Report to the Oak Foundation on the Potential for Bundled Services for Unserved Communities in Belize

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Overview

With high levels of poverty in the southern area of Belize, development of this region is a priority of the national government. A key instrument in meeting this goal is enhancing access to critical services such as electricity and telecommunications. Traditionally, strategies to enhance such services have been undertaken separately, with little overlap. While progress in the development of off-grid electricity technologies and wireless communication have enabled populations without access to these services to gain access much more quickly than with traditional wire-based services, the synergisms that could emerge if such services were "bundled" together never materialize.

In contrast, when these services are bundled—which has only become technically feasible in recent years—providing simultaneous electrification, telecommunications, and Internet access, a wider range of critical end-use services and benefits, including productive uses, can be provided to under-developed communities. Basic electrification can be made available for households at the same time that electricity, telecommunications, and Internet access is provided for local entrepreneurs and businesses, as well as community facilities such as schools and health clinics. The potential benefits are substantial. Local businesses and microentrepreneurs can have access to new mechanisms to advertise their products and services more widely, thereby expanding their markets. Local schools can have entrée to a variety of new educational tools, ranging from Internet-based training to enhanced access to information resources. And local health clinics can enjoy benefits ranging from expedited information on accessing critical medicines and medical equipment to the capacity to consult with medical personnel elsewhere within and outside Belize on problematic health cases. The combination of these services therefore offers significantly greater value to the population served and simultaneously holds out the promise of enhancing the commercial viability of the investment.

Despite the potential benefits that the provision of "bundled" services can offer under-developed rural populations, the fact that such services have only become technically feasible recently means that widespread experience with the deployment of such services has yet to occur. The Renewable Energy Policy Project (REPP), a non-profit organization based in Washington, D.C. that works to accelerate the application of renewable energy technologies

in uses that meet critical needs, has received a grant from the Oak Foundation to evaluate the potential for bundled services in southern Belize as part of the government's strategy to assist the region in meeting its developmental goals.

During the week of June 9-15, 2002, REPP's work was initiated when two persons, George Sterzinger, the Executive Director, and Deborah Bleviss, a Senior Fellow, undertook a fact-finding trip to Belize. The purpose of the trip was to meet with critical governmental and private sector institutions in the country to determine interest in supporting a bundled services approach, evaluate the economic and engineering feasibility of providing bundled services in southern Belize and the necessary institutional support to carry it out, and develop a strategy for next steps.

Sterzinger and Bleviss met with representatives from the government, the private companies now providing telecommunications and electricity services, and representatives of non-profit organizations and communities in the southern Toledo District, the most impoverished part of the country and the region with the largest number of unserved communities (see list of meetings in Annex 1). Visits were made to possible demonstration sites, including Monkey River (a community of about 200 persons) and Punta Negra (a community of about 20 persons) on the Belize coast, as well as Pueblo Viejo (about 500 persons), an inland Mayan farming community.

Map of Belize

Based on this initial work, REPP has reached the following conclusions:

- Bundled services appear to be economically and technically feasible for many unserved communities in the country.
- REPP recommends that we move forward with a dual strategy. First, a pilot demonstration project is developed for Belize to demonstrate the technical and economic feasibility of the technology, and build the institutional and regulatory capacity to replicate the bundled services approach more widely. Second, and equally important, a process is initiated of engaging multilateral institutions, including potentially the Global Environmental Facility, and other interested funders to integrate bundled services approaches in their financing strategies.
- The pilot should consist of four components: a detailed technical and economic feasibility assessment; investment in the physical facilities; support for the appropriate regulatory changes to enable bundled services to be replicated elsewhere in the country; and the development of local institutional capacity, again to enable replication of the project. The cost of the pilot is estimated to be between $240,000 and $320,000.
- The recommended site for the pilot demonstration is Monkey River. Monkey River enjoys a variety of attributes that render it an attractive candidate for a demonstration. These include: a plentiful wind resource; a flat terrain that will render telecommunications costs relatively low; the existence of a mini-grid electrical distribution system as well as the community's experience with operating an off-grid electrical generation system; and a high degree of activism in the community along with some indigenous capacity to design and implement renewable energy and telecommunications systems.
- Critical to the success of the demonstration in spurring replicablity is the structure of the project financing and the regulatory changes that are intended to proceed simultaneous to the demonstration. While the first-cost of the physical facilities should be paid upfront in full to enable the project to be implemented, some of these costs should be reimbursed over time. These reimbursed funds may be placed in a revolving loan account for application

in other communities in the future or they may be returned to the original funders. As these financial structures are being designed for the implementation of the demonstration, similar work needs to proceed on restructuring overall government tariff and regulatory policy towards off-grid bundled services, so that these services may be replicated cost-effectively in other communities. To ensure that these policy changes take place, REPP recommends that the funds for the next phase be released at key milestone steps once government progress in implementing the changes is demonstrated.

- Also critical to spurring replication is the local institutional capacity to oversee the demonstration and then work with other local communities to develop their own bundled services programs. The Toledo Institute for Development and the Environment (TIDE) has expressed great interest in assuming this role. Other local institutions, such as Friends of Nature, may also be interested in being involved.
- Officials from at least two government programs see potential benefits from providing communities with access to electricity and Internet services, and have expressed an interest in participating in a bundled services pilot and possibly providing some financial support. They are the Ministry of Agriculture's CARD program, and a tour guide training program funded in part by the Inter-American Development Bank's Multilateral Investment Fund (MIF). In addition, a new program being developed by one of the telecommunications companies, INTELCO, to provide schools with computers and Internet hook-up also has the potential for participating with the bundled services demonstration, again possibly providing some financial support. Finally, the Global Environmental Facility's (GEF) Small Grants Program has indicated potential interest in providing some funding for a bundled services demonstration.

Existing Situation in Belize

Belize has an estimated 18 to 25 unelectrified communities[1]. These are found predominantly in the Toledo District. The unelectrified communities include inland Mayan farming villages, ranging in size from 500 to 700 inhabitants; two coastal communities, Monkey River and the much-smaller Punta Negra; and several small communities located on the offshore cayes. Many of these unelectrified communities have access to telecommunications services through a single community phone powered by photovoltaic solar panels; however, these telecommunications services lack sufficient broadband width to satisfactorily provide access to Internet services. In several of these communities, a few wealthier inhabitants, frequently shop owners, have access to additional private telecommunications services as well as private diesel-powered electricity generators to meet their electricity needs.

The lack of access to electricity and higher-quality telecommunications services has had a substantial negative impact on the development and growth of these communities. Without electricity services, the capacity of the children to study for school after nightfall is limited. Lack of electricity services has also constrained what the local health clinics can do, including storing and dispensing vaccines.

For the inland Mayan communities, many of which have been settled by recent Guatemalan Mayan immigrants familiar with "slash and burn" agricultural techniques, the lack of access to services has left them quite isolated, both in learning techniques to yield more productive and sustainable farming, as well as finding markets for their products. Hence, they continue largely with a subsistence farming lifestyle.

For the coastal communities, lack of access to services has also created a host of problems constraining their development. With limitations on fishing, the fewer fish that may be caught cannot easily be brought to market due to the lack of refrigerated storage. Fishermen interested in retraining for tourist-related professions, such as tour guides, lack

[1] A partial list includes: Bladen, Crique Sarco, Dolores, Esperanza, Golden Stream, Jalacte, Monkey River, Nalunca, Otoxa, Pueblo Viejo, Punta Negra, San Jose, San Pablo, Santa Cruz, Santa Elena, Swasey, Tambrand, and Trio.

easy access to training facilities as well as to services that can market their availability. And the development of tourist lodging on the attractive sandy beaches in the area is necessarily constrained if basic electricity services cannot be provided.

The main strategy used by the government to bring electricity to these communities—which is preoccupied by the final stages of privatizing its electricity, telecommunications and water sectors and setting up the appropriate regulatory oversight framework—is to subsidize the cost of extending the grid to these communities. The official policy is to divide the capital cost of line extensions into a subsidized and non-subsidized portion so that the non-subsidized investment is allowed to earn a 10% return on investment for the expected level of net revenue. (This general policy structure has been incorporated into the financial analysis REPP developed for the initial assessment of the bundled off-grid investments.) A five-year plan has been drawn up by the private electricity company, Belize Electric, Ltd. (BEL), for providing electricity services to most unelectrified communities in the country, a plan that calls for substantial subsidization from the national government. BEL officials concede, however, that they are running behind in implementing the plan, especially after the infrastructure damage caused by Hurricane Iris in 2001. Indeed, several of the communities REPP officials visited indicated they have been hearing a promise of electricity for at least five years. In fact, with multiple demands for government resources in a fiscal environment in which national debt has increased substantially, it is unlikely the government will be able promptly to meet the subsidization requirements for extending the grid to these isolated communities.

To date, there has also been little serious assessment by the national government of the potential for off-grid electricity supply to meet the needs of isolated communities. One community, Monkey River, was provided a diesel generator by the government, with BEL building the distribution network to the homes. The community was responsible for purchasing the fuel, maintaining the system, and collecting the fees to pay for both. While grid-connected customers receive a subsidy that renders monthly electricity costs for a basic level of services (generally lights and a fan) to be B$10[2], the Monkey River community did not receive a similar level of subsidy, although the import tariff for the diesel fuel was waived. As a result, the monthly household cost was so high that the community chose only to

operate the generator four hours a day (from 6 to 10 p.m.). The generator and distribution system were subsequently destroyed by Hurricane Iris. The generator has been replaced by the government, and BEL invested in a new mini-grid distribution system for the community, complete with street lights. But the import tariff for the diesel fuel is no longer waived, rendering its price more than B$5 per gallon. With such a substantial increase in the fuel price, the community has decided not to run the generator at all.

There are several programs that could synergize well with bundled services implementation, and, by sharing some expenses, could further reduce the costs of implementing a bundled services package. A program operated by the Ministry of Agriculture, known as CARD, provides services to small farmers and fishermen with the goal of increasing their incomes by enhancing their yields and finding markets for their products. Preliminary discussions with program officials indicate there is a willingness to consider sharing funds for projects that could result in farmers having access to computers and Internet services which would improve their productivity and assist them in marketing their products. In addition, a program implemented through the Belize Tourism Board (BTB) and the Belize Tourism Industry Association (BTIA), and partially funded by the Inter-American Development Bank's MIF program, is focused on retraining fishermen who have been historically overfishing the coast to be tour guides; a significant component of the program involves Web-based training. Again, preliminary discussions with program officials indicate a willingness to "share" costs for computers and related Internet hook-up equipment in now-unserved coastal villages participating in such a training program.

Furthermore, a new program is being launched through INTELCO, a telecommunications company that will begin operations in Belize in 2003, that will provide computers and access to the Internet for 500 schools in Belize. Initial discussions with INTELCO officials indicate they would be willing to have some of those computers and Internet connections be located in schools within communities getting bundled off-grid services. INTELCO officials indicated support for a strategy in which the computers were used by the schools during school hours, but then functioned as fee-for-service Internet "cafés" after hours.

[2] The exchange rate is US$1 = B$2.

Conclusions

For many of the unelectrified communities in Belize, preliminary assessment by REPP indicates that an off-grid electrification strategy, combined with a telecommunications/Internet package, is a more cost-effective option than grid extension, as well as one that provides more value. In the specific case of Monkey River, for example, this community is 12 miles from the nearest grid connection. With general cost estimates for grid-extension ranging between $10,000 and $20,000 per mile, the cost for grid extension for this community is projected to be between $120,000 and $240,000, and these costs do not include the additional generation costs to supply electricity to the community. In contrast, the estimates for the off-grid electrification and wireless interconnection are between $100,000 and $125,000.

Moreover, it is likely that bundled services packages can be implemented more quickly than can extension of the grid. For the coastal communities, wind appears to be an attractive resource, with solar photovoltaics potentially meeting electricity needs in smaller communities. For inland communities, photovoltaics, possibly operating in a diesel-hybrid system, appear a likely option. With recent technological strides, the telecommunications component is the least expensive part of the bundled services package, with costs in some communities (which do not require relay stations) potentially amounting to as little as hundreds of dollars.

Financial Feasibility

As noted above, an initial financial analysis by REPP of off-grid, bundled services projects that characterize the conditions in the unserved areas of the Toledo District indicates that such services appear to be feasible and viable for this area of Belize (see Annex 2 for detailed analysis). The analysis contains reasonable estimates of costs and policies (which, though not yet in place, have been assumed based upon positive initial reactions from government policymakers). In particular, the analysis incorporates cost estimates for electric generation equipment and wireless telecommunications connections representative of market prices today. Equally important, project revenues are based on rough approximations of what grid-connected residential customers pay for basic service.

Two different types of projects were examined: a coastal option and a mountain option. The coastal project analysis is based on REPP's present understanding of the type of project that would support bundled services for the community in Monkey River. Hence, the coastal project relies on a 20 kilowatt (KW) wind turbine to supply electricity. In addition, no cost was assumed for the construction of a distribution grid since this grid is present in Monkey River. The mountain project relies on photovoltaic-based "solar home systems" for electrification because the wind resource appears inadequate in the mountainous regions. For both types of projects, the telecommunications component is assumed to be wireless technology capable of providing both the distance and bandwidth coverage required, namely modified WiFi technology. WiFi technology is currently sold commercially to provide wireless local access networks for homes and businesses. Several firms are modifying the technology to provide long distance line-of-sight applications (up to 10 miles). (More detail on the application and development of this technology is provided in a copy of a newspaper article in Annex 3.)

For both the coastal and mountain options, the feasibility analysis provides for the reduction of the initial capital cost to reflect the social functions served and/or the government's willingness to reduce the cost to users; as noted earlier, this is presently done for grid-connected customers. Capital costs were reduced so that users would pay a monthly tariff no greater than approximately the "typical" bill for residential users served by the grid and the project investors would earn no more than a 10 percent internal rate of return on their investment in the project. As indicated above, the "policies" upon which this analysis is based are not presently in place. Rather they will require consideration by government and regulatory officials and would be part of the negotiations of the pilot phase.

At this point, the financial analysis is not intended to offer a final answer to the question of project viability and feasibility. The best use for this type of financial analyses is to provide a framework for review of the project. In particular, it provides an outline of the project into which many of the specific conditions that determine whether the project is "feasible and viable" can be placed. To be "feasible and viable" a project must simultaneously meet several minimum conditions. It must be commercially viable, that is, loans must be judged to be able to be repaid and some reasonable return on equity

investment must be possible for investors to achieve after all critical costs have been covered. In addition, the project must provide quality service equal to or better than either the presently available and/or the grid service the project is displacing. It must also be affordable to a sufficient number of the population to qualify as providing that community with service. Finally, the project must assume reasonable levels of financial and policy support from the national government, non-governmental and multilateral agencies that would participate in the project

The final resolution of the specific value for many of the variables will depend upon negotiation with policy makers, community leaders, and other interested parties. By providing a framework in which the broad structure of the project can be understood, and by providing all participants a chance to see the range of variables and the effect changes in variables will have on the project, the analysis of commercial feasibility can be used to negotiate the critical next steps. This work will be a critical part of the pilot demonstration phase.

Pilot Demonstration

Based upon the existing situation in Belize and the initial financial analysis, REPP recommends that we move forward with a "pilot demonstration" of the bundled services approach. This pilot demonstration phase should consist of four components:

1) Conduct a detailed technical and economic feasibility assessment of the proposed demonstration site.
2) Implement the physical demonstration.
3) As the feasibility assessment and demonstration progress, work with the government and private sector institutions to define and put into action the critical policy and institutional changes that will enable Belize to implement bundled off-grid services on a wider scale.
4) Develop the local institutional capacity to oversee the implementation of the demonstration, participate in the policy and institutional changes at the national government level, and eventually expand the demonstration to other communities.

REPP recommends that the demonstration be a coastal demonstration focusing on Monkey River for the following reasons:

- *First*, the Monkey River community is sufficiently large as to make wind a cost-effective option for electricity generation in an area in which wind is abundant. Solar photovoltaics, in contrast, would be a more expensive option. Moreover, Monkey River's flat terrain also renders the telecommunications component relatively inexpensive (see the financial analysis in Annex 2).
- *Second*, the community already has had experience with off-grid electricity generation with the diesel generator it had used prior to the hurricane. This experience included organizing for the maintenance of and payment collection for the system.
- *Third*, the infrastructure already exists for a mini-grid distribution system to individual users. As noted earlier, BEL rebuilt the distribution system after the hurricane, although it is presently not hooked up to any electricity supply.
- *Fourth*, there is already some indigenous experience in the community with designing and implementing renewable energy/telecommunications systems. One of the entrepreneurs in the community, Elinor Sandlin, had an operating small wind turbine and photovoltaic system to run her shop and enable her access to telecommunications, including Internet services; the system was destroyed during Hurricane Iris.
- *Fifth*, the community is well-recognized as being very activist and organized. Frequent meetings have been held with the Prime Minister and other government officials on issues ranging from access to electricity to hurricane recovery to eligibility to participate in the program to put computers in schools.
- *Sixth*, at least two of the programs identified by REPP that could potentially share in the project costs have direct applicability to Monkey River, and the community has already engaged in some discussions about these programs. With Monkey River located in the midst of the marine conservation region and with many of its residents historically making their living as fisherman,

the Belize tourism training program is directly applicable to the village. Indeed, preliminary discussions with BTIA indicate a willingness to include Monkey River in its Internet tour guide training program. Similarly, as noted earlier, Monkey River has already had discussions about its eligibility for the computers-in-schools program; at the time of the discussions, the community was told that if it had electricity, it could get the computers.

- *Finally*, with Monkey River situated between the inland villages and the offshore cayes, it would be a centrally located focal point for a demonstration, with residents of both being able to visit the site relatively easily.

The other communities evaluated in the fact-finding mission do not enjoy all the advantages as a potential demonstration site that Monkey River does. For the inland communities the electricity component of the bundled systems is expected to cost more both because wind is not as likely to be an option and the larger communities will require more energy supply. Moreover, the "hilliness" of the inland villages also means that the telecommunications component will probably be more costly since the use of several relay stations will likely be required. (For those communities with community phones, the towers for the relay stations are already in place, but new equipment will be required on each station.) Furthermore, the communities have not had any experience with community-based off-grid generation, have no existing mini-grid infrastructure in place, and do not appear as activist as Monkey River. Moreover, they do not seem to have progressed as far as Monkey River in exploring the potential applicability of the three programs that could eventually share in the costs of a bundled services project.

The other site visited, Punta Negra, located approximately 7 miles southwest of Monkey River on the coast, is very small. There are only about 20 residents in the community, rendering it too small to make cost-effective use of a wind turbine. There are plans to add a Guest House to Punta Negra, but the electricity demand is not likely to grow substantially as a result. It should be noted, however, that in conversations REPP had with the representative of the GEF Small Grants Program, he expressed some interest in having the Program possibly support a second demonstration; he noted a potential interest in Punta Negra.

1) Feasibility Assessment

Before a full-scale demonstration could successfully be implemented, a detailed technical, financial, and institutional feasibility study would need to be undertaken. This assessment would determine the optimal technologies to be used, in supplying both the energy and the telecommunications components. It is likely that some mapping of the renewable resource would need to be made as part of this process. The feasibility study would also address critical institutional features, including the community structure for maintaining the system and for collection of the fees from community users. Furthermore, the assessment would include a detailed appraisal of the portion of the demonstration in which expenses could be shared by such cooperating programs as the CARD program, the tourism training program, and INTELCO's school computer program. Finally, the feasibility study would develop a proposed fee structure for users of the bundled services. It is expected that such a fee structure would adhere to the following basic principles: first, for electricity services, all users would pay a fee, but at a subsidized rate roughly similar to what grid-based users pay; and second, for Internet and telecommunications services, only commercial uses would be charged a fee which would cover the incremental costs of using the equipment plus some fee to help support the overall effort.

2) Demonstration

Implementation of the demonstration would be a critical element in the path to replicating the bundled services approach elsewhere in Belize as well as outside of the country. Based upon the initial financial and technical analysis, the energy component of the demonstration is expected to consist of a 12 to 20 KW wind turbine with possible ancillary photovoltaics installations.[3] The telecommunications and Internet service is anticipated to be provided by modified WiFi technology and would be limited to one or two initial computers. REPP recommends that the initial first-cost of the bundled services pilot be paid in full by the donors so that the "proof-of-concept" may be implemented expeditiously. However, part of that cost would be repaid through the fees paid by the users

of the bundled services. The funds received from the fees could be returned to the donors or placed in a revolving loan account where they could be applied to future bundled services investments in other communities in the country.

3) Policy and Institutional Changes

Off-grid bundled services cannot be implemented on a wide scale in Belize unless they are accorded equivalent treatment as grid-connected electricity services. As noted earlier, whereas grid-connected rural customers pay an electricity bill of approximately B$10 monthly for a basic level of services, the experience with off-grid electricity generation in Monkey River rendered an effective exorbitant cost to the community of B$.40 per kilowatt-hour (kWh); for a base level of equivalent services, this would amount to a household electricity bill of approximately B$20 per month at an average use of 50 kWh . In preliminary conversations REPP had with the Chairman of the Public Utilities Commission or PUC, created in 1999 to oversee and ensure fair and equitable provision of electricity, telecommunications, and water services from the private sector, the Chairman indicated a willingness to extend the presently articulated policies with respect to subsidizing grid extension to off-grid bundled services projects.

Critical in the process of moving from demonstration to replication is the identification, development, and implementation of important policy and institutional reforms within the national government that establish a fair and equitable strategy for bringing electricity and telecommunications to rural areas. Without these changes, replication of the bundled services approach is not likely to move forward in Belize. Among the changes needed are the development of a structure for evaluating whether grid or off-grid electrification for any given community is more cost-effective, and the establishment of a tariff policy that provides the same costs for basic electricity services regardless of whether these are grid-based or off-grid. There may also be a need to address reforms in the telecommunications arena, including whether integrated franchises or ownership models may be allowed which provide both electricity and telecommunications services.

[3] A 20KW wind turbine was assumed in the financial analysis to be conservative on costs.

To ensure that the demonstration does not move forward without these changes being developed and implemented, REPP recommends that the funding of the demonstration phase be broken into several distinct stages, with funding allocated accordingly, and key policy reform milestones defined for each stage. In order for funding to be released for each stage, adherence to the applicable milestone for the previous stage would have to be demonstrated.

4) Development of Indigenous Institutional Capacity

Also critical in the process of moving from demonstration to replication is the development of indigenous institutional capacity to oversee implementation of the bundled services approach. Development of such a capacity within a local institution offers many benefits. First, an institution within close proximity of the demonstration site can be available to oversee critical elements of the implementation, responding quickly to any problems that may develop. Second, the institution can play an important role in undertaking the necessary training for the community as a whole, as well as the specific individual(s) responsible for system maintenance and repair, and for collection of the fees. Finally, with the experience it gains during the demonstration phase, the institution could then seamlessly switch to facilitating and overseeing replication in other communities.

The development of indigenous institutional capacity would consist of several concrete components. First, the institution would need to hire a full-time staff person with technical expertise in renewable energy and telecommunications. As part of the capacity-building process, this staff person would work closely with the experts undertaking the feasibility assessment and the actual implementation of the demonstration. The institution would also be responsible for undertaking the necessary training for the community involved in the demonstration as well as for the individuals in the community responsible for specific jobs. Finally, the institution would be responsible for working with other communities to replicate the bundled services approach once the demonstration is complete.

REPP spoke at length with individuals from Toledo Institute for Development and the Environment (TIDE), which is responsible for conservation of the protected marine

sanctuary off the coast of Toledo. TIDE expressed great interest in assuming this institutional role, seeing it as a logical component of its mission statement to support sustainable development in Toledo. Indeed, TIDE has already waded into the area of renewable energy, since it has outfitted one of its ranger stations with a photovoltaic array to provide electricity services. Other local institutions may also have an important role to play in the pilot demonstration. In recognition of this potential institutionalization role, REPP initiated discussions with the GEF Small Grants Program about supporting some portion of a local institution's costs during the demonstration phase. TIDE is now following up with more specific discussions with personnel from the Small Grants Program.

In addition to a direct implementation role in the pilot demonstration, it is also important to ensure that representatives of critical institutions and functions from within the Toledo District are consulted and feel ownership of the bundled services project in order to foster interest in replication and ensure that the interests and concerns of Toledo's residents are addressed. Hence, REPP recommends that consideration be given to creating an oversight committee or board. Such a board could include representatives of local businesses, and such institutions as Friends of Nature and the Toledo Development Corporation.

Cost of the Pilot Demonstration Phase

The estimated cost of the demonstration phase is between US$240,000 and US$320,000. A breakdown of the costs by each component is shown below.

Expected Costs for Demonstration Phase of Bundled Services Project

Component	Cost Including Cost Sharing
1) Feasibility Assessment	$50,000 - $60,000
2) Implementation of Demonstration	$100,000 - $125,000
3) Policy and Institutional Changes	$50,000 - $75,000
4) Indigenous Institution-Building	$40,000 - $60,000

Replication of the Bundled Services Approach

As the demonstration phase proceeds, REPP plans to work with its partners in Belize and beyond to identify the best options for replicating the bundled services approach in other unserved communities in Belize and potentially in other countries as well. A variety of potential sources of funding have been identified, but their suitability will depend on the timing of the actual replication phase. A brief summary of the potential sources of funding is provided below:

1) Multilateral Development Banks—REPP has engaged in a long-standing dialogue with the Inter-American Development Bank (IDB) about its interest in providing a loan to Belize to support off-grid electrification. In the 2000-2001 period, IDB had undertaken a study of potential rural electrification strategies and projects for the Central American countries, including Belize. Loans or technical assistance projects were identified for all countries in the region except Belize. Hence, there has been interest at IDB in the bundled services approach due to this gap. Moreover, there has been some experience in IDB with the bundled services concept since a loan in this subject area was approved for Honduras last year. At present, however, IDB is not developing any new loans to Belize because the country has exceeded its debt limit.

2) Global Environmental Facility (GEF)—REPP has also been exploring the potential for support from the GEF in a future replication phase. Among renewable rural electrification projects, the GEF has given a high priority to those that support "productive services". Discussions have ensued with two possible host organizations, the IDB and the United Nations Development Program (UNDP). Discussions have proceeded further with UNDP because it has greater institutional capacity and experience in developing GEF projects. Among the options the UNDP has mentioned is the possible development of a Medium-Sized Project, a window in the GEF that allows for expedited project review and approval for projects receiving GEF funding of one million dollars or less. At present, however, development of all GEF projects has been placed on hold due to problems with non-payment of past-year obligations by the U.S. government.

3) Caribbean Development Bank (CDB)—A facility has recently been created within the CDB to proffer renewable energy loans. With some GEF funding through the UNDP, this program, the Caribbean Renewable Energy Development Project (CREDP), has just initiated preparatory activities to be conducted over the next 6 months that will establish the financial mechanisms to be used by the project.

4) Expansion to Honduras and Guatemala—TIDE is presently engaged in a program to integrate its marine conservation oversight activities with those of Guatemala and Honduras, working primarily with NGO counterparts in these countries. During REPP's fact-finding trip, the idea was raised of extending this tripartite cooperation into bundled services. Such a strategy could integrate well with IDB's loan for bundled services to Honduras and the ongoing activities in that country in off-grid rural electrification by Soluz, a small private company.

ANNEX 1

Meetings Held During REPP Fact-Finding Trip to Belize

National Government

Dr. Gilbert Canton,
Chairman, Public Utilities Commission
Ismael Fabro,
Department of the Environment
Sergio Garcia,
Chief Agriculture Officer, Ministry of Agriculture, Fisheries & Cooperatives
Daedra Isaacs,
Executive Asistant, Ministry of Budget Management
Cresensio Sosa,
CEO, Ministry of Investment and Public Utilities

Private Companies

Gary Bennett,
Belize Telecommunications Ltd.
Juan McKenzie,
CEO, INTELCO
Lynn Young,
President and CEO, Belize Electricity Limited

Other

Andrew Godoy,
General Manager, Belize Tourism Industry Association
Philip Balderamos,
National Coordinator, GEF Small Grants Program, Belmopan

Toledo District

Dr. Ludwig
Palacio, Manager,Center for Employment Training
Wil Maheia,
ExecutiveDirector, Toledo Institute for Development and the Environment (TIDE)
Elinor Sandlin,
Businesswoman, Monkey River Town
Town Council, Monkey River Town
Village Council, Punta Negra
Village Director, Pueblo Viejo

Belize Coastal Investment Analysis - Base Case
Micro Grid 20 year Financial Analysis

Project Investment	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Generation																				
Wind Turbine and Inverter	100,000.00																			
Diesel Gen Set	0.00																			
Battery Storage	40,000.00																			
Distribution																				
Primary	0.00																			
Secondary	0.00																			
Wireless Link	1,000.00																			
Total Investment	141,000.00																			
Private Use Cost Share	35,250.00																			
Debt	28,200.00																			
Equity	7,050.00																			
Revenue																				
Internet Kiosk Revenue	500.00	535.00	572.45	612.52	655.40	688.17	722.58	758.71	796.64	836.47	861.57	887.41	914.04	941.46	969.70	998.79	1,028.76	1,059.62	1,091.41	1,124.15
Electric revenue	7,500.00	8,025.00	8,586.75	9,187.82	9,830.97	10,322.52	10,838.64	11,380.58	11,949.61	12,547.09	12,923.50	13,311.20	13,710.54	14,121.86	14,545.51	14,981.88	15,431.33	15,894.27	16,371.10	16,862.23
Households	50.00	53.50	57.25	61.25	65.54	68.82	72.26	75.87	79.66	83.65	86.16	88.74	91.40	94.15	96.97	99.88	102.88	105.96	109.14	112.41
KWH Usage	30,000.00	32,100.00	34,347.00	36,751.29	39,323.88	41,290.07	43,354.58	45,522.31	47,798.42	50,188.34	51,693.99	53,244.81	54,842.16	56,487.42	58,182.05	59,927.51	61,725.33	63,577.09	65,484.40	67,448.94
Total Revenue	8,000.00	8,560.00	9,159.20	9,800.34	10,486.37	11,010.69	11,561.22	12,139.28	12,746.25	13,383.56	13,785.06	14,198.62	14,624.58	15,063.31	15,515.21	15,980.67	16,460.09	16,953.89	17,462.51	17,986.38
Wind Generation	43,800.00	43,800.00	43,800.00	43,800.00	43,800.00	43,800.00	43,800.00	43,800.00	43,800.00	43,800.00	43,800.00	43,800.00	43,800.00	43,800.00	43,800.00	43,800.00	43,800.00	43,800.00	43,800.00	43,800.00
Expenses																				
Diesel Fuel Cost	0.00	0.00	0.00	0.00	0.00	0.00	0.00	861.15	1,999.21	3,194.17	3,947.00	4,722.41	5,521.08	6,343.71	7,191.02	8,063.75	8,962.67	9,888.55	10,842.20	11,824.47
O&M	5,762.50	5,762.50	5,762.50	5,762.50	5,762.50	5,762.50	5,762.50	5,762.50	5,762.50	5,762.50	5,762.50	5,762.50	5,762.50	5,762.50	5,762.50	5,762.50	5,762.50	5,762.50	5,762.50	5,762.50
Administration																				
Sub Total	5,762.50	5,762.50	5,762.50	5,762.50	5,762.50	5,762.50	5,762.50	6,623.65	7,761.71	8,956.67	9,709.50	10,484.91	11,283.58	12,106.21	12,953.52	13,826.25	14,725.17	15,651.05	16,604.70	17,586.97
EBITDA	2,237.50	2,797.50	3,396.70	4,037.84	4,723.87	5,248.19	5,798.72	5,515.63	4,984.53	4,426.89	4,075.57	3,713.71	3,341.00	2,957.10	2,561.69	2,154.42	1,734.92	1,302.85	857.81	399.41
Amortization of Total Investment	2,872.23	2,872.23	2,872.23	2,872.23	2,872.23	2,872.23	2,872.23	2,872.23	2,872.23	2,872.23	2,872.23	2,872.23	2,872.23	2,872.23	2,872.23	2,872.23	2,872.23	2,872.23	2,872.23	2,872.23
Net Income	-634.73	-74.73	524.47	1,165.61	1,851.64	2,375.95	2,926.49	2,643.40	2,112.30	1,554.65	1,203.34	841.48	468.76	84.87	-310.54	-717.82	-1,137.31	-1,569.39	-2,014.43	-2,472.82
NPV of Net Income	7,338																			
IRR	10%																			

Wind Turbine Installed Capacity	20
Cost per KW (US$)	2500
Capacity Factor	25%
Battery Storage (US$)	20000
Wireless Link (US$)	500
Social Function Cost Share	75%
Internet Kiosk Monthly Revenue	10
Capital Structue Debt	80%
O&M Analysis	
Investment	35,250.00
Annual Rate for Operations	5%
Estimate of Labor costs	4000
Total O&M	5762.5
Households	50
Year 1 - 5	7%
Year 6 - 10	5%
Year 11 - 25	3%
Monthly Tariff	12.5
Average Usage per month	50
Cost per kWh ($)	0.13
Interest Rate	8.00%
Commercial Rate	16%
Percent of Project Finance	100%
GEF Rate	0%
Percent of Project Finance	0%
Exchange Rate	2
Net Income Retention	50%
Project Costs in Dollars	
Turbine	0
Primary Lines	0
Secondary	0
Diesel per Gallon	5
kWh per Gallon	10
Fuel Cost per kWh	0.5
O&M Labor Costs	5000

Belize Project: Coastal
Solar Home System Assumptions

INVESTMENT	
Module Cost Dollars - US $	275
Exchange Rate	2
Module Cost-50 Watts	550
Module Cost-100 Watts	0
Taxes - Duty	5%
Taxes - VAT	0%
Lights - $	80
Fixtures - $	40
Taxes	
Taxes	
Installation-50 Watt	200
Installation-100 Watt	0
Batteries as Investment	0
MARKET	
Total Market Size	250
PerCent of Installations 100 Watt	0
CAPITAL STRUCTURE	
Customer Downpayment	100
GRANT-Year One	
GRANT-Year Two	
GRANT-Year Three	
GRANT-Year Four	
GRANT-Year Five	
Grant per SHS	650
Minimum Equity Percent	20%
Limit of Investment	1354
Actual Investment	707
REVENUE	
Tariff for 50 Watt System	10.5
Probabilty of Payment	1
Revenue Transfer from Micro Grid	$373.69
Tariff for 100 Watt System	

OPERATION AND MAINTENANCE	
O&M Efficiency/HH per Variable Unit	250
Manager	0
Junior Electrician	1190
Administrative	0
Motorcycle Cost	0
Motorcycle Maintenance	10%
Motorcycle Fuel	0
Office Rent	0
Office Equipment	0
Office Supplies	0
Controller- US$	80
Controller- C$	160
Battery50	100
EDUCATION AND OUTREACH	
WiFi Interconnection	1000
Computer	0
Car Cost	0
Car Maintenance	0%
Car Fuel	0
Outreach per Household	0
Personnell Benefit Loader	0%
SYSTEM OPTIONS	
Battery Replacement (Yes=1,No=0)	0
Controller Replacement (Yes=1,No=0)	0
ECONOMIC ASSUMPTIONS AND RESULTS	
Interest Rate for Debt	8%
Discount Rate	12%
Return on Investment	17.88%
Net Present Value NOI	$5,468
Capital Structure Debt	80%
Total O&M per year	$57.28
O&M per tariff	$4.77

Solar Home System - 20 year Financial Analysis

INSTALLED COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10	YEAR 11	YEAR 12	YEAR 13	YEAR 14	YEAR 15	YEAR 16	YEAR 17	YEAR 18	YEAR 19	YEAR 20
Module Cost-100 kw	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Module Cost-50 kw	1,354	1,354	1,354	1,354	1,354	1,354	1,354	1,354	1,354	1,354	1,354	1,354	1,354	1,354	1,354	1,354	1,354	1,354	1,354	1,354
Number of Installations	50	75	100	13	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wireless Interconnect	400	400	400	400	400															
Yearly Investment	68,075	101,913	135,750	17,319	17,319	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Investment per System	1,362	1,359	1,358	1,386	1,386															
INVESTMENT																				
Cumulative Installations	50	125	225	238	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250
Total Investment	68,075	169,988	305,738	323,056	340,375	340,375	340,375	340,375	340,375	340,375	340,375	340,375	340,375	340,375	340,375	340,375	340,375	340,375	340,375	340,375
CAPITAL STRUCTURE																				
State Grant - Annual	32,500	48,750	65,000	8,125	8,125															
State Grant - Total	32,500	81,250	146,250	154,375	162,500	162,500	162,500	162,500	162,500	162,500	162,500	162,500	162,500	162,500	162,500	162,500	162,500	162,500	162,500	162,500
Other Grant	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Customer Downpayment	5,000	7,500	10,000	1,250	1,250	1,250	1,250	1,250	1,250	1,250	1,250	1,250	1,250	1,250	1,250	1,250	1,250	1,250	1,250	1,250
Annual Investment for Developer	30,575	45,663	60,750	7,944	7,944															
Investment per HH	612	650	664	705	707															
Company Debt and Equity Investment	30,575	81,238	149,488	167,431	176,625	176,625	176,625	176,625	176,625	176,625	176,625	176,625	176,625	176,625	176,625	176,625	176,625	176,625	176,625	176,625
Debt	24,460	65,990	122,090	138,445	146,050	146,050	146,050	146,050	146,050	146,050	146,050	146,050	146,050	146,050	146,050	146,050	146,050	146,050	146,050	146,050
Yearly Incremental Equity	6,115	9,133	12,150	1,589	1,589															
Equity	6,115	15,248	27,398	28,986	30,575	30,575	30,575	30,575	30,575	30,575	30,575	30,575	30,575	30,575	30,575	30,575	30,575	30,575	30,575	30,575
Total Capital	68,075	169,988	305,738	323,056	340,375	340,375	340,375	340,375	340,375	340,375	340,375	340,375	340,375	340,375	340,375	340,375	340,375	340,375	340,375	340,375
EXPENSES																				
ADMINISTRATION AND O&M																				
Billing and Maintenance - Fixed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Billing and Maintenance - Variable	2,864	7,161	12,889	13,605	14,321	14,321	14,321	14,321	14,321	14,321	14,321	14,321	14,321	14,321	14,321	14,321	14,321	14,321	14,321	14,321
Materials and Supplies	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total O&M	2,864	7,161	12,889	13,605	14,321	14,321	14,321	14,321	14,321	14,321	14,321	14,321	14,321	14,321	14,321	14,321	14,321	14,321	14,321	14,321
Gross Income/EBITDA	3,809	8,963	15,835	16,694	17,553	17,553	17,553	17,553	17,553	17,553	17,553	17,553	17,553	17,553	17,553	17,553	17,553	17,553	17,553	17,553
Amortization of Debt	2,858	7,710	14,264	16,174	17,063	17,063	17,063	17,063	17,063	17,063	17,063	17,063	17,063	17,063	17,063	17,063	17,063	17,063	17,063	17,063
Net Present Value of Equity	23,300																			
Net Operating Income	952	1,254	1,571	519	490	490	490	490	490	490	490	490	490	490	490	490	490	490	490	490
Net Present Value of NOI	5,468																			

Replacement Costs											
Year	Battery	Controller	Lamps	Fixtures	ReplC,50	Battery 100	Controller	Lamps	Fixtures	ReplC, 100	
1	0	0	0		0	0.00	0	0	0	0.00	
2	0	0			0	0.00	0	4	0	4.00	
3	0	0			0	0.00	0	4	0	4.00	
4	0	0			0	0.00	0	4	0	4.00	
5	0	0			0	0.00	0	4	0	4.00	
6	0	0			0	0.00	0	4	60	64.00	
7	0	0			0	0.00	0	4	0	4.00	
8	0	0			0	0.00	0	4	0	4.00	
9	0	0			0	0.00	0	4	0	4.00	
10	0	0			0	0.00	0	4	0	4.00	
11	0	0			0	0.00	0	4	60	64.00	
12	0	0			0	0.00	0	4	0	4.00	
13	0	0			0	0.00	0	4	0	4.00	
14	0	0			0	0.00	0	4	0	4.00	
15	0	0			0	0.00	0	4	0	4.00	
16	0	0			0	0.00	0	4	60	64.00	
17	0	0			0	0.00	0	4	0	4.00	
18	0	0			0	0.00	0	4	0	4.00	
19	0	0			0	0.00	0	4	0	4.00	
20	0	0			0	0.00	0	4	0	4.00	
	$0				NPV	0.00				NPV	81.69
	$0.00				ReplPmt50	0.00				ReplPmt100	10.74

Battery50		100
Battery100		0
Controller50		168
Controller100		0
Lamps50	N/A	
Lamps100		4
Fixtrues50	N/A	
Fixtures100		60

O&M Materials and Supplies - Cont'd

Billing and Maintenance Summary Sheet

Billing and Maintenance Fixed	
Manager	0
Admin Asst.	0
Rent Office	0
Vehicles	
Vehicle Main.	
Fuel	
Office Supplies	0
Office Equipment	0
Sub Total	0

Billing and Maintenance - Variable

Personnell	14,280
Vehicles	0
Vehicle Main.	0
Fuel	0
Tools	41
Sub Total	14,321

Education and Outreach Summary Sheet

Personnell	1,000
Vehicles	$0
Vehicle Main.	$0
Fuel	$0
Informative Materials	$0
Sub Total	$1,000

Worksheets

Personnel	Number	Salary	Gross	
Manager		1	0	0
Admin Asst.		1	0	0
Senior Electrician		1	0	0
Junior Elec.		1	1190	14280
WiFi Interconnect				1000
Computer				0
Loader		0%		

Vehicles	Cost	Annual
CAR		
Initial Cost	0	$0
Maintenance	0%	0
Fuel	0	0
MOTORCYCLE		
Initial Cost	0	$0
Maintenance	10%	0
Fuel	0	0
Tools	200	$41
OFFICE		
Rent	0	0
Equipment	0	$0
Supplies	0	0
OUTREACH	0	0

ANNEX 3
Article on WiFi Technology
The New York Times

Tinkerers Say They've Found a Cheap Way to Broadband
By JOHN MARKOFF

CUPERTINO, Calif., June 7 - Anyone looking for the next big thing in Silicon Valley should stop here at Layne Holt's garage.

Mr. Holt and his business partner, John Furrier, both software engineers, have started a company with a shoestring budget and an ambitious target: the cable and phone companies that currently hold a near-monopoly on high-speed access for the "last mile" between the Internet and the home.

At the core of their plan is the inexpensive wireless data standard known as Wi-Fi or 802.11b, which is already shaking up the communications industry, threatening to undermine the business plans of cellular phone companies by offering a much cheaper method for mobile access to the Internet.

The pair's company, known as Etherlinx, has taken the 802.11b standard and used it to build a system that can transmit Internet data up to 20 miles at high speeds - enough to blanket entire urban regions and make cable or D.S.L. connections obsolete.

Their secret weapon is a technology known as a "software-designed radio," which has permitted them to create an inexpensive repeater antenna that can be attached to the outside of a customer's home. The device, which the Etherlinx executives said they believe can be built in quantity for less than $150 each, would communicate with a central antenna and then convert the signals into the industry-standard Wi-Fi, or wireless fidelity, signal for reception inside the home.

Because of the staggering costs of wiring the nation's homes for high-speed networking, only 7 percent, or 7.5 million homes, now have high-speed Internet access, according to a February report from the Federal Communications Commission.

The two Etherlinx executives say they have a religious fervor to change that by making broadband available widely and cheaply.

"We're bandwidth junkies, and I can't imagine a world in which people don't have broadband," Mr. Furrier said. "That's our mission."

Without venture capital backing, in a garage just six blocks from the garage where Steven P. Jobs and Stephen Wozniak launched Apple Computer 26 years ago, Mr. Holt is making his clever and inexpensive radio repeater by modifying inexpensive Wi-Fi cards, the circuitry that sends and receives the signals.

Although he has partially broken with the Wi-Fi standard, he argues he is doing just what the unlicensed radio spectrum was originally set aside to encourage - innovative wireless network designs.

Mr. Holt, a 54-year-old software designer and engineer who began his

career at the Lockheed Corporation in Sunnyvale, Calif., replaces the software that supports the Wi-Fi 802.11b standard with his own code, thereby dramatically extending the range of the cheap, mass-produced hardware. Each repeater contains two cards - one that Mr. Holt has enhanced and another that is able to speak the 802.11b standard to a home computer.

Today, while most of the Wi-Fi industry is working on a more complex technology known as "mesh routing," which involves lashing together hundreds or even thousands of short-range transceivers, the Etherlinx developers believe they have found a crude, cost-effective approach that is capable of leapfrogging the last-mile problem.

"A French engineer would say this isn't the most elegant solution," Mr. Furrier said, "but we didn't care about that. We took advantage of these cheap commodity chips and we just wanted to make it work."

In doing so, they say they believe they not only will be able to skate around the cable and phone companies but dodge the growing industry fears of congestion in the unlicensed Wi-Fi radio band, which is also supporting competing uses such as Bluetooth, an alternative, short-range wireless standard, as well as some wireless telephones.

"The Wi-Fi industry is heading for a train wreck," Mr. Furrier said.

The Etherlinx technology has been operating in a small for-pay trial in Oakland, Calif., for a year. The company began trials here last month using an antenna atop a high-rise building in neighboring Campbell, Calif., where the company has its corporate offices.

Etherlinx is already beginning to attract serious attention from both government officials who are interested in last-mile solutions and corporate executives who believe the lack of high-speed Internet connections is the biggest obstacle to growth in the computer industry.

"We have a huge incentive to see the last mile open up," said Graham Wallace, chief executive of Cable and Wireless P.L.C., one of the world's largest Internet backbone companies.

To attract industry attention, Etherlinx cobbled together a demonstration antenna on the back of a Jeep Cherokee and took it to an industry conference in Southern California last month. Parked in front of the conference hotel, the founders were able to show Intel's chief executive, Craig R. Barrett, that their technology was capable of offering Internet access to the entire hotel as well as to the homes on a ridge behind the conference center.

"I don't think there is a method that has emerged yet as a winner," said Leslie Vadasz, a veteran Intel executive who heads the company's venture arm, "but we are talking to these guys. What they have done is a very smart way of reusing engineering that has been done for other purposes."

Etherlinx began the for-pay trial in Oakland last year after the company failed to get venture capital in Silicon Valley. The company is now selling Internet service commercially to about a dozen customers.

"The V.C.'s are licking their wounds and they don't believe us," said Mr. Furrier, a 36-year-old networking engineer. "That's why we have taken a go-to-market approach."

So far, the company has been run on about $200,000 in private investment - far less than the tens of millions of dollars that have been poured into other Wi-Fi startups.

Etherlinx is not the only company taking new approaches to sending wireless data over longer distances in the unlicensed portion of the radio spectrum. The communications and computer industry is now at work on a second-generation standard known as 802.16, which is intended to address longer-distance communications challenges.

The latest efforts follow the collapse of an earlier attempt to establish a commercial wireless industry based on line-of-sight technology known as the Multipoint Microwave Distribution System, or M.M.D.S. Giant companies like A T & T, Sprint and WorldCom and startups like Winstar and Teligent all developed M.M.D.S. service, but they have either halted development on their systems or declared bankruptcy.

Industry experts said the M.M.D.S. technology failed in part because it required the receiver to be within sight of the transmitter, but also because it required expensive installation and a huge upfront investment to license the spectrum from the government.

"The cost of the license for the spectrum killed them," Mr. Holt said.

Etherlinx is by no means alone in its approach.

Several other companies are also beginning to explore alternatives not requiring line-of-sight that they believe will be more resistant to interference and will be easy for customers to install without expensive on-site help.

Nokia has a research group in Silicon Valley that has been trying to develop such technologies, and Iospan Wireless Inc. of San Jose, Calif., and Navini Networks in Richardson, Tex., are selling products that are along the lines of the Etherlinx approach.

However, Mr. Furrier said he hoped that speed would outweigh size or capital in determining the success of a business in the market. In addition to the company's Oakland trial, Etherlinx is planning to offer commercial service in Campbell, which is not currently served with D.S.L., and in wealthy surrounding suburbs such as Los Gatos and Saratoga.

He argues that the absence of venture funding has actually been an advantage for his company.
"What we've hit on is a low-cost design point and used our fast design to get to market first," he said.