Renewable Energy:
GEF PARTNERS WITH BUSINESS FOR A BETTER WORLD

At a time when most people scarcely think twice when they flip a light switch or listen to a radio and increasing numbers take access to the Internet equally for granted, two billion people—a third of the world's population—live without the benefit of electricity or other modern energies. Nearly half a billion people have limited or unreliable access.

Most of these people—a substantial and growing portion of the world community—live in areas of developing countries that are too remote to connect with an electrical grid. Governments and the development community alike are growing increasingly interested in renewable energy as the key to supplying these distant communities with reliable power. Renewable energy also shows great promise as a supplementary power for electrical grids in developing countries, a way for them to reduce environmental impacts and dependence on foreign sources of energy. In both cases, renewable sources provide clean energy that protects the local environment and reduces greenhouse gas emissions, as well as important social and economic benefits.

Renewable energy (see box) represents multiple technologies that harness power from the sun, wind, water, earth, and certain kinds of organic matter with few impacts on the environment. Once the technology is in place and maintained, it can power lighting, heating, cooling, water pumps, communications, and more, both cost-effectively and reliably, utilizing locally abundant energy sources. "Bringing it close to home" has the added benefits of badly needed local jobs and business opportunities.

The potential for renewable energy in these regions, however, is challenged by several factors, not least of which are the up-front costs of installing equipment and the limited resources of the people who need it. Difficult institutional, regulatory, and capacity barriers also hamper efforts to promote renewable energy.

Many believe that the private sector should play a primary role in expanding the use of renewable energy in developing countries—by establishing strong, sustainable, and profitable local markets in renewables. The good news is that governments and development agencies want to partner with the private sector to make it happen.

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The annual world market for renewable energy systems (excluding large hydropower systems) is several billion U.S. dollars. Business experts believe that renewable energy markets are poised for expansion, particularly in developing countries. Installed renewable energy capacity in developing countries already exceeds 60,000 megawatts. According to the World Bank, in the next four decades, developing countries will need 5 million megawatts of new electrical generating capacity. If renewable energy captures just 3 percent of this market within ten years—not unreasonable given current International Energy Agency projections—by 2010 renewable energy investments in developing countries could exceed $5 billion a year.[1] Off-grid applications of renewable energy will also take off in the next decade, particularly as solar photovoltaics (PV) technology costs decline. These applications include solar-powered lighting, water pumping, telecommunications, and small industry targeted to millions of rural inhabitants through public-private partnerships. This promising outlook clearly offers considerable opportunities for businesses—both foreign and domestic—willing to enter a unique and expanding market.

[1] All dollar amounts are U.S. dollars.

What is Renewable Energy?

Renewable energy consists of:

- *Electricity* generated from solar, wind, biomass, geothermal, and hydropower resources
- *Fuels*, such as biofuels and hydrogen derived from renewable sources
- *Heat* generated by solar thermal systems and geothermal sources.

Sources of renewable energy include:

Solar. Energy captured from the sun through:

- *Photovoltaics:* Use of semiconductor materials to convert sunlight directly into electricity.
- *Solar thermal technologies:* Space heating and water heating for residential, commercial, and industrial uses.
- *Solar thermal electric technologies:* Concentration of sunlight to create heat for generating electricity.

The solar industry has grown on average more than 17 percent a year since 1992. Developing countries exhibit strong potential for growth in off-grid applications, although a number of barriers must be overcome. More than half a million individual "solar home systems" already provide lighting, entertainment, and income generation for rural households in developing countries. Applications in off-grid telecommunications and small industry are growing rapidly.

Biomass. This includes wood, grasses, crops, and crop residues converted to usable energy by burning or more environmentally benign gasification. A range of technologies produces heat, electricity, and liquid fuels. Electricity generated is expected to be competitive as long as biomass resource costs remain reasonable. Biomass currently meets about 14 percent of world energy demand and, in some areas, constitutes the chief source of energy for heating and cooking. Power generation from biomass exceeds an estimated 50,000 megawatts worldwide, most of which is in developing countries.

Wind. Wind energy systems are the fastest growing energy technology in the world. Highly reliable machines provide electricity under 5 cents per kilowatt at selected sites with good wind resources. The next generation of machines should cut costs further. Total installed capacity worldwide increased by 35 percent from 1998 to 1999, amounting to more than 13,000 megawatts. India, with more than 1,100 megawatts of installed capacity, leads the developing world in exploiting wind.

Geothermal. This consists of hot water or steam derived from reservoirs below the surface of the earth. This power source is expanding in Indonesia, Philippines, Mexico, Kenya, and Central America. Even greater potential exists in tapping hot dry rock deep beneath the Earth's surface. Global electricity generating capacity from geothermal stands at 8,200 megawatts, about half of which is in developing countries.

Small hydropower. Power harnessed from small rivers and streams. Tremendous interest exists in small hydro applications, because of their good potential and few negative environmental impacts. More than 35,000 megawatts of small hydro are installed worldwide, about half of which are in developing countries. China alone accounts for more than 15,000 megawatts of installed capacity.

Sources: Global Environment Facility, "The GEF Portfolio of Grid-Connected Renewable Energy : Emerging Experiences and Lessons" (2001) and "The GEF Solar PV Portfolio: Emerging Experiences and Lessons" (2000), Washington, DC; and International Energy Agency, *Evolving Renewable Energy Market* (1999), OECD, Paris.

Renewable Energy: IT'S ABOUT TIME

Around the world, a transition to renewable energy systems has already begun. From private investors to governments to multilateral assistance agencies, renewable energy is receiving increasing investment shares and attention. For example, in a recent G-8 summit in Okinawa, Japan, assembled ministers for the first time recognized the importance of renewable energy and took new initiative, saying, "we call on all stakeholders to identify the barriers and solutions to elevating the level of renewable energy supply and distribution in developing countries." The International Energy Agency, under the Organisation for Economic Cooperation and Development (OECD), said in 1999, "the world is in the early stages of an inevitable transition to a sustainable energy system that will be largely dependent on renewable resources." The World Bank in 1999 committed itself to preparing several hundred million dollars a year in renewable energy projects as part of a new strategic initiative. In the past two years, Shell and British Petroleum have each committed $500 million for renewable energy investments. In addition, some countries, including developing countries such as China and India, are beginning to propose domestic targets for renewable energy ranging from 5 to 15 percent of new electricity supply within 10 to 20 years.

A transition to renewable energy is inevitable, not because fossil fuel supplies will run out—large reserves of oil, coal, and gas remain in the world—but because the costs and risks of using these supplies will continue to increase relative to renewable energy. Costs will increase as the environmental impacts of fossil fuel use are increasingly incorporated into the costs of energy and as the cheapest reserves are depleted. Risks can increase as fossil fuel prices and availability become more variable due to such factors as privatization, deregulation, and political events. Renewable energy avoids fuel costs and fuel price risks; thus, as the costs of renewable energy technologies continue to fall, renewable energy is expected to overtake fossil fuels as the lowest cost, least-risk investment.

The only question is how quickly will this transition take place? By the latter half of the century, as experts predict? Development agencies and many governments would like to accelerate the process to occur within the next couple decades, because it would reap enormous economic, social, and environmental benefits. In China alone, health impacts of current fossil fuel use are becoming a significant drain on the country's

Speeding up the switch to renewable energy would reap enormous economic, social, and environmental benefits.

"There is increasing concern about the environmental impacts of the world's ever-growing demand for energy; however, energy is—and will remain—a key component of sustainable development, with a vital role to play in eradicating poverty and improving the fundamental quality of life. Some two billion people living in poverty in developing countries do not have access to such services constraining their ability to improve their circumstances. The problem is a long-standing one—a vicious circle of poverty and environmental impact.

"Renewable energy holds great potential to break this vicious circle for significant segments of poor communities. Subsidized extension of the grid into rural areas in poorer countries is slowing dramatically and in future may only provide energy to a small fraction of poor communities. New self-sustaining ways to deliver affordable modern energy need to be found, involving innovative financing mechanisms and the right public "enabling environment." In all situations, it is important that sustainable energy solutions are realistic, economically viable, and socially attractive.

"Together with Mohamed El-Ashry [GEF CEO] and colleagues on the G8 Renewable Energy Task Force, we will work to identify the barriers and practical solutions to elevating the level of renewable energy supply and distribution in developing countries."

—Sir Mark Moody-Stuart, Chairman of the Royal Dutch/Shell Group
and Co-Chair of the G8 Renewable Energy Task Force

Benefits of Renewable Energy to Economies, Societies, and the Environment

- **Economic.** At the local level, household electrification permits longer hours for income-generating activities. Renewable minigrid power can also expand job opportunities by encouraging such productive uses of energy as water pumping, electrified fencing, cooling, mills, sewing machines, ice-making equipment, and others. At a national level, renewable energy reduces dependence of developing nations strapped for cash to volatile commodities, such as foreign oil.
- **Social.** Electricity can bring dramatic improvements to any household, particularly for women and children. Lighting allows evening study by children and frees women from time-consuming fuel collection or allows them more time for household chores. Electricity permits better communications, reducing the isolation of rural populations, and enhances community social life and safety.
- **Health.** Health is improved, among other reasons, by reducing the physical stress of gathering fuel and diminishing indoor and outdoor pollution. Health care can improve from, for example, refrigeration of medicines.
- **Environmental.** Renewable energy has many fewer environmental impacts, reducing air and water pollution, discouraging destruction of natural areas for fuel wood, and substituting for fossil fuels, thereby, reducing contributions of greenhouse gases, the cause of global warming.

economic and social resources. Renewable energy would clearly be a boon to China's economy and the health of its people.

A plethora of barriers, however, continues to slow development of renewable energy markets. Some of them are daunting: imperfect capital markets; resistance by utilities; institutional, regulatory, and policy barriers; poor market acceptance; financing risks and uncertainties; transaction costs not included in market prices; lack of skilled personnel; and inconsistent quality standards and assurance. New business models are greatly needed to demonstrate how these barriers might be overcome in different situations.

Markets for renewable energy can only be sustainable if they permit private firms to make sufficient profits in the short to medium term rather than just the in the long term. Because the ability to pay of rural poor is low and because long-term, off-grid service costs are not known, market entry in rural off-grid markets is still considered a high-risk and low-return proposition. Financing rural renewable energy is particularly daunting and credit is often unavailable. The up-front costs of equipment and installation, not to mention ongoing maintenance costs, are not affordable for many rural residents without long-term financing options. But banks and other financial institutions, which tend to be unfamiliar with renewables or view them as too risky, are often reluctant to lend to consumers and entrepreneurs for these systems.

Overcoming these barriers—leveling the playing field—should allow markets for renewable energy to reach their full potential. For this reason, governments of both developed and developing nations, along with multilateral agencies and nongovernmental organizations (NGOs), are

Urgent Warning on Global Warming

A report by the Intergovernmental Panel on Climate Change (IPCC), released January 2001, warned that the planet could heat up by nearly 6 degrees Celsius in this century. IPCC is a panel of the world's leading scientists established by the United Nations. Its report will probably have an enormous impact on international debate on predicted climate change, which is still viewed skeptically by some.

The IPCC Third Assessment Report predicts an increase in surface temperatures of between nearly 1.5 to 5.8 degrees Celsius, an increase from its 1995 estimates of between 1 and 3.5 degrees Celsius. The projected increase—the most rapid in 10,000 years—would raise sea levels and increase flooding, droughts, and fires. The report pins the blame for global warming—even more strongly, than previous IPCC reports—on greenhouse gas emissions.

Source: Vanessa Houlder, "Urgent Warning on Global Warming," *Financial Times,* Jan. 22, 2001.

rallying behind efforts to promote renewable energy, which they regard as a cost-effective means for meeting many of their goals for rural poor—providing reliable access to energy and reducing poverty—as well as protecting local and global environments. Companies that decide to enter this expanding market are likely to find the business environment for renewables growing more and more supportive.

Public sector support, however, has distorted markets in the past. Early donor-driven renewable energy projects, mostly through bilateral assistance, resulted in significant equipment installation in developing countries, but these efforts focused on installing a targeted number of systems, without regard for commercial sustainability and replication. The expectation of continued demonstration projects funded through bilateral assistance has in some cases hindered formation or evolution of the commercial markets needed to sustain and expand renewable energy use. In many cases, the simple provision of equipment failed to motivate private sector markets to expand and, in some cases, even weakened markets.

In contrast, some markets for renewable energy in developing countries, such as in Kenya, have emerged without any explicit development assistance, primarily through private sector initiative. This fact and lessons learned from early projects have led development agencies to rethink their role in supporting renewable energy business development.

Development agencies still believe that they and governments have a specific role to play that should result in even greater penetration and larger shares of rural households benefiting from renewable energy than would occur merely by relying on the private sector. Instead of withdrawing to let private markets develop on their own, the development community is taking a different tack, redirecting their efforts to removing barriers and reducing risk in renewable energy markets. They believe that well-balanced public-private partnership mechanisms could create the conducive environment that private sector delivery companies need to build their businesses to the specific requirements of local markets.

Development agencies have expanded their efforts to foster market development by working to remove market barriers to renewable energy.

Fostering Market Development in Comoros

The government of the Comoros, a small island nation in the Indian Ocean, fostered the local market for solar equipment with assistance from the UNDP/World Bank Energy Sector Management Assistance Programme (ESMAP). The program helped the government identify an international consortium of companies, which was granted a three-year grace period for taxes and duties, during which it could freely import equipment and had the right to export earnings free of taxes. The government pledged that it would grant the firm contracts for all public projects dealing with solar energy during the period. The government also initiated a public awareness campaign to promote solar energy use in off-grid regions. The consortium credits ESMAP with its decision to enter the Comoros market. Similar projects are under way in Swaziland and Bolivia.

Source: World Bank (2000), "Energy Strategies for Rural India: Evidence from Six States" (draft ESMAP report), Washington, D.C.

Renewable Energy: RECENT INNOVATIONS IN THE DEVELOPING WORLD

Expansion of sustainable markets for renewable energy ultimately depends on private companies making substantial investments to build business infrastructure and provide reliable service. Those companies at the forefront are banking on an expanding market and continuing reductions in technology and transaction costs. Some are even beginning to turn a profit. They are making gains by innovating, adapting, and developing partnerships with a variety of government, nonprofit, and private companies in the countries in which they work.

The following examples of innovative projects are only a sampling of the activities of the increasing numbers of renewable energy companies active in developing countries.

Solar Power Adapted to Local Conditions in Burkina Faso

For rural people of the Sahel region, individual photovoltaic systems may be the only real alternative to costly conventional energies. Solar home systems are flexible, technically reliable, long lasting, and environmentally friendly. In 1988 the Spanish solar energy company Atersa launched a project to electrify 125 rural villages in Burkina Faso. Financed by the Spanish Development Fund, the project installed solar systems for lighting for streets and lighting, refrigeration, televisions, and/or radios in schools, health dispensaries, and social centers. Atersa adapted its approach to climatic, social, cultural, and educational conditions in the villages. Its engineers used similar components in all systems to ease installation and replacement. Systems were selected for easy maintenance, for example, gel batteries requiring no water refills. The country's humid and dusty climate demanded further adaptations, such as isolating regulators in plastic boxes and 18-watt lamps to avoid degradation. Refrigerators were designed specifically for solar applications, strengthening their endurance. The project also included training of in-country technicians, including 125 local technicians responsible for basic maintenance.

Harnessing Trade Wind in Costa Rica

Commencing operations in July 1999, the 24-megawatt Tierras Morenas wind farm is one of the largest wind projects in Latin America.[2] The plant, located in Tilarán de Guanacaste, Costa Rica, was developed by Energia Global International (EGI), a hydro and wind development company active in power marketing and based in Bermuda. The project was financed with $24.3 million of loan and grant support from the Danish development agency DANIDA, the Central American Bank for Economic Integration, and a consortium of five Costa Rican banks. EGI, the majority owner, partnered with International Wind Corporation and Aerogeneración de Centro America for the project. Denmark-based NEG Micon manufactured the facility's thirty-two wind turbine generators. The project sells its generation to the Instituto Costarricense de Electricidad (ICE), the nation's national utility, under a 15-year power purchase agreement. Tierras Morenas complements ICE's hydro-intensive generation mix, because its wind regime is strongest during Costa Rica's dry season. NEG Micon built the project under a fixed price, turnkey contract backed by excellent service agreements and warranties. Energía Global de Costa Rica administers the Tierras Morenas assets per agreement with Molinos de Viento del Arenal.

Fee-for-Service Solar Home Systems in the Dominican Republic and Honduras

In the Dominican Republic, the U.S. firm Soluz has been developing a subsidiary, Soluz Dominicana, into a successful fee-for-service business that targets up to 50 percent of the population in the rural com-

[2] Information from Energia Global International.

communities it serves and charges $10 to $20 a month for electricity service from solar home systems.[3] The Soluz business model revolves around a "service center" for up to 2,000 customers staffed by technicians covering 20 to 100 customers each. Collection rate success has typically reached more than 95 percent. By continuously improving this business model, Soluz expects to complete a robust "proof of concept" with Soluz Dominicana at a scale of 5,000 fee-for-service customers. This scale is expected to demonstrate breakeven, where revenues cover the direct costs of operations. By April 2000 Soluz Dominicana had served more than 3,500 customers, including about 1,700 systems on a fee-for-service basis. Soluz has begun replicating the fee-for-service concept in Central America by establishing Soluz Honduras. Pilot-level operations in Honduras at the 500-customer level attracted an additional $1 million in debt and equity investment in the latter half of 2000, including financing from the International Finance Corporation (IFC)/Global Environment Facility (GEF) Small and Medium Scale Enterprise Program (see box).

> "One of the most personally rewarding parts of this business is seeing lives completely transformed through the use of solar power, and GEF is helping make that happen. In remote areas of the world, where we have been a market leader for over 20 years, you see that solar does much more than just protect the environment, it provides a light to study by or refrigeration for vaccines; it changes lives. It's a tremendous feeling to be a part of that. It's also good business, and we commend GEF for its role in meeting peoples' basic needs in a way that both protects the environment and makes economic sense."
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> —Harry Shimp, president and chief executive officer, BP Solar

Financing Wind Farms in Morocco

A 50-megawatt wind farm in Koudia el Baida, Morocco, is one of a few wind projects in developing countries to be constructed on largely commercial terms.[4] A consortium of three firms, including Électricité de France (EDF), is constructing and operating the farm, financed through a number of commercial and development banks. With exceptional wind resources (annual average of 9.5 meters per second at hub height), the wind farm was expected to provide an unprecedented capacity factor of 46 percent when it began operation in late 2000. Ownership of the wind farm will be ceded to the Moroccan national electricity utility, Office National de l'Électricité (ONE), at the start of operations. The power purchase agreement with the consortium extends 19 years and provides full cost recovery. In 2000 ONE was seeking bids for two additional wind farms totaling 200 megawatts.

Lighting the Way for Nepalese Villagers

In 1993 the Solar Electric Light Fund (SELF) and Centre for Renewable Energy in Kathmandu, Nepal, decided to fund a solar home system project in Pulimarang, which, like many remote Nepalese mountain villages, is not expected to receive grid electricity and is not suited for wind power or micro-hydro.[5] Although mostly self-sufficient, such villages are among the world's poorest and lack currency for solar home system imports. A village management committee introduced the solar home system concept to villagers and took on selecting users, collecting payments, and supplying spare parts. Forty-six households purchased systems subsidized by SELF, either paying $245 or a down payment of $60 and nine payments during 3 years totaling $350. Each received a Siemens SP36 solar module with a 70 ampere-hour battery, charge controller, and three 8-watt fluorescent lights. Three village trainees address basic technical problems, backed up by the Nepali-run enterprise that handled initial installation.

[3] Information for this section comes from E. Martinot, R. Ramunkutty, and F. Rittner, *The GEF Solar PV Portfolio: Emerging Experience and Lessons* (Washington, D.C.: Global Environment Facility), pp. 27–28.
[4] Global Environment Facility (2001), "The GEF Portfolio of Grid-Connected Renewable Energy: Emerging Experiences and Lessons," Washington, D.C.
[5] Information for this section came from Siemens Showa Solar, Singapore.

Today, the original solar home systems still work well and household repayments are helping fund additional system purchases. Villagers like the improved lighting and consume 82 percent less kerosene. They report fewer fumes and better health, and can read, generate income, or watch TV more at night. Success has convinced the government to subsidize several hundred systems a year, and a network of dealers now services solar home system demand in Nepal. Some households opt to pay full market price, rather than wait for government subsidies—indicating a strong and potentially sustainable solar home system market.

Financing a Village Minigrid in the Philippines

Few examples exist of village-scale minigrids using renewable energy in developing countries, and even fewer appear to be operating on commercial terms.[6] One such project, however, began in the Philippines in late 1999: a village minigrid providing electricity to about eighty households.

Although local government paid for the grid interconnections among houses, Shell International Renewables financed the capital costs of everything else. Powering the grid is a 10-kilowatt generator fueled by liquid propane gas, 3 kilowatts of solar photovoltaic modules, and a battery bank. Shell operates the system as a "fee-for-service" operation, in which customers contract for a certain allocation of power each week (i.e., 5 kilowatt-hours), paying for it weekly at a service center to "refill" their allocation. At about $2.00 per kilowatt-hour, the service is expensive relative to grid electricity; nevertheless, it provides a much higher level of service than individual solar home systems at monthly fees that are comparable to many solar home system schemes now emerging in developing countries.

In 2001 Shell hopes to eliminate the use of liquid propane gas and convert the minigrid to run on biomass from coconut shells and photovoltaics, while increasing the power available for other productive uses in the village beyond household needs.

Rural Income from Wind and Solar Hybrid System

In October 2000 Synergy Power Corporation engineered, manufactured, and installed a wind-solar-diesel hybrid on the Philippine island of Atulayan, located 2 kilometers off the southeast coast of Luzon.[7] The Philippine government financed the system with help from a local Congressman as a demonstration project for rural electrification using renewable resources. The local utility, Synergy's client, formed a village cooperative to perform all the system's daily tasks, including maintenance and collection. The system was set up to prove that a well-designed renewable energy power system is economically far better than grid extension. Before the renewable components were added, the system was run off of a diesel genset for 4 hours a night. After the addition of renewable components, the genset runs only a fraction of this time. The village now has 24-hour grid-quality power for economically productive activities, such as seaweed drying, woodworking, and sewing. The final goal is to provide the community with the ability to develop economic activities, so they can afford to expand and take care of their own system in the future.

Supplying Water through Solar Power

WorldWater Corporation will supply water to about 100,000 people in Cebu, Philippines, through a program that combines solar powered water pumping technology, financing mechanisms with full-cost recovery through pay-for-service methods, and meaningful social preparation of beneficiary communities.[8] WorldWater will also provide turnkey engineering services, including hydrogeologic assessments, new wells, storage, and distribution and use of prepaid "smart" water cards to collect fees.

[6] Information for this section comes from Shell Renewables.
[7] Information for this section comes from Synergy Power Corporation.
[8] Information for this section comes from WorldWater Corporation.

WorldWater arranged financing for the program, which initially will establish self-contained water pumping and distribution systems in thirteen remote barangays (villages), totaling approximately 14,000 people. Under the full program, a total of 110 barangays in twenty-six municipalities will be provided with solar-powered water pumping and distribution systems. The Development Bank of the Philippines, Land Bank, and the Philippines National Bank will provide loans for funding of WorldWater systems for the remaining municipalities, estimated at $10 million.

Credit Delivery Scheme Aids Solar Sales in Vietnam

SELCO-Vietnam, a subsidiary of the Solar Electric Light Company (SELCO), has sold more than 1,000 solar home systems in Vietnam as part of a complex credit delivery scheme involving several local partners.[9] These include the NGO Vietnam Women's Union (VWU) and the development finance institution Vietnam Bank for Agriculture and Rural Development (VBARD).

VWU helps to market SELCO's systems and collects monthly payments on consumer loans provided by VBARD (VWU collects fees for these services). SELCO provides systems (receiving full cash payments) and is responsible for service. VBARD provides consumer loans, assuming risk for 75 percent of the purchase price. Of the remaining 25 percent, SELCO provides a collateralized guarantee to VBARD for 5 to 10 percent and the customer pays 15 to 20 percent as a down payment. SELCO covers its collateralized guarantee to VBARD with financing through the SME Program of IFC and GEF. If a purchaser defaults on the VBARD loan, SELCO repossesses and refurbishes the system and VWU finds a new buyer for it. If there is any loss in this repossession/refurbishing/resale process, VBARD has access to the SELCO guarantee. No defaults have occurred to date.

Local Solar Manufacturing Linked to Global Expertise

In 2000, U.S.-based AstroPower and the Spanish company Atersa launched a new approach to bringing solar power to rural areas of developing countries. The two solar companies formed a European joint venture company, AstraSolar, to develop and support a global network of module assembly companies. The network will allow assembly and targeted regional marketing by local companies in Africa, Asia, and Latin America with access to the resources, technology, and global reach of the two parent firms. Local firms contribute local labor, understanding of regional market requirements and infrastructure, and connections to local decisionmakers. AstraSolar will supply manufacturing equipment, solar cells, other raw materials, BOS components, and services spanning business planning, financing assistance, manufacturing and quality management, systems engineering, and marketing support.

[9] Information for this section comes from E. Martinot, R. Ramunkutty, and F. Rittner, *The GEF Solar PV Portfolio: Emerging Experience and Lessons* (Washington, D.C.: Global Environment Facility), p. 29.

Renewable Energy: LARGE-SCALE INVESTMENTS EMERGE

That local infrastructure and capability are expanding and strengthening is good as far as major investors are concerned. They are more comfortable taking on the risk of large investments in renewables in developing countries if they can build on existing local business infrastructure. Such infrastructure would already be adapted to local circumstances and business relationships, which are much more difficult for larger players to develop. Anticipating dynamic, long-term shifts in energy markets, a number of large companies are investing considerable resources in renewable energy in both developed and developing countries, with individual investment commitments now appearing on the scale of hundreds of millions of dollars. Company examples include:

Atlantis Solar (Switzerland)
Asea Brown Boveri (ABB) Power (Sweden/Switzerland)
Alliant Energy (United States)
British Petroleum (BP) Solar (United Kingdom)
Energía Hidroeléctrica de Navarra (EHN) (Spain)
Electric Power Development Co. (EPDC) (Japan)
Électricité de France (EDF) (France)
Endesa/Made (Spain)
Energia Global International (EGI) (United States)
ENI/Eurosolare (Italy)
Enercon (Germany)
Enron Wind (United States)
ERGA/ENEL (Italy)
Fibrowatt (United Kingdom)
First Solar (United States)
Fortum (Finland)
International Wind Corp. (United States)
Kansai Electric Power Co. (Japan)
Kyocera (Japan)
Mitsubishi (Japan)
NEG-Micon (Denmark)
Nuon (Netherlands)
Ormat (United States)
Photowatt (France)
SeaWest (United States)
Sharp (Japan)
Shell International Renewables/Shell Solar (United Kingdom/Netherlands)
Siemens Solar (Germany)
SIIF Energies (France)
Suncor Energy (Canada)
Tokyo Electric Power Co. (Japan)
Total-Fina/Total Energie (France)
Unocal (United States)
Unión Fenosa/Gamesa (Spain)
Vestas (Denmark)

Renewable Energy: LOCAL PARTNERSHIPS ARE CRUCIAL

As the above examples illustrate, renewable energy firms working in developing countries usually team up with local partners and subsidiaries to install innovative, locally adapted renewable energy systems—both for off-grid and minigrid systems. In the process, they build up local bases of capability and installed capacity. Regardless of foreign partnerships, support for local renewable energy companies or other local companies interested in entering renewable energy markets is one of the most important elements of market expansion.

Value added at the local level can be high, because service delivery can involve substantial service and transaction costs, such as operation and maintenance, fee collection, and marketing. Small- and medium-scale enterprises (SMEs) at the local level profit from both supply side (service delivery) and demand side (rural industries and productive uses, such as water pumping for agriculture) opportunities. A variety of business models are emerging:

Decentralized virtual utilities. Operating on the same "fee-for-service" principle as traditional utilities, enterprises place technology, such as solar home systems, on the premises of consumers, who pay fixed monthly payments or prepay for service. South Africa and some South Pacific islands are at the forefront in developing this model, in partnership with international energy companies.

Local electricity retailers. In this model, small local businesses or cooperatives establish an electricity retail business, either off-grid as an isolated system or on a grid and buying in bulk. For isolated systems, companies choose a technology or combination of technologies best suited to the location. India encourages such "independent rural power producers," which contract with local communities for power service. Grid-connected retailers either establish a new local distribution system based on a substation delivery point or lease an existing one. For both, the ability to prepare a sound business plan to obtain credit financing or backing by a stronger partner is crucial. India has made good progress with such independent power producers contracting with local communities.

Energy equipment dealers. In this model, local dealer networks sell renewable energy technologies, such as solar, wind, and other small-scale sources in remote and low-income areas. In Sri Lanka, a World Bank–supported project channeled credit financing for small dealers in household solar systems through the national banking system and community-based microfinance offices. Creation of a financing infrastructure is a key feature of establishing effective dealer networks, enabling them to extend retail credit to off-grid customers.

Creative concessions. This model allows a limited number of bidders to compete for the exclusive right to serve a market. This permits a critical mass of customers; attracts larger, better-organized and -financed companies; and increases the potential of reducing unit costs of equipment, transactions, operation and maintenance, and per-unit overhead, among others.

As part of an effort to reform and privatize the power sector, Argentina joined with the World Bank and GEF to implement a project to provide electricity to about 70,000 rural households through eight private concessionaires, partly with renewable energy. The concessionaires obtain an exclusive license in a given province and select the best combinations of technologies. In turn, the companies must provide service to all customers requesting it and maintain service continuity for the life of the concession. Each concession contract is tailored to conditions in each province and awarded through a competitive bidding process. In 1995 an early rural off-grid concessionaire began providing off-grid electricity services in Jujuy, the first province involved in the project. By 1999 this concessionaire had furnished 556 additional rural households and 43 additional schools with individual solar home systems of different sizes.

Renewable Energy: PROMISING POINTS OF ENTRY

Opportunities are expanding for competitive off-grid commercial or near-commercial renewable energy in rural areas of developing countries, including off-grid, minigrid, and on-grid applications.

- **Home electrification with stand-alone photovoltaic systems.** More than half a million rural households in developing countries have such systems. A vast potential global market lies in the hundreds of millions of households not yet reached by grid-connected or minigrid sources. Individual homes can receive electricity from small-scale (20- to 100-watt) photovoltaic/battery systems that cost roughly $300 to $1,500 and continue to decrease in cost. Savings from avoiding other fuel use often makes solar home systems economically competitive with conventional energies.

- **Electricity for village power (minigrid) systems.** Wherever a critical mass of consumers, for example, a village, exists far from electrical grids, minigrids become a viable option. The benefits to the community include AC power, 24-hour service, and power for small businesses and other productive uses. Even if developed for renewable energy, minigrids may easily be later connected to a larger grid, because the distribution system is essentially the same. Communities can choose and combine the least expensive of a variety of technologies, for example, wind power, biomass power (from animal, agricultural, or forest residues), small-scale hydroelectric power, and hybrid PV/wind/diesel systems integrated with battery storage. This permits the best and most cost-effective solutions, given local circumstances.

  As many as 100,000 diesel minigrids now in operation could also be retrofitted with cost-effective photovoltaics, wind, or hydropower. This opportunity constitutes a large potential market in dollar terms. Countries are quite willing to pay for these retrofits, because of the real rural development benefits that minigrid power brings, not least of which is limiting rural to urban migration.

- **Small industrial applications.** In addition to minigrid systems, village power can also encompass stand-alone industrial applications, such as small factories powered with solar power, that result in local income and jobs. Examples of stand-alone applications are beginning to emerge. One promising example is set to occur in India under the IFC/GEF Photovoltaic Market Transformation Initiative (PVMTI). That program has agreed to finance a series of solar-powered water pumping, purification, and bottling plants. Each installation will be a business franchise that will extract water and then purify, package, and retail it as drinking water to domestic and commercial customers. By processing and selling bottled water close to consumers—previously impossible without electricity—these franchises reduce transport costs. The franchises are able to compete favorably with bottled water trucked in from centralized bottling plants farther away, while keeping income and jobs in the local community.

- **Mechanical water pumping for agriculture and domestic water using wind or solar power.** Wind-powered pumps use mechanical power to pump water in areas not connected to central electric power networks. With good wind resources, wind pumps can be less expensive than other means. Their cost, however, depends on whether they can be manufactured domestically or must be imported.

- **Biogas digesters for lighting and water pumping.** Family-size digesters now provide fuel for home lighting in more than 5 million Chinese households, and community-size digesters coupled with engines and electric generators provide electricity for water pumping and lighting in India.

- **Electricity for electric power grids.** Wind farms, biomass power (from agricultural and forest industry residues), geothermal power, and methane from urban and industrial wastes (to fuel gas

turbines) are competitive and viable technologies for urban and industrial electricity. Benefits include increased reliability of the grid and reduced peak electricity charges, service expansion costs, and emissions. Grid-connected photovoltaics may start a distributed generation market, expandable to fuel cells and microturbines. Grid-connected installations can range in size from a few kilowatts to hundreds of megawatts and may include cogeneration. Many of these applications can already produce electricity at costs competitive with conventional forms of electric power. Large markets for grid-connected photovoltaics are anticipated when prices drop to $3 per peak watt and lower.

- **Transportation fuels.** The viability of converting sugar cane to ethanol for motor vehicles has been fully demonstrated in Brazil in the past two decades. Today, more than 60 percent of Brazil's sugar cane production goes to produce ethanol. Technological advances have continued to improve the economic competitiveness of ethanol and gasohol relative to conventional gasoline, but the price of oil and competitive forces in global automotive technology markets greatly affects this.

- **Building heating, cooling, and hot water with solar technologies.** Active and passive solar heating and cooling and solar hot-water heating can reduce the energy consumption of many types of residential and commercial buildings. Passive solar designs can be incorporated into building architectural designs. Active solar hot-water heating systems can be installed during building construction or retrofitted afterward. Depending on electricity prices and solar resources, solar hot-water heating can be economically competitive with electric water heating, but generally not with natural gas water heating. Competitive markets for solar hot water heating technologies exist in many developing countries.

Renewable Energy: WHAT COMPANIES NEED ON THE GROUND

At a recent workshop in Marrakech, Morocco, representatives from small and large renewable energy companies exchanged ideas with development agencies, financiers, and governments on appropriate business models for investing in renewable energy in developing countries and on ways to share and mitigate investment and business risks. It was recognized that most renewable energy companies are small, underdeveloped, and not yet profitable. They could benefit from a variety of assistance from governments and multilateral assistance agencies.

Developing and running an effective renewable energy company in developing countries requires business models that are specially adapted to local circumstances. Companies need to find innovative approaches and accept some degree of trial, error, and risk. For example, a fee-for-service approach to off-grid applications is one business model that is being used increasingly to reduce risk and increase affordability. Many other business models also show continuing promise. Some could lead companies to evolve into rural infrastructure service companies.

Most rural-based renewable energy companies need more effective business planning, better management skills, and greater financial skills. As noted above, partnering with local entrepreneurs is key to developing a commercially viable local marketing infrastructure, because of their familiarity with local markets, access to local sources for certain supplies and equipment, and appropriateness for revenue collection.

Renewable Energy: SHARING THE RISK

Forward-looking energy companies seeking investment opportunities in developing countries are increasingly focusing on ensuring economic and environmental benefits. GEF wants to partner with them to share the risks in expanding renewable energy markets, thereby accelerating a worldwide transition to renewable energy. Charged with helping developing nations reduce their carbon emissions during economic expansion, GEF works with implementing agencies, such as the World Bank Group and agencies of the United Nations, to fund projects that emphasize renewable forms of energy, energy efficiency, and sustainable development. GEF also works with host-country governments, helping to remove market barriers and catalyzing ongoing carbon-reduction initiatives.

GEF wants to partner with the private sector to share the risks of renewable energy investments during the worldwide transition to expanded use of renewable energy.

GEF actively seeks private sector partners with which to develop and underwrite clean energy projects—those with few or no carbon emissions—in developing countries. These projects may be stand-alone or initiatives that expand large power projects using traditional fuels.

GEF is active in the largest developing nations—China, India, Brazil, and Mexico—as well as in smaller countries. It facilitates projects in both established and restructuring marketplaces, working with large international partners, as well as with smaller developers and technology specialists.

Partnership with GEF helps private power developers frame project proposals to best meet investor requirements, as well as the economic and global environmental needs of specific host countries. GEF can fast-track private-sector projects, potentially helping its partners to avoid delays and enabling them to realize higher returns from international investments.
GEF can also:

- Contribute to project financing and locate additional funding partners
- Build the host country's market volume and stability
- Increase the capabilities of companies within the host country to provide supporting products and services
- Expand market niches into mainstream opportunities
- Work with the host government to encourage policies favorable to private sector investment and cut bureaucratic red tape
- Markedly increase the chances of project viability and long-term profitability.

"In my mind, there is no more important objective than to develop nonpolluting and renewable energy systems that can be used worldwide. GEF's work in promoting all kinds of renewables in the developing world is arguably the most important component of achieving a sustainable energy future. GEF's program is promising because it is actively seeking private sector partners with which it can develop and underwrite clean electricity projects. I believe partnerships like these are critically important, because they allow for the continuation of economically competitive projects once GEF grants are no longer required. Without a doubt, GEF efforts in these markets deserve continuing support of both the public and private sector."

—Roger Sant, chief executive officer,
Applied Energy Systems

GEF projects can:

- Identify the social and environmental concerns that affect project approval and suggest ways to meet host-country global environmental obligations.
- Help identify the need for and develop new commercial entities within the host country that, for instance, provide trained workers or distribute a project's output

- Competitively solicit bids to reduce retail equipment costs
- Sponsor educational campaigns to increase demand for the project's output
- Support governments in changing tax or subsidy policies in ways that promote renewable energy on a more level "playing field" with conventional energy
- Develop or strengthen regulatory frameworks, for example, for off-grid utility concessions that provide energy services to rural areas using renewable energy
- Build capacities of government agencies and NGOs to promote renewable energy development, often along with studies, resource assessments, and market characterizations
- Create new financing vehicles, such as revolving funds, credit lines, partial credit guarantees, and contingent business loans that are forgivable under specified conditions.

By facilitating individual projects, GEF helps forge lasting and beneficial relationships between host countries and international investors, increasing prospects for future projects in expanding, profitable markets. By providing financing, technical and business assistance, equipment subsidies, and marketing support, GEF specifically strengthens small- and medium-sized enterprises (SMEs), as well as the market infrastructure (sales and service networks, trained technicians, supportive government policies, and end-user education and awareness) that facilitates activities by all businesses, small and large, especially domestic firms. GEF especially supports nonrecurring, one-time business development costs that companies need to cover to establish or strengthen energy service businesses in rural areas.

The Global Environment Facility and Renewable Energy

The Global Environment Facility (GEF) is the chief funder of renewable energy in developing countries and, as such, will have a significant impact on expansion of the field. GEF is a grant-making vehicle for sustainable development created in the aftermath of the 1992 Earth Summit in Rio de Janeiro (United Nations Conference on Environment and Development). Governed by a 32-member council of donor and recipient countries, GEF funds projects that are implemented by the United Nations Development Programme, the United Nations Environment Programme, and the World Bank Group.

Today, GEF is a major force in promoting renewable energy and the chief driver and catalyst among development agencies. In GEF's first decade (1991–2000), it approved $570 million in grants for 48 renewable energy projects in 47 developing and transition countries. Total project costs have exceeded $3 billion, because GEF grants have also leveraged significant financing and other resources from governments, other donor agencies, regional development banks, implementing agencies, and the private sector.

GEF's renewable energy projects fall into two categories: removing barriers to markets for commercial or near-commercial technologies and reducing long-term technology costs through research, demonstration, and commercialization. Along with its three implementing agencies, GEF seeks to involve and support the private sector and promote commercial and sustainable markets for a variety of renewable applications.

GEF's overarching goal is to develop sustainable private markets to expand the use of renewable energy in developing countries and maximize the social, economic, and environmental benefits this can bring. GEF renewable energy projects involve private firms as manufacturers and dealers, local project developers, financial intermediaries, recipients of technical assistance, technology suppliers and contractors, and project executors. Private project developers, for example, receive financing and technical assistance, while also benefiting from improved regulatory frameworks.

For example, completed or ongoing GEF projects have supported private solar home systems dealers in Bangladesh, China, India, Indonesia, Sri Lanka, Vietnam, and Zimbabwe; wind power and small hydro power developers in China, India, and Sri Lanka; bagasse power developers in Mauritius; and solar hot water heating manufacturers and installers in Tunisia. Domestic technology development grants have featured in some projects, notably for wind turbine and solar PV manufacturers in China. Some projects, such as a World Bank/GEF project in Sri Lanka, facilitate innovative microfinancing approaches through local organizations that increase affordability and expand local markets. In addition, a variety of private-sector financing vehicles are emerging, including several through the International Finance Corporation (see box on IFC/GEF projects).

GEF has recently begun to consider long-term project approaches, such as a new 10-year project in Uganda to remove market barriers to private sector development of about 70 megawatts of biomass, hydro, and solar energy systems. The project will build on a newly enacted private power law through comprehensive capacity building, institution strengthening, and introduction of regulatory approaches to facilitating environmentally sustainable private sector delivery mechanisms.

Business-Friendly IFC/GEF Support for Renewables

GEF and the International Finance Corporation (IFC), the private sector affiliate of the World Bank Group, are increasing accessibility to resources for private-sector investments in renewable energy in developing countries. Four private sector–oriented IFC/GEF projects have established conduits for rapidly providing business financing to firms meeting established eligibility criteria, supporting eligible investment projects, and providing business advisory services.

The **Small- and Medium-Scale Enterprise Program (SME)** stimulates greater involvement of private small- and medium-sized enterprises in GEF-eligible activities by lending GEF grant funds to carefully screened intermediaries at long-term, low-interest rates. Intermediaries commit to using the funds to finance GEF-eligible small- and medium-scale enterprise projects, either with debt or equity investments. The program allows the intermediaries to fund long-term loans or equity investments in relatively high-risk, experimental SME investments, for which normally priced capital is presently lacking. To date, $1.6 million in loans have been approved for three rural PV electrification projects: Soluz Dominicana in the Dominican Republic, Grameen Shakti in Bangladesh, and SELCO-Vietnam.

The **Photovoltaic Market Transformation Initiative (PVMTI)** is a strategic intervention to accelerate the sustainable commercialization and financial viability of photovoltaic technology in Kenya, Morocco, and India, especially for rural electrification. The initiative makes selected investments in private sector photovoltaic market development projects received in response to a competitive solicitation, providing them with appropriately structured concessional financing ranging from $0.5 to $5 million. GEF financing of $30 million is attracting additional cofinancing of $60–90 million by project sponsors and other sources (including commercial banks). IFC administers the project through an external management agent. Projects are being selected based on their strategic impact in overcoming the barriers and transforming the photovoltaic market in a manner consistent with GEF objectives.

The **Renewable Energy and Energy Efficiency Fund (REEF)** is the first global private equity fund devoted exclusively to tapping the sizable opportunities in emerging markets for renewable energy and energy efficiency. The fund will mobilize up to $230 million in financing for such projects (through a private fund manager) to stimulate investment in environmentally friendly energy technologies in the developing world, particularly countries eligible for IFC financing in Africa, Mexico and Latin America, the Caribbean, Asia, and Central and Eastern Europe. In renewable energy, the fund will target both grid-connected and off-grid projects, particularly in low-impact hydropower, solar/photovoltaics, geothermal, wind, and biomass. GEF financing of $30 million and IFC financing of $35 million has helped attract private equity financing of $65 million and up to $100 million in parallel debt financing.

Solar Development Group (SDG). A development and investment program for the solar photovoltaic industry intended to accelerate for-profit private sector business activity in the distribution, retail, and financing of environmentally sound and reliable energy to those rural communities in developing countries without access to a reliable electric grid. SDG will accomplish this through education and awareness programs, training and technical assistance, and ultimately investment in private sector photovoltaic companies. Founding investors include IFC, the World Bank, GEF, and a number of U.S. foundations. SDG comprises two separate entities: a $30 million investment fund for for-profit investments, Solar Development Capital, and a $20 million not-for-profit foundation with a charitable mandate, Solar Development Foundation. Both funding pools are managed by Triodos PV Partners.

For More Information

For more information on GEF activities and its procedures and requirements for renewable energy projects in the developing world, please contact:

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GEF Publications for Further Reading

The Difference GEF Makes: 2000 Annual Report (2001)
Promoting Energy Efficiency and Renewable Energy: GEF Climate Change Projects and Impacts (2000)
The GEF Solar PV Portfolio: Emerging Experience and Lessons (2000).