Green Power for Green Places:

Renewable Energy for Protected Areas Management

Managing a conservation and development project efficiently and effectively means making wise and sustainable use of available energy resources. Toward that end, and in line with maximizing the environmental benefit of their activities, project planners in southern Mexico have identified critical energy needs in their field work, and have incorporated photovoltaic (PV) and wind technologies into a diverse range of activities.

Pioneers of conservation and development in Southern Mexico are exploring even cleaner and brighter ways of protecting biological diversity while promoting sustainable development. Since 1994, three international conservation organizations, in conjunction with their respective local non-governmental organization (NGO) partners, have set about integrating energy planning into remote conservation and sustainable development activities.

The rationale? Approaches to conservation are becoming more comprehensive and sophisticated, and as a result, the need for basic energy services increases. Community conservation promoters are now employing video equipment to enliven educational workshops, while resource managers increasingly rely on telecommunication systems to improve coordination of resource monitoring, and agroecologists are finding benefits in labor-saving electric pumps for efficient drip irrigation as part of low-impact, high-value cultivation practices.

New tools for conservation and development in Mexico

Conservation International (CI), The Nature Conservancy (TNC), and the World Wildlife Fund (WWF) are leading the way in adopting renewable energy technologies to enhance their conservation strategies in and around Southern Mexico's most critical tropical ecosystems. Renewable energy augments the tools available to these global leaders, as they strive to balance economic development of local populations with the preservation of some of the richest biodiversity in the world.

Under the Mexico Renewable Energy Program, these groups are utilizing solar and wind energy to increase efficiency of remote operations and provide productive alternatives to communities in and around 10 protected areas in the states of Chiapas, Quintana Roo, Oaxaca, Yucatán, and Campeche (see Map).

Operating conditions in remote conservation projects always present challenges. Basic infrastructure and

El Triumfo base camp

energy services are poor or non-existent, creating practical challenges for daily operations of remote facilities, and equally importantly, limiting the range of possible productive alternatives for community development. Energy is a critical yet often overlooked component of virtually all conservation activities.

Despite their inherently polluting nature, gasoline generators remain the most common source of electricity for remote conservation activities. The fact that "energy" per se is not typically considered central to conservation agendas, often leads to management decisions that are contrary to overarching conservation objectives. In simple terms, for lack of an explicit energy policy, many groups ultimately resort to utilizing polluting conventional energy options to power on-the-ground operations.

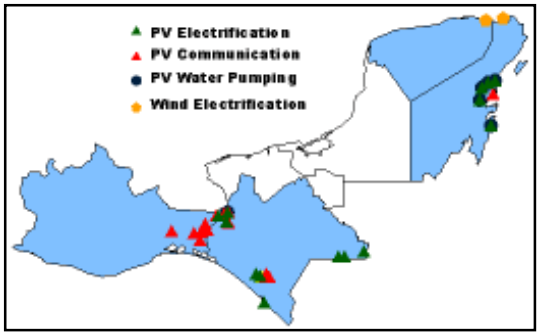
At the same time, bufferzone communities frequently solicit extension of electric lines into the area, threatening to create breaches through critical biological corridors, and clearing the way for unwanted development sprawl. Conservation organizations are typically hard-pressed to mitigate this pressure, for lack of solutions that are both effective alternatives to grid extension and are appropriate and acceptable to the human populations in question.

Renewable Energy:
A Tool for Conservation and Development

- Minimizing ecological impact while maximizing social impact.
- Reducing pressures on tropical forests from illicit activity and conventional development practices.
- Curbing damage caused by traditional fuel use.

In an effort to reconcile this conflict and demonstrate the feasibility of alternatives to fossil-fuel generators or line extension into undeveloped tropical forest land, the U.S. Agency for International Development (USAID) and the U.S. Department of Energy (DOE) have jointly sponsored the integration of renewable energy into ongoing conservation activities in Mexico. Since 1994, DOE's Sandia National Laboratories has managed the Mexico Renewable Energy Program, partnering with Mexican agencies, NGOs, rural producers, industry associations, research and financing institutions, to build local awareness, confidence, and capacity in productive applications of PV and wind technologies.

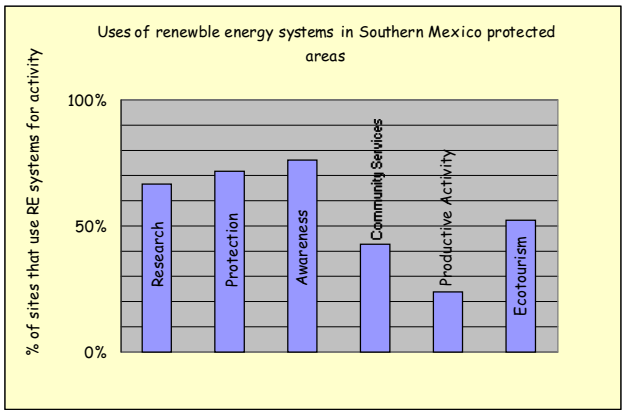
Under the "Protected Areas Management" component of this program, CI, TNC, WWF, and Mexican NGO and governmental partners have received technical assistance and training from Sandia team members in PV and wind technologies, applications and economics, as well as funding for initial demonstration projects in priority conservation activities throughout Southern Mexico.



Protected Area RE installations: Southen Mexico

Solar and wind energy provide light, communications, water, teaching tools, and more...

As of January, 1999, program partners have installed 74 systems, totaling over 25 kilowatts, which provide critical electricity services both for operations and infrastructure needs, and for innovative community development activities. The systems range from 30 Watts to 11,400 Watts (most are under 300 Watts), providing such services as water pumping and purification, communications, scientific and audio-visual equipment, refrigeration, fans, computers and basic lighting, among others (see examples highlighted below).



1998 Survey of initial 51 installations

Local NGOs played a central role at all stages in developing these projects, building internal capacity to successfully operate and maintain the systems in the process. Collaboration with program managers at CI, TNC and WWF was instrumental to ensuring consistency of those projects within each organization's regional conservation strategy.

The following examples illustrate the range of conservation activities now benefitting from clean energy:

✸ **Center for Ecodevelopment of the El Ocote Biosphere Reserve** *("CEDRO", a training center run by Línea Biosfera, a WWF partner)*

Seven PV systems, ranging from 75-375 Watts, provide lighting, audio-visual equipment, water pumping and radio communications services for a training center for community promoters of agroecology techniques, community health and human rights. Promoters use the radio network to communicate among the communities and with the center.

CEDRO classroom

✸ **Ranger and visitor center in bird sanctuary** *(Isla Contoy National Park; facility managed by Amigos de Isla Contoy, collaborator of TNC)*

Three 300 W wind turbines provide lighting and other facilities power, while an independent PV system provides water pumping, for a ranger station and visitor center on Isla Contoy, an island designated as a bird sanctuary, located just off the shores of Cancún, Quintana Roo. The sanctuary attracts thousands of tourists annually.

✸ **Radio network for organic coffee cooperative** *(Campesinos Ecológicos de la Sierra Madre de Chiapas, CESMACH, a WWF partner)*

4 initial PV systems to establish radio communications among the three principal producer groups separated by many kilometers of mountainous terrain, to enable cooperative to be competitive in international market through efficient operations and rapid information flow.

CESMACH base station

An unanticipated and significant side benefit has been the cooperative's improved community relations through vital radio services, including facilitating rapid response to area forest fires.

✸ **Ranger stations facilities power** *(e.g. as managed by the Instituto de Historia Natural and Amigos de Sian Ka'an, both TNC partners, in Chiapas and Quintana Roo, respectively)*

La Encrucijada base camp

Over 30 PV systems for key remote operations facilities such as biological research, monitoring of illicit activity such as timber extraction, and providing educational opportunities for bird watchers, school groups and other visitors.

✸ **Full facility power for reknowned tropical research center** *(Chajul Biological Research Center, managed by Conservation International Mexico)*

11.4 kW PV/propane backup hybrid system provides complete facilities services at Mexico's largest and most utilized tropical research station. Uses include lighting; audio-visual, scientific, and office equipment; fans; refrigeration; and water disinfection for 11 permanent staff and over 700 visitors annually (including researchers from around the world, Mexican students preparing Masters' theses, naturalists and other tourists).

Chajul biological research station

✸ **Community water supply for bufferzone community** *(Ejido of San Antonio Texas, working with WWF partner Línea Biosfera)*

A 1.9kW PV system pumps water from a stream 60 meters below, over 1 kilometer total distance, to provide potable water for 38 families. The women of this community used to spend over three hours per day hauling water on their heads, 15 Liters at a time, in 3 to 4 trips per day. Now they have running water at 8 community taps. The women and men of this ejido participated in all stages of the project development, including providing in-kind contributions in the civil works.

"Now, researchers and visitors are using computers, microscopes, centrifuges, fans, TV and video-cassettes, projectors…," at El Eden Center for Research and Ecotourism.

✸ **Ecotourism facilities power** *(e.g. El Eden and Ixcán, supported by WWF and CI, respectively)*

➢ 4 PV systems totalling 1.9 kW provide electricity for a central lodge/research station and three remote cabins in the El Eden Ecological reserve, a private reserve where entrepreneurial bilogists are demonstrating the profitability of conservation. This facility attracts biological researchers to the uniquely diverse ecosystem, fostering international educational exchanges and collaborative research through area universities, as well as luring nature-minded tourists from Cancun.

El Eden wildife observatory

➢ A 1.7 kW PV system provides full services at this unique ecolodge built on abandoned foundations by CI-Mexico and the local community, Ejido Ixcán, on the shores of the breathtaking Lacantún River that separates traditional community development activities from the restricted uses of the Montes Azules Biosphere Reserve. The Ixcán ecotourism initiative provides the Ejido Ixcán with an economic alternative to traditional development practices, and serves as an example for the bufferzone region.

Impacts of renewable energy: from rural lives to program management

Over 4,000 people, dispersed across remote communities, isolated research stations and ecotourism facilities, are now accessing clean and quiet electricity. For each of these cases, Sandia team members and local partners determined that extending the electric lines to the sites was not only prohibitively expensive (up to US$10,000 per kilometer), but in most cases was also politically improbable and ecologically unsound. Seeking the lowest-impact, least-cost solution to their energy needs, local partners compared the costs associated with operating and maintaining generators with those of alternative energy solutions over the 20-year lifetime of the renewable energy systems. In many cases, the accumulating costs of the "cheaper" generators far exceeded what program planners had imagined they were spending to provide small amounts of energy to remote sites, and the renewable energy systems compared favorably.

What is the cost of operation?

"Although the costs are initially high, in time you will recuperate your investment." Instituto Nacional de Ecología

The following examples illustrate additional impacts on the various actors and stakeholders crucial to long-term conservation and community development.

Communities: participation and quality of life

Women from the community of San Antonio Texas in the bufferzone of the El Ocote reserve now fill their water jugs for the family's daily consumption from one of five community taps. For all of their lives, these women have trudged down and back up the mile-long footpath to the nearest creek, balancing full 10-liter jugs on their heads and bringing their daughters along to do the same. Now, a PV-powered pump silently pumps throughout the day, filling a 10 cubic meter tank built by the community with materials solicited from the local municipality for this priority project. The convenience of running water—what to most urban families is a basic service—now relieves the women of San Antonio Texas the time and substantial energy they previously expended out of necessity. Moreover, these women have been empowered to take a greater role in community decision-making as a result of the participatory process engaged in developing the community water.

In addition to the time and effort savings for the women of the community water project has given "...greater credibility to the organization and the activities that it promotes..." reports Mauricia González of Línea Biosfera, San Antonio Texas.

Producers: competitive and sustainable

The over 200 coffee producers who took the risk in "going organic" when joining the CESMACH organic coffee cooperative, are now part of a sophisticated business that has the tools to access international markets despite its remote and disperse nature. The PV-powered radio network enables the producers to mobilize coffee with an efficiency previously unattainable. The higher income being earned by these producers is both benefiting their families and luring other producers away from less sustainable coffee cultivation practices. At the same time, the radio network provides equal access to information throughout the cooperative—a factor that members believe is essential to building a strong, unified group of producers. Success with organic coffee has inspired the co-op to pursue other agroforestry products to meet new demands for sustainably-harvested products in the global market.

Operations personnel: low-impact and efficient

The quiet, clean alternative of renewable energy reduces organizational costs of conventional energy dependence, while increasing the ability to appreciate the surrounding habitat—in its natural state. Personnel that operate remote research stations, visitor centers, ranger posts, and other reserve facilities are the ones that have previously organized the transport and payment for kerosene, gasoline, propane, diesel and lubricant oil to provide basic services to remote sites. They are also the ones who

"I feel that now with the new photovoltaic system, we can be sure to have lighting that is very reliable…it doesn't make noise, it doesn't consume gasoline, and it is equipment that one could call "ecological", as it doesn't damage the environment." Ramón Guerrero, Operations Manager at Ixcán Ecolodge, Chiapas

have spent hours servicing the generator equipment, trying to avoid inevitable oil leaks, and living with the constant noise that has been the tradeoff to having electricity. When asked to tally the costs associated with operating and maintaining generators previously used at over a third of the sites, the operators were shocked to realize that the expenditures ranged from $1,500/year to over 5,000/year.

NGO planners: consistent and strategic

As program managers of conservation organizations focus more explicitly on the energy needs inherent in effective remote operations, they recognize the consistency of renewable energy services with overall conservation and development goals. In addition, planners are seeing how renewables can foster strategic approaches to conservation. Basic water, lighting and communications services can be exchanged for land use improvements by local communities. A more permanent presence with reliable electricity aids more constant vigilance and deters illicit practices such as wood extraction. PV radios and remote sensors enable modernized forest fire prevention and response efforts. Fuel dependence and long-term maintenance costs can be reduced. A "green" image can meet the growing demand of ecotourists—and donors.

More than just technology: local capacity building fosters sustainability & replication

How do we ensure that our partners' needs continue to be met into the future? Lessons worldwide have taught us that successful technology adoption is as much about the people, the social, cultural and institutional context, as it is about the technology. As low-maintenance as these technologies are compared to their well-known alternatives, satisfactory performance will always depend on how well the systems are designed to match the needs, how well they are installed, and whether the users have access to the resources to maintain them over time. The Mexico Renewable Energy Program has therefore dedicated particular attention to building local resources, including:

- NGO capacity to identify and define key energy needs;
- NGO understanding of comparative economics between renewables and conventional energy options;
- NGO ability to communicate those needs to local vendors, to analyze vendor offers, to evaluate vendor workmanship, and to properly operate and maintain the systems once installed;
- Competent and competitive local vendor network, and inclusion of vendor guarantees to ensure quality product, installation, and service at a competitive price;
- Emphasis at the local NGO level on budgeting for long-term operations and maintenance, including periodic battery replacement (and ecological disposal), pump replacement, and other more minor costs;
- Consideration at the international NGO level of full life-cycle cost analysis, as well as environmental benefits when comparing renewables with alternatives;
- Involvement of appropriate financing institutions in training and demonstration events to facilitate innovative financing mechanisms for renewable energy systems.
- Local capacity-building through formal training, installation workshops, and on-going technical assistance has played a key role in establishing projects that can be maintained and replicated in the long-term.

Signs of sustainability

While the true test of sustainability is time itself, the high performance of the systems installed under this program and the favorable responses from people who are operating them, suggest that the service provided today will continue to satisfy local needs well into the future. To ensure lasting satisfaction,

Testing module voltage

the Sandia team seeks continual feedback from its partners and makes periodic site visits. Reports from the field continue to reflect satisfied partners.

In addition to direct responses from Sandia team inquiries, abundant yet subtle clues in less formal settings suggest that alternative energy is no longer a

novelty, or just a temporary solution to remote energy needs. Basic concepts of how solar systems work, of good (and bad) installation practices, of how to care for them, and of why renewable energy is preferable to running generators, are now passing from one biologist to another, between producers, and among family members, through daily conversation.

Field personnel are performing routine inspections of their systems; they know how to monitor their performance, and when to take preventive measures like adding water to the batteries. When cloudy weather lingers, they know they need to watch their electricity use carefully. Users are setting aside funds for future battery replacement. If there is a problem with the system that they cannot fix, they know who can fix it and how to negotiate for the service.

Most impressive is the degree to which a few key individuals have captured the concepts of PV systems through working on their own project designs and installations. Mauricia González of Línea Biosfera and Zeferino Trujillo of CESMACH are two examples of the "champions" among our local partners. Both Mauricia and Zeferino have participated as instructors in subsequent training sessions, sharing their knowledge and experiences from living with their own PV systems.

Replication in and around reserves…and beyond

As a result of the projects completed under this program, surrounding communities have solicited technical assistance from our partners, whose system performance and knowledge of the same has inspired confidence in local populations. Our partners have assisted small producers and community committees in preparing requests for quotes from vendors and support from municipalities that ensure system quality and vendor guarantees. Over 260 systems have been installed, through direct purchase or with municipal support, as a result of community interest and confidence.

The impact of the Mexico Renewable Energy Program has caught the attention of the Mexican government. The Secretary of the Environment, Natural Resources and Fisheries (SEMARNAP) has requested assistance from the Sandia team in considering how the agency can utilize renewable energy to meet remote operations needs throughout the entire system of natural protected areas in Mexico. Future efforts will benefit from the lessons gleaned from the pilot projects, as well as from efficiencies gained by institutionalizing the approach to addressing energy needs for these remote areas.

Interest in renewable energy use in protected areas management has spread to Central America as well.

Ixcán Ecolodge

NGOs in Guatemala and Honduras have taken their own initiatives in incorporating renewables into conservation efforts. On a regional basis, Sandia, Winrock and other team members have been in discussion with local groups about possible exchanges between program managers from around Central America and NGO partners from the Mexico program.

These expressions of interest at the national level in Mexico and from Central America suggest that the impacts of this program will extend beyond Southern Mexico. Given the lessons learned and institutional capacity established within CI, TNC, WWF and local partners, the Sandia team anticipates that renewable energy technologies will be incorporated more readily into future conservation and development efforts by these and other organizations in the region.

Lessons: energy services for conservation and development

The experience gained over the four years of this program serves to reinforce many of the assumptions articulated early on about *involving the partners.* Projects cannot be successful in the long-run if they don't answer to people's needs, if there is no participation in the field where it matters, and if project development does not emphasize capacity-building along the way. Initial evidence indicates that the emphasis on partner involvement at every stage of project development has led to energy services that have met the local needs and will be maintained into the future. Time will be the true test.

"Conservation of important biological areas normally requires communication, illumination, and construction of spaces for community services, all of which are helpful in improving the local participation in conservation efforts." Javier Castañeda, WWF/Oaxaca

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Additional lessons have been generated by these experiences which may help to guide future efforts. These include:

♦ The importance of demonstration systems. There is no substitute for "neighbor envy". Just as a picture is worth a thousand words, a PV water pump in action is worth a thousand pictures. Actual systems serve not only to raise interest and confidence, but can serve as excellent training tools, and are worth the initial investment. Well-installed systems can also turn around negative impressions left by systems that were poorly installed and have not been maintained.

♦ Local market conditions and lack of user awareness can lead to low-quality vendor service at high prices. Local vendors may have little incentive to provide high-quality product or installation at competitive prices, and often the work is contracted out with little to no supervision. There often is, however, room for improvement. Establishing precedents with vendor guarantees, and working together with both vendors and end users on quality and pricing issues can begin to set new trends. Another lesson on local vendors: equipment delays may be unavoidable and out of their control.

♦ Budgeting for long-term system maintenance can be difficult for some NGOs whose budgets are limited to annual cycles. While some systems are productive in nature or otherwise can warrant a fee-for-service that can contribute to a maintenance fund, other systems that are designed to meet basic infrastructure needs may rely strictly on annual operations budgets to cover these costs. For systems that require large lump-sum expenditures such as for battery replacement, some careful budgeting may be required to plan for such periodic but infrequent expenses.

♦ Feedback from the program partners suggests that future training should delve more deeply into system troubleshooting to help build confidence among system operators that they can detect problems prior to soliciting vendor aid. In fact, it may be that system operators have received enough training, since to date no major problems have been reported that couldn't be resolved locally. However, the more confident the user, the more effective s/he will be in sharing knowledge and skills with others.

Prepared by Winrock International for Sandia National Laboratories

"Renewable Energy Systems have facilitated the provision of services below the cost of converntional schemes that would cost a lot of money and produce strong environmental impacts—such as powerline construction projects for the introduction of electricity." What's more, "it is possible to transfer this technology to the communities that interact with the natural protected areas as an alternative compatible with the natural resources." Instituto de Historia Natural

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World Wildlife Fund