414	$2,164
Investor Payback	$0	$0	$0	$0	$0	$0	$0	$1,000	$1,000	$1,000
Free Cash Flows	$0	($415)	($505)	($523)	($169)	$58	$258	$1,258	$258	$258
EVA	$190	($85)	$75	$455	$1,078	$1,918	$2,659	$3,523	$4,171	$4,565
WACC	**10.29%**									

NPV of FCFs	**$8,580,672**
NPV of EVA	**$8,580,672**
ROE	**34%**

Appendix 2: Letters of Interest

E+Co
energy through enterprise

January 28, 2003

Mr. Scott Baron
Developing Power
608 High Street
Ann Arbor, MI 48104

Dear Scott:

I have reviewed Developing Power's business plan to undertake an initial pilot project in Bahia, Brazil. Once at the implementation phase, E+Co's B-REED program would undertake due diligence to consider Developing Power for an investment.

B-REED employs E+Co's "enterprise-centered" approach of providing enterprise development services ("EDS"), together with early stage capital, up to $150,000, in the form of debt, equity, or a mezzanine structure. B-REED seeks to develop or strengthen sustainable energy enterprises that use clean or efficient energy technologies to meet the energy needs of populations under-served by traditional means, creating environmental and social benefits and stimulating sustainable local economic growth. Developing Power's business strategy conceptually meets B-REED's investment guidelines. As part of our EDS, we could also assist you by facilitating introductions to key stakeholders in Bahia and Brazil.

We look forward to hearing of your progress.

Sincerely,

Gina Rodolico
Program Manager – Brazil

Solar Development Group

Mr. Scott Baron
Developing Power
608 High St., #H3
Ann Arbor, MI 48104

Date	Our Reference	Direct phone number	Direct fax number	Email
24 February 2003	PWC/PWC	+1 703 522 5928 ext. 207	+1 703 522 6450	pwcovell@igc.org

Subject
Business Plan

Dear Mr. Baron,

Thank you for sharing the executive summary of your business plan. We would indeed be interested in seeing your full business plan and potentially working with you to further refine and implement it. Please send it to our Brazilian investment officer, Mr. Guilherme de Freitas Valle, at gfv@bol.com.br and tel. +55 11 3501 1239, with copy to me.

Yours sincerely,
STICHTING TRIODOS PV PARTNERS

Philip Covell

Advisor: Stichting Triodos PV Partners

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Appendix 3: Major NGOs and Governmental Agencies Involved in RETs

Entity	Purpose	Regions of Focus
Solar Electric Light Fund	SELF brokers the purchase and delivery of SHSs by working with rural solar electric associations, local PV-system suppliers, solar entrepreneurs, farmers, cooperatives, donor agencies, corporations, non-governmental organizations, multilateral development banks, and governments.	SELF has developed pilot PV projects in China, India, Sri Lanka, Nepal, Vietnam, Indonesia, Brazil, Tanzania, Uganda, South Africa and the Solomon Islands.
Winrock International	Winrock works to establish Renewable Energy Project Support Offices (REPSO) to foster cooperation between government agencies, private enterprises, nonprofit organizations, and communities in the common pursuit of harnessing proven clean energy technologies for sustainable development.	Winrock has implemented a variety of renewable energy projects throughout the world but primarily in India, Philippines, South Africa, Central America, Nepal, and Indonesia.
National Renewable Energy Laboratory (NREL)	NREL brings together developing and industrialized country governments, public and private organizations, multilateral institutions, consumers and other in an effort to ensure access to modern energy services by the poor.	The Global Village Energy Partnership project database documents over 140 projects from over 30 countries where NREL has been involved in bringing renewable energy to the developing world.
The Energy Sector Management Assistance Programme (ESMAP)	The Energy Sector Management Assistance Programme (ESMAP) is a global technical assistance program sponsored by the World Bank and the United Nations Development Programme (UNDP) and managed by the World Bank. ESMAP focuses on the role of energy in economic development with the objective of contributing to poverty alleviation and economic development, improving living conditions, and preserving the environment in developing countries and economies in transition.	Since its creation, ESMAP has operated in some 100 different countries through approximately 450 activities covering a broad range of energy issues.
USAID	USAID spearheads the U.S. Government's efforts to help developing countries and economies in transition to design effective new strategies to meet growing energy demand. To this end, USAID promotes free market policies that enable more efficient power production, energy conservation, increased use of renewable energy sources, and private sector participation in the energy sector.	USAID activities in FY 1998 leveraged more than $140 million in public and private investment in environmentally sustainable energy production around the world, including Nepal, Guatemala, and West Africa.
Intermediate Technology Development Group (UK)	ITDG's energy program aims to increase poor people's access to energy technology options, through improving the efficiency and productivity of biomass use, and through small-scale, low cost, off-grid electricity supply.	ITDG works directly in four regions of the developing world – Latin America, East Africa, Southern Africa and South Asia, with particular concentration on Peru, Kenya, Sudan, Zimbabwe, Sri Lanka, Bangladesh and Nepal.

Appendix 4: HOMER Cost of Energy Calculations

The following example cost calculation is used in HOMER to arrive at a solution:

$$C_{NPC} = \frac{\text{Total Annualized Cost Components}}{\text{CRF (interest rate, project lifetime)}}$$

The cost of energy was calculated using the following formula in HOMER:

$$COE = \frac{\text{Total Annualized Cost Components}}{\text{Primary Load Served + Deferrable Load Served}}$$

Appendix 5: Cost Trends and Affordability of Renewable Energy Technologies

While it has been recognized that renewable energy technologies have the potential to effectively meet the electricity needs of people in rural areas of developing countries, not until recently have the costs declined enough to make the technologies affordable on a larger scale. Technological advancements, economies of production, and increased demand have led in part to this cost decline, which is predicted to continue as markets for renewable energy further develop. Compared to what most people in rural areas currently pay for energy services (e.g. kerosene, candles, diesel, battery charging, collecting firewood or dung) or grid extension, it is reasonable that RETs could replace these options at similar costs with higher reliability and lower environmental and health impact.

Partly explaining the cost decline of renewable energy technologies has been increased global production, as the growth rate of RETs has increased dramatically over the past decade (see Table 5-1). Surpassing most fossil fuels, RETs such as photovoltaics and wind have experienced growth rates of over 20% per year. The learning or experience curve (the logarithmic relationship between price and cumulative sales) for photovoltaics has been 20%, resulting in an 80% cost reduction since 1980 (Maycock 2002). Wind power, currently the world's fastest growing energy source, has grown at a rate of nearly 40% between 1997 and 2000, and in locations with good wind resources it is considered to be the lowest cost energy option (Wind Power Monthly 2002). Biomass, geothermal, and microhydro have also demonstrated cost reductions and depending on the location, are viable and cost-effective solutions. Table 6-2 shows the current status and projected costs of the main renewable energy technologies.

Table 5-1: Global Trends in Energy Use, 1990-2000

Source	Average Annual Growth Rate (percent)
Wind power	25.1
Solar photovoltaics	20.1
Natural gas	1.6
Oil	1.2
Nuclear power	0.6
Coal	-1.0

Source: World Watch Institute 2001

Table 5-2: Current Status and Potential Future Costs of Renewable Energy Technologies

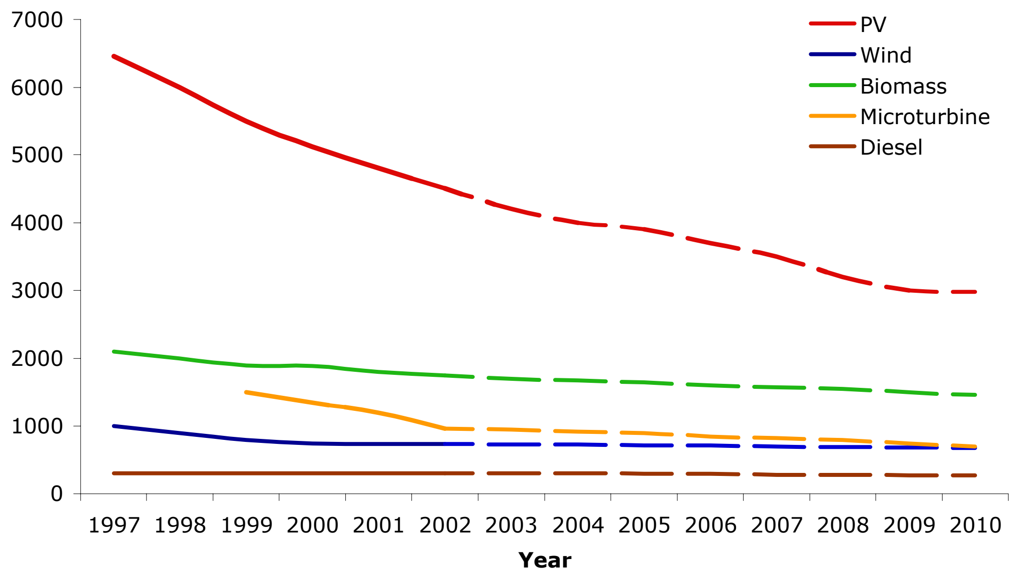
Technology	Increase in installed capacity from 1995-2000 (percent a year)	Capacity factor (%)	Energy production 1998 (TWh)	Turnkey investment costs (U.S. dollars per kilowatt)	Current energy cost (cent/ kWh)	Potential future energy cost (cent/ kWh)
Biomass energy (electricity)	~3	25-80	160	900-3000	5-15	4-10
Wind electricity	~30	20-30	18	1100-1700	3-13	3-10
Solar photovoltaic electricity	~30	8-20	0.5	3500-10000	25-125	5-25
Solar thermal electricity	~5	20-35	1	3000-4000	12-18	4-10
Hydroelectricity						
Large	~2	35-60	2510	1000-3500	2-8	2-8
Small	~3	20-70	90	1200-3000	4-10	3-10
Geothermal energy	~4	45-90	46	800-3000	2-10	1-8
Marine energy						
Tidal	0	20-30	0.6	1700-2500	8-15	8-15
Wave	-	20-35	unclear	1500-3000	8-20	unclear

Current	-	25-35	unclear	2000-3000	8-15	5-7
OTEC	-	70-80	unclear	2250*	unclear	unclear

*Source: World Energy Assessment 2000; *Based on data from Sea Solar Power Inc.*

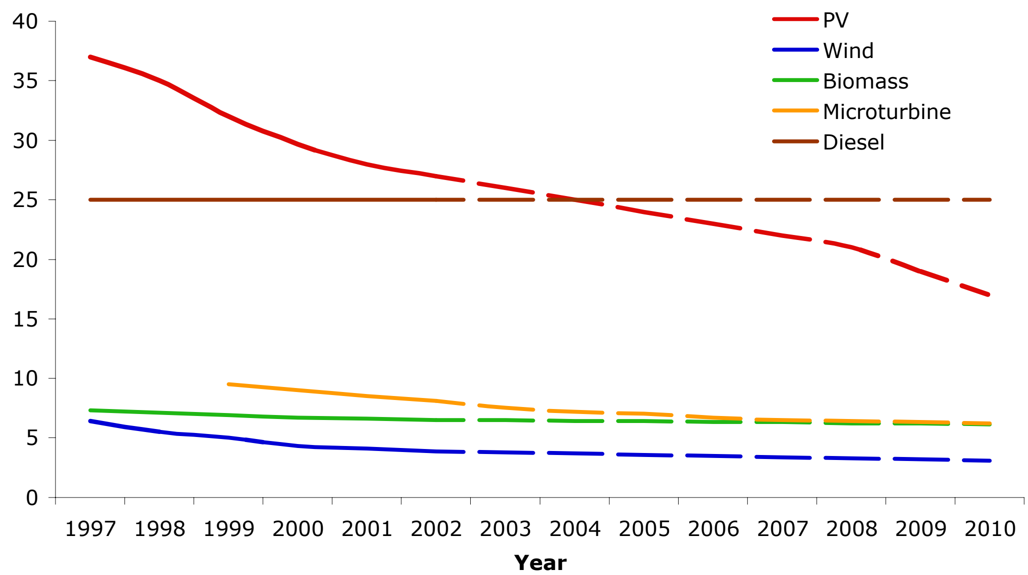
Figures 5-1 and 5-2 show the declines since 1997 and projected declines in the capital cost and cost of energy (COE) for selected energy technologies (PV, wind, biomass-gasification, microturbine, and diesel generation). Because RETs are characterized as having little or no fuel costs and maintenance and operation costs are minimal, the COE from renewable sources is competitive with fossil fuel based generation such as diesel power. And in rural areas of developing countries, the cost of diesel fuel is exaggerated because it is difficult and expensive to transport to remote areas, often leaving communities without power. While the average capital costs for RETs are typically higher than diesel generators, RETs can be competitive in certain locations and costs are predicted to decline over time. Compared to the average cost of grid-based power in rural areas of between $0.15 per kWh and over $0.70 per kWh, RETs can be a cost-effective option for rural villages (WEA 2000).

Figure 5-1: Installed Capital Costs ($/kW) for Selected Energy Technologies



Sources: Renewable Energy Technology Characterizations, DOE and EPRI
Assumptions: Biomass gasification, MORE

Figure 5-2: Cost of Energy (cents/kWh) for Selected Energy Technologies



Sources: Renewable Energy Technology Characterizations, DOE and EPRI

In many cases, renewable energy technologies must compete with current energy services in rural areas such as kerosene, candles, diesel gensets, collecting dung and firewood, battery charging, and grid extension. Various studies indicate that people in rural areas of developing countries pay considerable amounts for these services and have even higher willingness to pay for modern energy services such as electricity (ESMAP 2000, World Bank 1996). Cost declines of RETs in conjunction with innovative financing mechanisms allow the means to substitute the use of polluting and unreliable energy sources in developing countries with improved renewable based systems.

Appendix 6: The Microfinance Connection

Microfinance will play a significant role in allowing Developing Power clients to achieve access to credit. This Appendix documents the recent advancements in the microfinance field as a background for the overall context in which Developing Power will operate.

Advances in commercial microfinance in the past decade are allowing a significant number of poorer people in developing countries to raise their income and standard of living. Microfinance refers to the provision of credit and savings financial services to low-income and remote people at interest rates that enable cost recovery and profitability. Microfinance Institutions (MFIs) generally do not require collateral, credit history, or loan guarantees from borrowers and can include banks, savings and credit cooperatives, credit unions, and non-governmental organizations. A large-scale shift from subsidized microcredit to commercial microfinance has increased the number of profitable and self-sufficient MFIs throughout the world, resulting in new opportunities to serve the financial needs of poor and rural communities and enhance economic productivity. Quickly becoming an industry, microfinance is transforming from a social enterprise to alleviate poverty to the future of retail banking in developing countries. Besides providing financial services, MFIs are also generally active in supporting and delivering technical and business training to encourage microenterprise development.

Microfinance and renewable energy are highly complimentary as the provision of electricity can significantly enhance economic productivity and profitability for microfinance customers. The microfinance and renewable energy industries share similar histories and goals for the future including: 1) small amounts of credit as well as electricity make a large difference to the quality of life and economic position of low-income people, 2) community organization and ability to pay are essential components for sustainability, 3) recognition that sustainability is best achieved through full cost-recovery and private sector mentality, and 4) sustainability serves outreach.

Driving the demand for financial services is the need for capital by low-income people to become more productive and to gain access to the global economy. According the Thomas Friedman's best-selling book *The Lexus and the Olive Tree*, "globalization is the overarching international system shaping the domestic politics and foreign relations of virtually every country…and that almost everyone [in the world] now is feeling—directly or indirectly—the pressures, constraints, and opportunities to adapt to the democratizations of technology, finance, and information that are at the heart of the globalization system" (1999). As James Wolfensohn, president of the World Bank, explained, "in the Voices of the Poor study, where we interviewed 60,000 people in 60 countries, we asked them what was the number one thing they wanted. They said technology and information, they didn't say food, they didn't say charity. Poor people know as well as anybody else that what keeps them poor is lack of competitiveness and lack of knowledge" (2000). Access to electricity is the foundation and necessary component that allows for income growth and the use of communication and modern technologies for microenterprise development. Electricity also strengthens household development in communities by providing: lighting for extended operating hours for businesses and improved working conditions, power for electrical tools and machines, refrigeration for preservation of food and vaccines, and improved educational opportunities through lighting and visual aids.

As previously indicated, rural populations in developing countries will pay a significant amount for reliable and clean energy, which improves their quality of life or enables them to be more productive. The problem is that rural customers often cannot get affordable credit to pay for the electricity service. Although MFIs are improving outreach in developing countries, an estimated 90% of the people in developing countries lack access to financial services from institutions (Robinson 2001). Many loans have occurred through informal moneylenders, who charge excessive rates of interest and who do not offer savings capabilities. Bridging the gap between moneylenders and commercial financial institutions (of which rural people do not have access), MFIs are capitalizing on this large unmet demand for financial services leading some to conclude that "the microcredit and microenterprise development projects are going to be *the* significant component of the 21st century's development initiatives in both poor and industrialized countries" (Rahman 1999, emphasis in original article).

The growth in commercial microfinance institutions is largely a product of the past 20 years. The 1980's represented a turning point in microfinance, where both the Grameen Bank (Bangladesh) and BRI (Indonesia) showed that MFIs could reach more than 1 million borrowers with very high repayment rates. With the rise of BancoSol (Bolivia) in the 1990's, attention was given to developing appropriate regulation and supervision for formal sector MFIs, and commercial microfinance was no longer limited to a small group of scattered institutions. Institutions such as the Grameen Bank, BRI, and BancoSol have provided financial services at a profit to approximately a third of all households in their respective countries, and they have spawned the extension of their methods by institutions in other developing countries. Consequently, the number of MFIs focusing on profitability and outreach has grown rapidly and microfinance is developing into a fledgling industry.

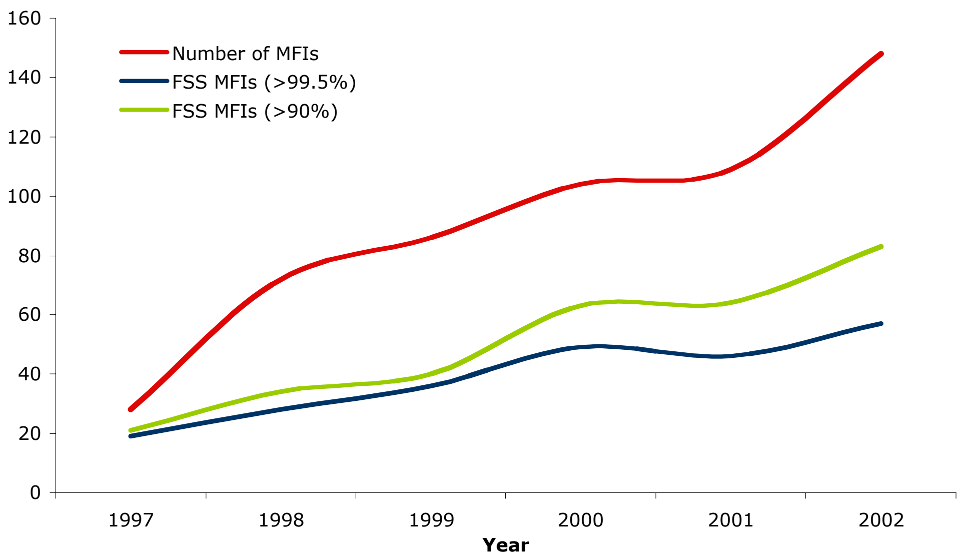
The MicroBanking Standards Project, a project funded by the Consultative Group to Assist the Poorest (CGAP), tracks various statistics of many of the MFIs around the world. Other responsibilities include establishing industry benchmarks and performance standards, enhancing the transparency of financial reporting, and improving the performance of microfinance institutions. Considered the best database in the industry, the MicroBanking Bulletin database contains data on 148 microfinance organizations operating in 53 countries. An important result of the project's analysis is the calculation of "financial self-sufficiency" (FSS), or the adjusted operating income divided by the adjusted operating expense, which indicates whether the MFI is making a profit and is therefore sustainable. Historically, the Bulletin used a ratio of 90% as the threshold for MFIs being financially self-sufficient (conservative due to predicted errors in the adjustment calculation—determining the difference between financial and operational self-sufficiency), but currently it uses 99.5% as the threshold for a MFI to be financially self-sufficient. Figure 6-1 shows the total growth and growth in financial self-sufficiency in the MFI industry based on data published in the Bulletin. Table 6-1 shows various statistics on MFIs in different geographical regions and is separated by the criterion of FSS.

Table 6-1: Institutional Characteristics of Microfinance Institutions by Region

	Number of MFIs	Average Total Assets per MFI (US$)	Average Total Gross Loan Portfolio Outstanding per MFI (US$)	Average Number of Active Borrowers per MFI	Average Loan Balance per MFI (US$)	Average Financial Self-Sufficiency (FSS) (%)
All MFIs						
Africa	29	2,896,020	1,884,422	11,586	116	88.6
Asia	30	95,311,066	38,459,718	246,338	339	97.1
Eastern Europe	16	4,095,167	3,439,051	2,419	1,569	87.1
Latin America	58	11,816,202	8,958,460	13,276	722	92.0
Middle East & North Africa	5	6,348,640	3,101,464	8,685	337	75.5
Financially Self-Sufficient MFIs						
Africa	9	4,947,490	3,253,035	11,357	152	123.5
Asia	11	42,343,445	27,184,668	366,046	235	126.1
Eastern Europe	4	4,273,034	3,897,385	2,275	1,574	106.8
Latin America	25	18,997,283	15,058,137	19,990	824	117.8
Note: 10 MFIs did not report data for all categories so were excluded from table (total MFI in table=138 whereas 148 MFIs reported to the MicroBanking Bulletin)						

Source: MicroBanking Bulletin Database 2001

Figure 6-1: Growth in the Number and Self-Sufficiency of Microfinance Institutions from 1997 to 2002



Source: The MicroBanking Bulletin Nov. 2001

The debate among microfinance experts in the 1990's largely concentrated on the difference between two dominant theories for serving lower-income populations with financial services: the financial services approach and the poverty lending approach (see Box 6-1). Because MFIs that embody the financial services approach hold the most potential for large-scale outreach and sustainability, they will be the focus for partnerships with Developing Power. Salient features of self-sufficient microfinance institutions include: charging full interest rates to cover costs, using savings deposits to finance loans, allowing flexibility in determining interest rates, enforcing strict repayment policies (usually starting with small loans before allowing borrowers to obtain larger loans), making frequent payment collections, and generally loaning to women (Mosley and Hulme 1998, Robinson 2001, Rhyne 1998). MFIs with these features have challenged beliefs that the poor cannot afford and repay credit at commercial rates, that the poor do not save, and that asymmetric information is a limitation to serving the poor. Rather, FSS MFIs typically maintain repayment rates over 90%, finance most loans through local savings (which is more in demand than credit), and have developed sophisticated methods for reducing risk and assessing creditworthiness.

Box 6-1: The Debate Between the Financial Systems and the Poverty Lending Approach to Proving Financial Services to the Poor

While commercial microfinance in many areas has increased outreach and attained profitability, there still remains a debate between the financial systems and poverty lending approach to providing financial services to the poor. The poverty lending approach focuses on reducing poverty through credit (mainly to the poorest of the poor) and relies on donor and government subsidies. The financial systems approach focuses on commercial financial intermediation among poor borrowers and savers with an emphasis on self-sufficiency. Ultimately, the debate centers on whether or not interest rates should be subsidized. However, literature on both microfinance and rural finance indicates that the poverty lending approach has not been sustainable nor reached a large number of borrowers mainly because of constraints on donor funds and that the "extremely poor" should not be the responsibility of the financial sector; the poorest of the poor are better served with direct aid. In contrast, the financial systems approach targets the "economically active" poor (those that have some form of employment or are not destitute), and has achieved significant outreach. Given the large demand for both financial services and electricity in developing countries, it is important that limited funds for supporting microfinance be used to disseminate lessons from fully sustainable microfinance systems in order to replicate success and attain greater outreach.

Microfinance has been used successfully, in many cases, with regards to renewable energy mainly to finance solar home systems (SHSs). To date, approximately 700,000 solar home systems have been installed in developing countries, reflecting a cumulative investment on the order of US$300-500 million (G8 RETF 2001). At an approximate cost of $500 to $700 per system, microfinance is a practical solution for overcoming the high initial capital cost of a SHS. Based on market studies done in India, China, Sri Lanka, Zimbabwe, South Africa and Kenya conducted by various international development agencies over the past 5 years, the consensus is that approximately 5% of most rural populations can pay cash for an SHS, 20 to 30% can afford a SHS with short or medium term credit, and another 25% could afford an SHS with long term credit or leasing (SELF 2002). Attempts to microfinance SHSs have failed in some markets, however, because there has not been an appropriate match between loan maturities and ability to repay (many MFIs lend on short-term cycles—three to six months—which can be a limitation for the large capital cost of a SHS—Philips and Browne 1998). By requiring a down payment before extending credit, various MFIs have overcome this problem. The Grameen Bank in Bangladesh and Sarvodaya in Sri Lanka are examples of MFIs that provide loans specifically for SHSs and require a down payment (Grameen Shakti provides consumer credit for up to 3 years with a 15-25% down payment and Sarvodaya provides 2-5 year credit with a 20-25% down payment—Martinot et al. 2002).

Microfinance has also been used to finance mini-grid systems based on diesel and microhydro. In two rural villages in Bolivia for example, microfinance was used to assist with the connection charges (US$100 to US$125) for a diesel mini-grid, which allowed users to pay back the loans in monthly installments over five years and significantly increased the number of people who were able to purchase electricity (World Bank 1996). IT Peru, and affiliate of U.K.-based Intermediate Technology Development Group (ITDG), developed a successful program to finance the purchase of microhydro mini-grids and started a revolving loan fund to leverage additional funds. By 1998, the organization had financed 15 systems, including 5 for individual clients and 10 for communities, helping provide access to electricity where previously unavailable (NREL 2000). Financing for microhydro has also been used considerably in Nepal, where rural energy entrepreneurs have installed and operated mini-grids based on microhydro with access to credit from a public-sector agricultural development bank and private financing from commercial microfinance institutions (Martinot et al. 2002).

A second major role of many MFIs is to provide business development training and support for microenterprises. Microenterprises refer to very small businesses that produce goods or services for cash income, and, in general, have few employees and are often home-based. Microenterprises are not an insignificant component of the economy in developing countries, where depending on the country, microenterprises employ an estimated 30 to 80% of the working population (FINCA 2002). Along with microenterprise development organizations, MFIs are often active in providing support services to microenterprises because pure banking is inadequate to address the manifold needs of the rural poor. Examples of microenterprise support include providing: technical advice, bookkeeping skills, business management training, information and links to global markets, and assistance with legal and permitting issues. Examples of MFIs supporting microenterprise development include ACCION, CARE, FINCA, and the Grameen Bank.

Appendix 7: Carbon Trading and the Clean Development Mechanism

The Clean Development Mechanism (CDM) is one of four “flexible mechanisms” adopted in the Kyoto Protocol (the 1997 international agreement on climate change) as a means to reduce greenhouse gases (GHG), a leading cause of climate change. The CDM has gained much attention because of its potential to induce significant capital flows to developing countries for projects that enhance sustainable development. The objective of the CDM is to allow private entities in Annex I countries (industrial) to provide technical and financial assistance to non-Annex I countries (developing) on projects that lower GHG emissions below what would have occurred without the project. The emissions reductions (or a share of the reductions) are then quantified and compared to a baseline, which can be used by the private entities to count towards their own emission reduction requirements.

The credits gained from CDM projects are referred to by various terminologies including “offsets”, “certified emissions reductions” (CERs), “assigned amount units” (AMUs), or “emission reduction units” (ERUs) and can be traded or used to meet requirements in the first commitment period of the Kyoto Protocol (2008-2012—but only for CDM projects that have commenced after year 2000). However, projects resembling the CDM architecture are also currently generating offsets used for compliance in domestic and voluntary carbon markets throughout the world. The CDM is typically favorable to many parties and is seen as a “win-win” because developing countries can attract additional private investment that would not ordinarily occur, and the investing companies can achieve GHG reductions typically at a lower cost than from in-house reductions. Table 7-1 shows the advantages and disadvantages for the parties involved in the CDM.

Table 7-1: CDM Players—Advantages and Disadvantages for Involvement

Stakeholder	Advantages	Disadvantages
Non-Annex I countries	• Access to “clean” technology • Foreign direct investment • Jobs, new skills to workforce • Improved living standards • Improved access to energy	• Could get bogged down in bureaucracy • Political sensitivities
Annex I countries	• Cost effective means to meet Kyoto commitments • Leverage access to new markets • Show commitment to climate change issue • Step forward on engaging developing countries participation	• Bureaucracy and transaction costs may be high • Emissions trading (in-house reductions) may be an easier approach • Uncertainties surrounding many of the unresolved issues
Non-Annex I private sector entity	• May provide business opportunities in many sectors • Provide the possibility of partnerships and JVs with Annex I companies • Reduce energy costs	• Threat from Annex I companies taking domestic markets
Annex I private sector entity	• Depending on domestic regulation, may be a cost effective option to reduce emissions • Market opportunities • Partnerships and Joint Ventures • CO_2 business opportunities • Reputation and Public Relations benefits	• Uncertainty and unfamiliar with new mechanism • “Hidden” costs • High transaction costs

Source: UNDP Issues and Options—The Clean Development Mechanism (1998)

Various projects are eligible under the CDM including: switching from fossil fuels to renewable energy, efficiency improvements, advanced agricultural management, reforestation, and waste reduction. The guidelines for the CDM, documented in Article 12 of the Kyoto Protocol, do not specify eligible projects but require that CDM projects:

• Result in real, measurable, and long-term emissions reductions that are additional to what would have occurred under a baseline situation, i.e. emissions reductions that would not have occurred without the project;
• Result in sustainable development benefits for the host country.

CDM projects that involve switching to renewable energy and incorporate the notion of technological “leap-frogging”—skipping over the development of energy-intensive infrastructure—are considered desirable and the easiest to quantify with regards to both criteria. The auditing, verification, and certification of CERs (required under the Kyoto Protocol) against a baseline can be calculated in various ways and can be compared to measurable activities (i.e. based on the avoided average GHG emission rate in the host country (grid extension), based on the avoided emissions from the replacement of diesel generation or the use of kerosene, etc.). It is also commonly recognized that improved access to clean energy greatly enhances sustainable development. Much has been written describing the energy-poverty nexus with the conclusion that clean and sustainable energy is essential to human development and poverty alleviation. Consequently, the Activities Implemented Jointly (AIJ), a pilot program initiated by the UNFCCC that ended in 2000 and allowed entities in one country to undertake GHG reduction projects in other countries, approved various projects involving renewable energy, including wind projects in Chile and Costa Rica, rural solar electrification in Bolivia, and a RET mini-grid project in Mexico.

Article 12 of the Kyoto Protocol stipulates that an “Executive Board” be formed to govern the CDM process and define eligibility. Although the exact functions of the Executive Board have yet to be defined and operationalized, its main responsibilities would be to assess CDM projects and coordinate requirements (e.g. designate “operational entities” to audit, verify, and certify projects; supervise and administer projects). Given the obvious benefits and applicability of renewable energy projects in the CDM, arguments have been made to simplify or “fast-track” the approval process, particularly for small-scale RET projects. As shown in Table 7-1, bureaucracy and transaction costs can be significant and may overwhelm smaller projects. However, smaller energy projects that are customized to the local condition are often the most appropriate method for delivering energy in a sustainable manner and are in accord with the goals of the CDM (large-scale energy projects would have lower transaction costs in the CDM but have historically not proven sustainable). The World Resources Institute and others, therefore, have advocated that energy projects less than 20-30 MW be automatically declared eligible and additional (see Box 7-1), use a standardized baseline (CO_2/kWh), and follow expedited and simplified certification procedures (WRI 2000, Sandor 2001).

As more renewable energy projects in developing countries are undertaken, there is significant potential to group or “bundle” projects. In carbon trading markets, bundled projects with larger sources of offsets may be required to qualify for certain trading schemes. Developing Power will seek to group projects for this purpose where applicable and will use conservative standard value calculations to simplify offset calculations and to reduce transaction costs.

The success of the CDM will partly be determined by the worldwide demand for carbon allowances (an offset is “fungible” with an allowance or carbon credit once it has been certified—both are equal to 1 ton of CO_2 that is reduced or not allowed to escape into the atmosphere). Whereas currently the Kyoto Protocol is not ratified and parties to the convention are not required to make GHG reductions, companies are financing CDM-like projects in hope of using the offsets to count under the CDM if Kyoto is ratified or to comply with current requirements under the significant domestic and voluntary programs to reduce GHGs.

Examples of domestic initiatives in response to climate change include the United Kingdom Emissions Trading Scheme (ETS), which gives incentives for voluntary participation and began in February 2002, and a mandatory GHG cap in Denmark on all fossil fuel generation. The European Union recently approved the creation of a EU-wide carbon market, which would grant GHG allowances and require mandatory reductions in various industries starting in 2005. The Chicago Climate Exchange (CCX), a voluntary carbon market unveiled in 2000 and starting in the Midwestern United States is an example of a large voluntary initiative that could drive the demand for carbon offsets through projects designed under CDM guidelines. Representing 20% of all the Midwest emissions, CCX design-phase participation includes many of the largest corporations in the United States involved in various industries (e.g. automotive—Ford Motor Company, energy—American Electric Power, forestry—International Paper, chemicals—Dupont, etc.).

These domestic and voluntary programs have largely risen out of the anticipation of the ratification of the Kyoto Protocol or to comply with future domestic regulations. Currently, these programs represent a significant market for carbon credits; the Pew Center on Climate Change claims that over 65 trades of GHGs have taken place since 1997, representing 55 to 77 million tons of GHGs with most carbon credits having sold from between US$2.16 and US$12.6 per ton of carbon (2002). Natsource data indicates that the prevailing price in the market is US$14-44.4 per ton of carbon for government-issued permits, and the price for CERs (offsets from CDM projects) is in the range of US$6.5-11.1 per ton of carbon (Maggiora 2002).

Various models have been designed to predict the potential size of the market for carbon under different scenarios, with some concluding that carbon will eventually be the world's largest traded commodity. Recent estimates that include the withdrawal of the United States from the Kyoto accords and the subsequent agreements reached at the Conference of the Parties in Marrakech in 2001 predict that the size of the carbon market could be between $300 and $700 billion by 2010 at between $3 and $34 per ton of carbon under various scenarios (Grutter 2002).

Various studies have also attempted to estimate the size of the CDM component of the Kyoto Protocol, concluding that CDM could account for a significant percentage of global carbon trading, satisfying between 10 and 57 percent of the carbon market and resulting in US$2.8 to 21 billion of investments (see Table 7-2). Assuming $10 billion is invested in CDM projects per year, compared to ODA of $50 billion per year to developing countries, the CDM could add 20% to these flows. The withdrawal of the United States from the Kyoto accords may lessen these estimates; however, the impact of voluntary and domestic carbon markets (including the EU trading program starting in 2005) between now and 2010 is uncertain but is likely to include projects resembling the CDM. There still also remains the possibility that the Protocol can go into force without ratification from the United States (as of August 2002, Annex I countries representing 36% of Annex I emissions have ratified the Protocol, leaving 19% needed to reach the 55% requirement to make the Protocol enter into force).

Table 7-2: Estimates of the CDM Market in 2010

Model	Market Share (%)	Market Size (MtC)	Market Price (US$/tC)	Market Value (US$ billion)
OECD	33	397	19	7.5
ABARE	-	117-351	181-203.5	2.6-7.1
G-Cubed	38	400	13	5.2
Second Gener.M	48	503	26	13
EPPA	55	723	24	17.4
Green	31	397	-	-
SGM	43	454	-	-
Zhang	47	292-421	9.6	2.8-6.7
Morozava and Stuart	-	-	111	18
US Administration	19-46	144-344	24-42	6-8.3
Austin et al.	33-55	397-723	13-26	5.2-17.4
Vrolijk	10-21	67-141	-	2.77-2.99
Haites	27-57	266-575	36.7	9.8-21

Source: Maggiora, April 2002

While certain issues with regards to the CDM have yet to be resolved, the mechanism is already providing incentives to experiment with projects under the current CDM architecture. Issues yet to be resolved that affect the acceptance of renewable energy projects in the CDM include the role of the Executive Board, the amount of CDM credits allowed to meet Annex I commitments (Europe and the US are opposed on this issue where Europe wants restrictions on the amount of reductions coming from CDM projects), whether developing countries will be required to make emissions reductions, rules for fast-tracking or simplifying small-scale projects, and guidelines for organizing private investments (multilateral, bilateral, etc.).

Box 7-1: Additionality and the Use of Public Aid to Finance CDM Projects

In the context of international climate change policy, additionality represents a fundamental principal within the Clean Development Mechanism and is described in Article 12 as “reductions in emissions that are additional to any that would occur in the absence of the certified project activity.” This directive has been be broken down into three main types of additionality: environmental, investment, and financial. Environmental additionality refers to emissions reductions being additional to business as usual and implies that projects must make environmental improvements in host countries. Investment additionality requires that a project only be financially viable with the sale of carbon offsets. The Conference of the Parties 7 meeting in Marrakech however, ruled that investment additionality is not required for CDM projects because it would add undue complications and impede development of the CDM. Financial additionality refers to CDM funding being additional to Official Development Assistance (ODA) and has been contentiously debated from various parties. The driving issue is that CDM projects funded with ODA money will detract public investment from groups like the Global Environment Facility (GEF)—whose main mandate is to fund projects that mitigate climate change—and will discourage the use of limited aid funds for more urgent problems (i.e. poverty, malnutrition) in the least developed countries. The general consensus among policy-makers is that there is no practical way to ensure that projects funded with aid money pass the financial additionality test. Therefore, the most likely scenario is that CDM projects will be primarily funded through the private sector. However, in 1999 the World Bank created the Prototype Carbon Fund (PCF), a public-private fund designed to invest in CDM and Joint Implementation (JI) projects for a limited period of time in order to demonstrate and disseminate experience and insight into the CDM. The PCF limits funding and claims to not interfere with private CDM investments. Regardless of how the debate over financial additionality results, ODA will be an essential factor for building capacity within developing countries to enhance the investment climate and prepare potential markets for CDM projects.

Conclusions

1. Key Findings

The advantage of the Developing Power model compared to other existing business models is that Developing Power incorporates trends in public-private partnerships, microfinance, renewable energy technologies, system design, and prepayment with a unique market entry strategy to electrify the large remote village segment of the market in developing countries. The result is a business model that has the potential to reach scale and leave a positive sustainable impact. The following key findings support this proposition:

Rural consumers can afford modern energy.

There is overwhelming evidence from rural electrification programs in the past ten years indicating that rural consumers of energy are already spending a significant portion of their income on energy and are willing to spend more for upgraded services. On average, rural poor people spend between $7 and $25 on energy per month, including inefficient and dirty sources such as kerosene, candles, dung, and firewood. These expenditures can represent between 10-30% of an average rural consumer's income. Developing Power hybrid systems provide these consumers with enhanced energy services—in the form of electricity—for approximately the same amount of money that they are currently spending. For a typical rural village in Bahia, Brazil, for example, the expected monthly fee per person is $13 per month for about 42 kWh of electricity usage.

Hybrid power microgrid systems are an attractive solution for large off-grid villages.

Hybrid power microgrids utilize a combination of technologies, mostly renewable energy based, to provide high-quality 24-hour electricity for rural off-grid villages. Although hybrid power systems are a relatively recent application of energy technologies (only approximately 10,000 households in the developing world are using hybrid power), their application is expected to be large. The main advantage of hybrid systems is that they offer the highest quality power for the lowest cost compared to other rural electrification options. Additionally, the addition of renewable energy technologies to existing diesel microgrids is a feasible and cost effective way to provide higher quality electricity to rural villages. On average, power for a hybrid system can be provided for 1/3 the cost of traditional grid extension and for 1/5 the cost of what rural consumers are already spending on energy.

Sophisticated hybrid system design reduces life-cycle costs.

Developing Power designs hybrid power systems using the optimization program HOMER (Hybrid Optimization Model for Distributed Generation). HOMER finds the lowest cost system based on the expected electricity demand, resource availability, and input costs of the capital equipment and operation. The optimal system represents the system that optimizes renewable resource use and uses the minimal amount of diesel fuel (if a diesel generator is modeled) to meet the expected electricity demand. Therefore, the use of HOMER reduces the risk of over or under-building a system given the specific parameters in the village and determines the system with the lowest life-cycle costs.

Prepayment systems are necessary for hybrid power implementation.

Developing Power uses a system of prepayment meters and smart cards to collect payment and manage electricity use of the hybrid power systems. Prepayment is common in the developing world, but has only recently been applied for electricity. The use of Developing Power's system has three distinct advantages: 1) prepayment reduces risks for the owner by collecting payment upfront, 2) prepayment allows customers to pay when they have capital available, and 3) smart cards and electricity meters allow the Energy Service Company to record and monitor electricity use on the system.

Partnerships are essential for sustainability.

A large number of organizations globally have a mission to advance rural electrification. The expertise they have gained must be leveraged to increase the likelihood of solutions that are appropriate and sustainable. Developing Power's business model is to rely on local partners that have an in depth understanding of the cultural, economic, and political environment where projects will be undertaken. These partnerships benefit all stakeholders because Developing Power helps them achieve their missions and our partners help the company develop a flow of deals and access to information.

A scalable business model requires access to capital.
As demonstrated by the work of Hernando de Soto, businesses in the developing world generally remain small and constrained due to lack of capital. In order to grow, these businesses require capital at attractive rates and with appropriate terms. The proposed capital structure of Developing Power utilizes the most appropriate and available financing to achieve the growth targets needed to reach scalability. The strategy is to utilize grant financing for an initial pilot project to demonstrate the proof of concept and then utilize a combination of debt and equity to scale the business model. Available financing in the United States such as the EX-IM Bank, angel investors, and rural energy finance companies give Developing Power better terms and rates than in-country companies can generally obtain.

Electricity provides considerable social and environmental benefits in rural villages.
The benefits from access to electricity with the most measurable impact include improved education, human health, communication and entertainment, comfort, protection, convenience, and productivity. Developing Power expects to electrify 75,000 people in 10 years resulting in over $24 million in social and environmental benefits. For every $1 invested in a Developing Power project there is an average of $1.5 in social and environmental benefits.

Significant use of distributed renewable energy solutions allow countries to leapfrog the traditional energy ladder, resulting in a safer and cleaner energy delivery model.
Thomas Edison envisioned a world of decentralized electrical supply where power would be generated at or near the site where it would be consumed. However, for a variety of reasons, the opposite has transpired, and the dominant model for delivering electricity in industrialized nations is through a network of large centralized power plants linked by a regional transmission grid. As Developing Power and other rural electrification businesses pioneer a new paradigm for bringing electricity to off-grid regions where power is generated locally through renewable energy, the result may be closer to what Edison had originally conceived. The consequences of this outcome are significant in a world where threats to national security, reliability, and climate change play an important role in determining the quality of life for future generations. In addition, wide scale adoption of renewable energy technologies offers the opportunity for further cost reductions in the global market, increasing their competitiveness in more developed markets.

2. Recommendations for Future Research
The recommendations for future research are separated into system design and business model implementation. More research in these areas will support the eventual proof of concept of the Developing Power business model.

System Design
- Integrate the use of HOMER with microgrid design programs such as VIPOR (Village Power Model for Renewables), developed by the National Renewable Energy Laboratory. This will allow for more sophisticated design of systems and optimal placement of microgrid transmission lines.
- Test HOMER results against other design programs such as Hybrid 2, a National Renewable Energy Laboratory optimization program that provides greater resolution at the village level.
- Gather data for an actual rural village or set of villages and use HOMER or other system design models to determine the hybrid power design.
- Run sensitivity analyses on system designs to determine how changes in key parameters affect the life-cycle costs compared to other electrification options.

Business Model Implementation
- Research other geographical regions where the Developing Power model is likely to be effective. This includes markets that have supportive institutional and political environments and that have a viable resource base for supporting hybrid system design.
- Investigate further linkages with microfinance and other rural services that could be combined with the Developing Power business model.
- Continue dialogue with potential investors and sources of capital such as the EX-IM Bank and E+Co.

- Develop an electricity load survey given to rural consumers of electricity that will provide the data needed to effectively model the electricity load parameter in HOMER.
- Test various designs of smart card prepayment systems to find the best system for the lowest cost.

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Presentation Slides for Business Pitch

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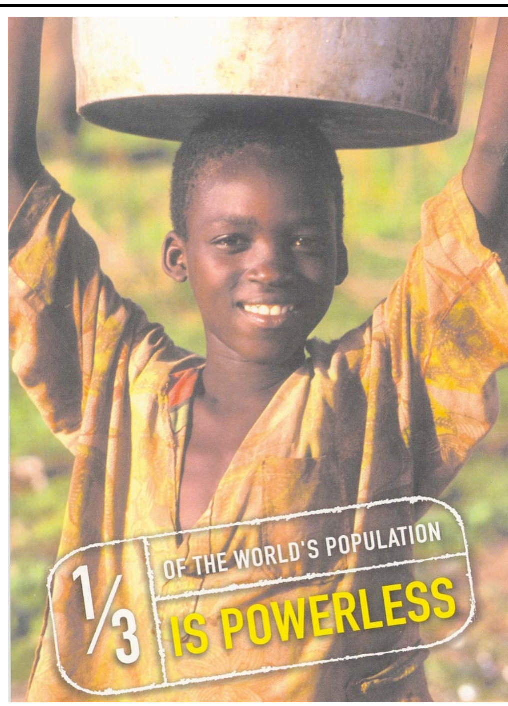
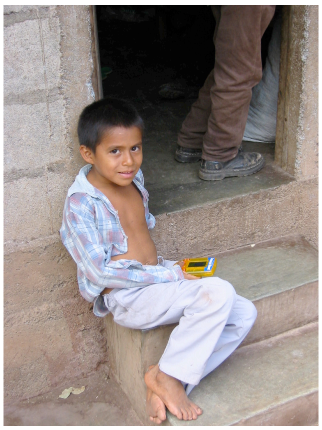
The Problem



The Need

- Electric utilities cannot meet growing demand for power in rural areas
- Utilities currently rely on expensive grid extension as only option
- Utilities under legal obligation to invest in rural electrification



Result: Consumers remain powerless and spend $20 billion per year on ad-hoc energy options such as kerosene, firewood, dung, and batteries

Value Propositions

Benefits to Customers:

Electrification of rural villages for 1/3 the cost of traditional grid extension

Benefits to End Users:

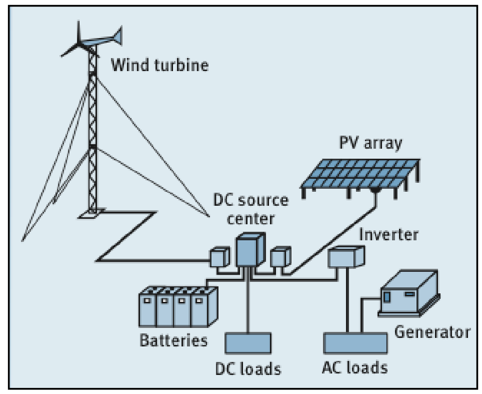
Electricity for 1/5 the cost of what is currently being spent on energy

The Solution: Developing Power

Developing Power Business Model

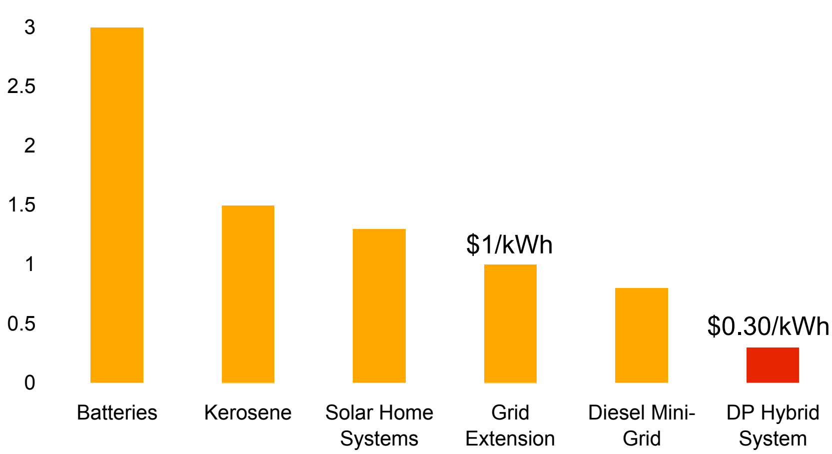
1. Partner with NGOs to obtain access to local markets and to develop deal flow
2. Use HOMER to design optimal system; construct systems based on optimal design
3. Establish Energy Service Company using local labor to maintain and operate the system
4. Implementing pre-payment metering system for collecting payment
5. Sell complete system to a range of potential owners

Hybrid Power Microgrid Systems



Rural Electrification Costs

Average Cost of Electricity for
Village Power Options: 10kW ($/kWh)



Source: National Renewable Energy Laboratory

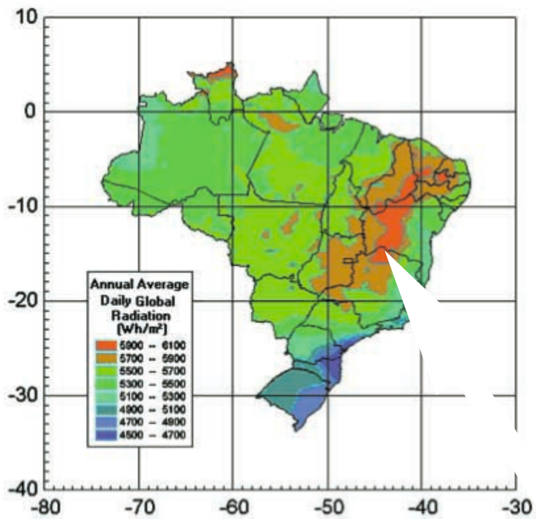
Viable Hybrid Markets

Market Opportunity: Brazil

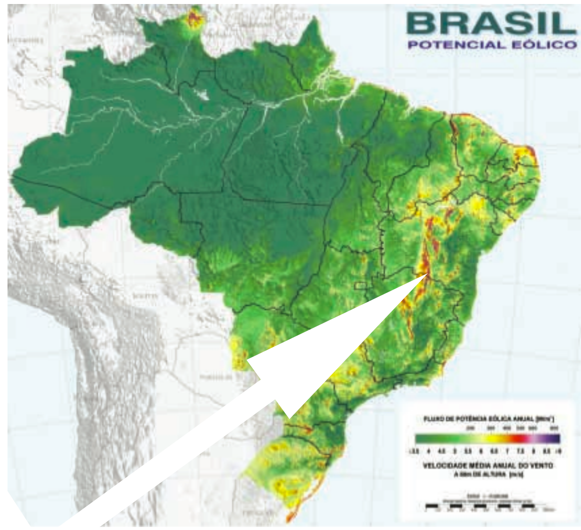
- Brazilian electricity law of 2002: “universal electrification” by 2007
- Concession utilities required to significantly increase investment
- Grid extension rate of only 10,000 households per year in Bahia
- 635,000 households (59%) in Bahia are off-grid
- Law allows independent power producers to develop projects

Bahia Resources

Solar

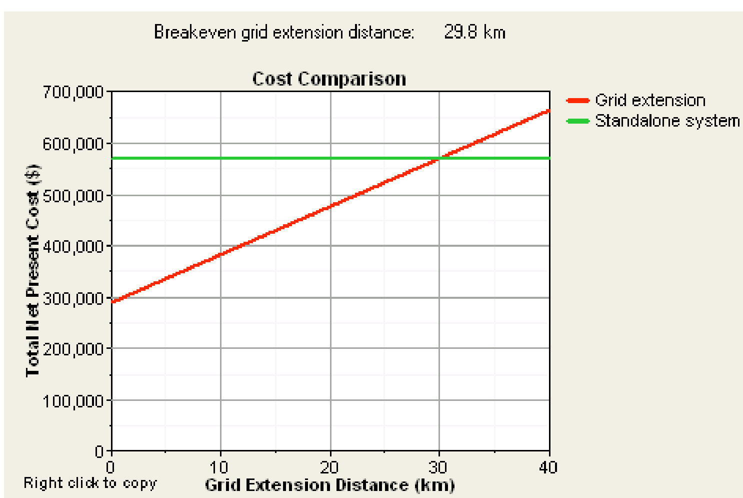


Wind



Bahia has the best solar and wind resources in all of Brazil

Cheaper than Grid Power



Cheaper then Grid Power

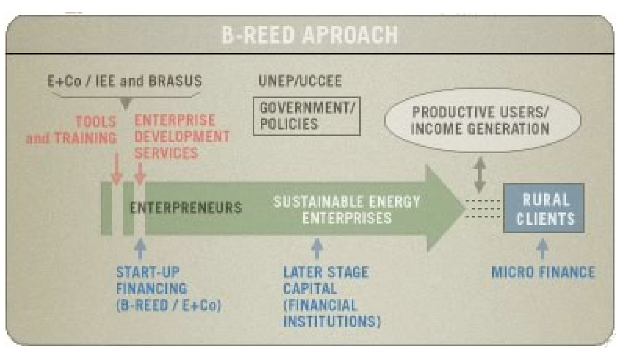
Distance to Grid

Village Size

	< 5 km	5-15 km	15-30 km	>30 km	Total # of villages
< 20 households	5,431	1,810	905	905	9,051
20-40 households	2,304	768	384	384	3,839
40-100 households	759	253	127	223	1,265
> 100 households	573	191	96		955
Total # of villages	9,067	3,022	1,511	1,511	15,111

Build Partnerships

- Help identify villages that are more than 30 km from grid
- Build relationships with NGOs, governmental officials, and utility representatives
- Leverage skills to train microgrid operators and collect resource data
- Develop deal flow for Developing Power

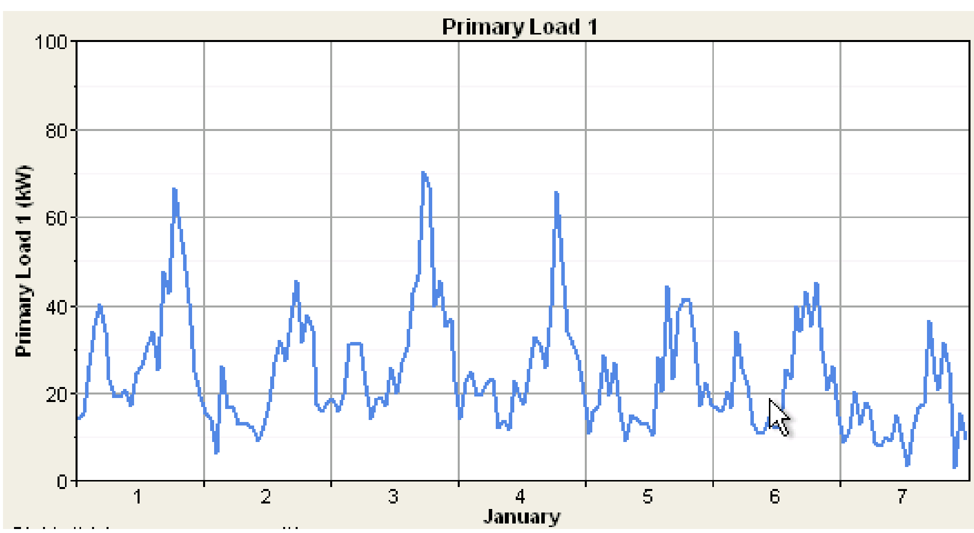


Rural Village Assumptions

Measure	Assumption	Source
Number of people in village	500	500 people is an average size village
Average expected electricity consumption	500 kWh/year/person	Average level of electricity needed to increase productivity (EPRI estimate)
Expected System Size	100 kW	Expected capacity to meet peak loads given electricity demand profile
Downtime of system (% of time it is not providing electricity)	0%	24-hour electricity for productive use; can specify lower % in model
Average wind speed	7.26 m/s	Taken from actual wind site in Brazil (GE Wind Energy)
Average solar radiation	6 kWh/m2/day	Average for inner Bahia
Expected diesel fuel costs	0.2 $/L	Subsidized cost of diesel in rural Bahia

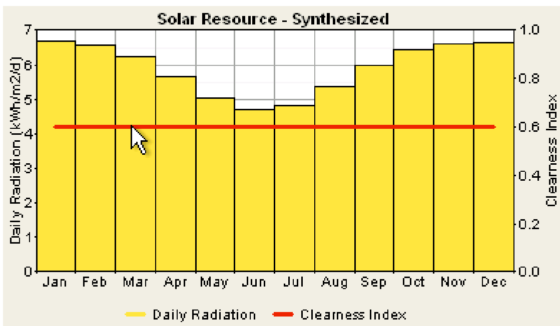
HOMER

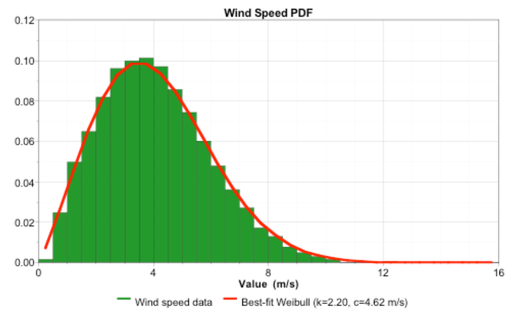
Parameter # 1: Electricity Load



HOMER

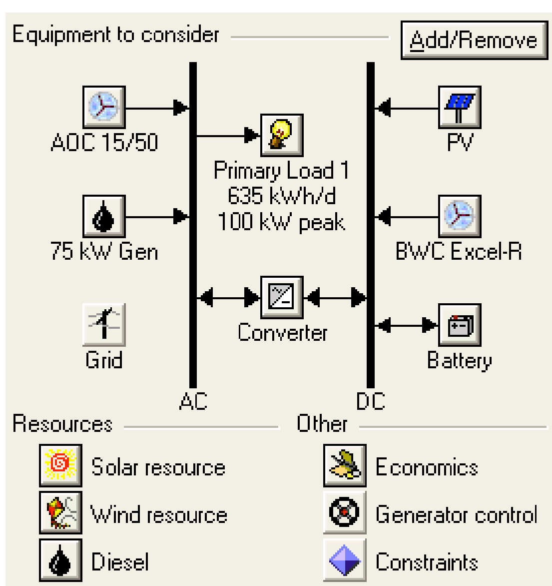
Parameter #2: Resource Availability





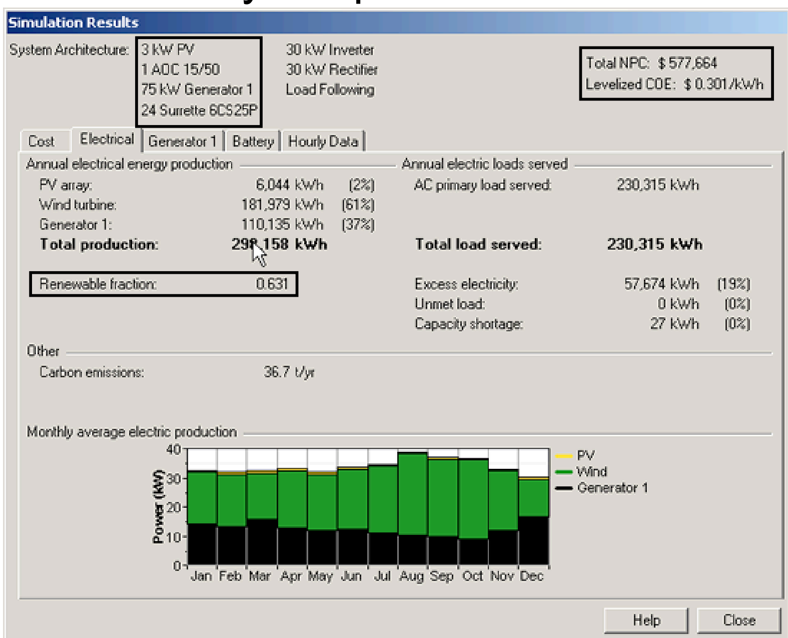
HOMER

Parameter #3: Technologies and Input Costs



Model Results

24-hour hybrid power = $0.30/kWh

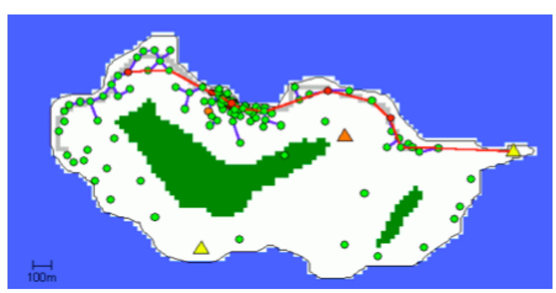


DEVELOPING POWER

Microgrid Installation

Hybrid System in Ceara, Brazil

Microgrid Configuration



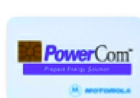
Energy Service Company

- Use local labor to maintain and operate system
- Leverage local partners to train technicians in community
- Train existing mechanics or “fix-it” types that are common in rural communities
- Employ 1-2 technicians per village

ESCO Model Maximizes Sustainability of System

Pre-Payment System

Smart Card



Smart Card Meter

Advantages

- Reduces cash flow risk by collecting payment upfront
- Allows customers to pay when the money is available
- Capitalizes on familiarity with prepayment in Brazil

Benefits to Owners

	Grid[1]	Microgrid
Initial Capital Cost	$400,000	$240,000
Net Present Operating Cost	$350,000	$238,000
Developing Power Fee	-	$100,000
Total Net Present Cost	$750,000	$578,000
Economic Savings to Utility = $172,000		

1 Village 50 km from the grid

New Profit Center

	Grid	Microgrid
Price of Energy	$0.15/kWh	$0.35/kWh
Net Present Revenue[1]	$290,100	$676,700
Profit Margin[2]	-85%	14%

1 Based on annual electricity usage of 230,315 kWh
2 Based on grid extension cost of $1/kWh

- $0.35/kWh charge results in a 14% profit margin for owner
- Expected charge per person per month at $0.35/kWh: $13

Result: DP systems can be sold to a range of potential owners including microfinance institutions, partnering NGOs, and community groups

DEVELOPING POWER

Unique Approach

- First company to focus on the use of hybrid systems in conjunction with prepayment in rural electrification
- One of few experts on HOMER modeling system
- Emphasis on sustainability by working intimately through local partners
- Early lead in Brazil after recent change in electricity laws

DEVELOPING POWER

Competition

Source	Competition
Rural Electrification Companies	Almost exclusively focused on solar home systems
NGOs and International Aid	Not market driven, focus on individual projects to prove technologies
Domestic Utilities	Focus mainly on grid extension

Qualifications

- Joint MS/MBA from the University of Michigan
- 5 years experience in the energy industry
- Co-author of chapter on rural energy in upcoming book by CK Prahalad
- Graduate of renewable energy in developing world course at Solar Energy International
- Rural experience in Costa Rica, Cuba, and Nicaragua
- Proficient in Spanish
- General Electric Wind Energy

Board of Advisors

Strategy

- CK Prahalad: Renowned strategist at the University of Michigan; member of UN Commission on the Private Sector & Development
- Todd Bartholf: Director of Renewable Energy at CH2M Hill; former Senior Officer at Winrock International

Financing

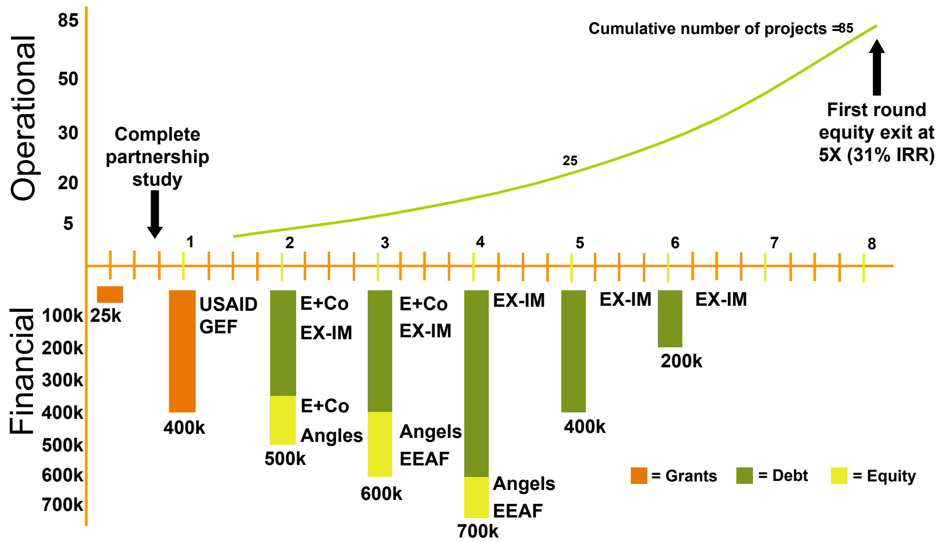
- Gina Rodolico: Senior Officer at E+Co and Program Director for Brazil
- Sanjay Wagle: Principal at Expansion Capital, clean tech investment company

Technology

- Ian Baring-Gould: National Renewable Energy Laboratory, hybrid power design expert
- Marc Ross: University of Michigan, Dept. of Physics, renewable energy expert

Growth Milestones

- Growth targets: 25 villages in five years
- Average system size: 100 kW
- Revenue per system: $300,000
- Financing after Year 1: 80% leverage (EX-IM Bank) & private investment



DEVELOPING POWER

Initial Efforts

Investment

- E+Co: Premier rural energy investment company
- Solar Development Group

Local Access & Knowledge

- Winrock International, Bahia Office
- Baixo Santa do Alto Gloria
- Instituto de Desenvolvimeinto Susentavel Energies Renovaveis

Technical Support

- National Renewable Energy Laboratory
- Energy and Security

Microfinance

- Parwaz
- Accion International

Benefits to Consumers

Energy Source	Cost	Total Cost per Person per Month	Power Quality
Batteries	$3/kWh	$160	Poor
Kerosene	$1.5/kWh	$80	Poor: limited to lighting, health risks
Solar Home Systems	$1.3/kWh	$50	Medium: not capable for larger uses of electricity
Diesel Microgrid	$0.80/kWh	$30	Medium: intermittent, usually only operating 4-6 hours per day
Developing Power Hybrid System	$0.35/kWh	$13	High: 24-hour electricity

Benefit Estimates

Benefit Category	Monthly Benefit at Household Level
Education and Earning Potential	$53
Human Health	$75
Productivity	$57
Environment	$1
Communications	$5
Total Benefits	$191

SROI

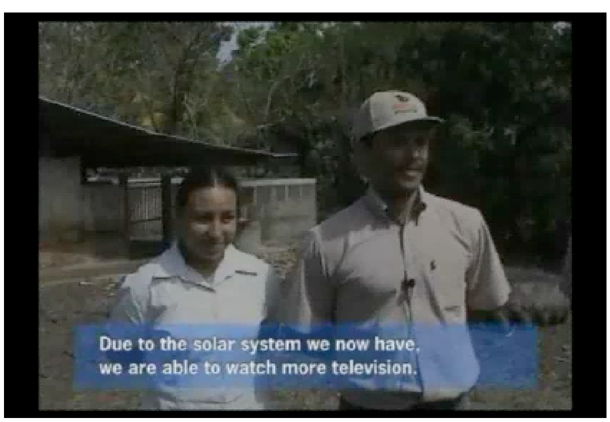
Social Return on Investment
(in $1,000 USD)

	Year 1	Year 2	Year 3	Year 4	Year 5	...	Year 10
Number of Projects	1	2	4	7	11	...	35
Cumulative Number of Projects	1	3	7	14	25	...	150
Cumulative Number of Households Served	100	300	700	1,400	2,500	...	15,000
Social and Environmental Benefits							
Education and earning potential	$0	$0	$0	$0	$127	...	$5,088,000
Communication and entertainment	$7	$20	$47	$93	$167	...	$1,000,800
Productivity in home businesses	$12	$37	$86	$171	$306	...	$1,836,000
Productivity in households	$28	$83	$193	$386	$690	...	$4,140,000
Human health benefits	$0	$0	$90	$270	$630	...	$7,650,000
Environmental benefits	$0	$0	$1	$2	$4	...	$22,500
Total Social and Environmental Benefits	$47	$140	$416	$921	$1,920	...	$19,714,800
Operating and Capital Costs							
Total operating expenses	($198)	($334)	($405)	($508)	($609)	...	($2,051,266)
Capital expenditures	($120)	($320)	($640)	($1,160)	($1,786)	...	($5,940,000)
Total Operating and Capital Costs	($318)	($654)	($1,045)	($1,668)	($2,395)	...	($7,991,266)
Social Purpose Benefit Flow	($271)	($514)	($629)	($747)	($475)	...	$11,723,534
Discount rate	10.3%						

NPV of Social and Environmental Benefits	**$24,628,180**
NPV of Project Costs	**$16,186,343**
Benefit-Cost Ratio	**1.5**
Social Purpose Value	**$8,441,837**

Blended Value	
Enterprise Value	$8,580,672
Social Purpose Value	$8,441,837
Less: Long Term Debt	$1,900,000
Blended Value	$15,122,509

The Context



Developing Power

- Provides power systems for 1/3 the cost of traditional grid extension
- Delivers electricity for 1/5 the cost of what is currently spent on energy
- Returns $1.5 in social and environmental benefits for every $1 invested
- Plans to electrify 25 large villages in 5 years, reaching 12,500 people
- Seeking $500,000 in equity capital over 3 years with a return of 5X (31% IRR) to first round investors
- Asking for $25,000 to complete partnership study and a $400,000 grant to implement the first pilot project