environmental and social aspects will need careful management to avoid adverse impacts – for example, primary and old-growth forests should not be targeted for energy use – but BIG-GT power plants will require access to the power grid and this places governments in a strong position to oversee the development of a sustainable power industry. ■

Note:
The following papers may be referred to by those interested to know more about the project discussed in this letter.
Elliott, T.P. & Booth, R.H., Sustainable Biomass Energy; Shell Selected Paper.
Elliott, T.P. & Booth, R.H., Brazilian Biomass Power Demonstration Project; Shell Special Project Brief.
Elliott, T.P., Biomass-Energy Overview in the Context of Brazilian Biomass-Power Demonstration, Bioresource Technology 46 (1993) 13-22.

Solar electricity for rural development: Experience in the Dominican Republic

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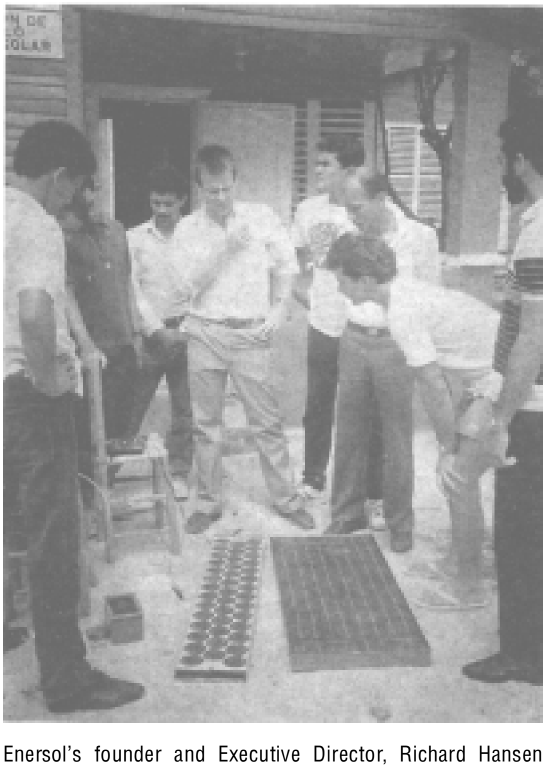
1. Introduction

The cost and difficulty of providing electric service to rural areas in developing countries has left an estimated two billion people worldwide without the benefits of electricity. But in the Dominican Republic, as elsewhere in the developing world, the increasing use of solar photovoltaic technology offers a practical alternative for rural electrification and promises a brighter future for many rural communities.

Since 1984, Enersol Associates, a US non-profit organization and ADESOL, Enersol's Dominican counterpart, have fostered rural electrification in the Dominican countryside using an approach called the Solar-Based Rural Electrification Concept, or "SO-BASEC". SO-BASEC makes use of photovoltaic technology and local human and institutional resources to bring power and light to rural communities beyond the reach of existing electricity distribution networks.

2. The SO-BASEC model

First developed in the rural town of Bella Vista on the Dominican north coast, the SO-BASEC approach uses micro-enterprise and credit program development to make solar technology available and affordable. To date, this approach has resulted in the installation of over 2,000 solar-electric systems in the Dominican Republic. Hundreds of systems have been financed through pilot-scale revolving funds operated by non-governmental organizations (NGOs).



Enersol's founder and Executive Director, Richard Hansen (center), conducts a solar energy training course. A module of solar cells is seen on the ground

Source : Enersol Associates Inc.

2.1. The role of solar technicians

With training and business development assistance, local technicians now operate small solar energy equipment supply enterprises that install photovoltaic systems for household, community, and commercial applications. The technicians provide timely system maintenance and ensure that system designs are appropriate to local conditions. The systems are simple and reliable, consisting of a photovoltaic module (typically 35 to 50 watts), a control box, wiring, lights, and a battery to store electricity. The systems cost between US$400 and $800 and, with periodic parts replacement, are designed to last about twenty years. In addition to electric lighting, typical systems power radios, black-and-white televisions, and small appliances such as fans and blenders.

2.2. The role of consumer credit programs

The lack of access to financing is widely recognized as a major impediment to widespread use of solar-electric systems in rural areas of developing countries (see, for example, Annan, et al., 1992). In the Dominican Republic, average family savings are too low for the majority of the rural population to buy systems with a single up-front payment. To address this problem, Enersol has helped several NGOs establish revolving credit programs that provide financing for solar-electric system purchases. These pilot-scale lending programs show that consumer credit can substantially increase the percentage of rural households that can afford photovoltaic systems.

The SO-BASEC program in the Dominican Republic has now led to the electrification of 0.5 percent of the 400,000 unelectrified rural households. Enersol estimates that approximately 10 to 30 percent of the unelectrified households would obtain solar-electric systems with three-year loans at prevailing interest rates given access to such financing. To reach other segments of the population without grants or interestrate subsidies, alternative financial arrangements such as leasing would be needed. Such arrangements are expected eventually to complement the NGO-operated credit programs.

3. Environmental benefits

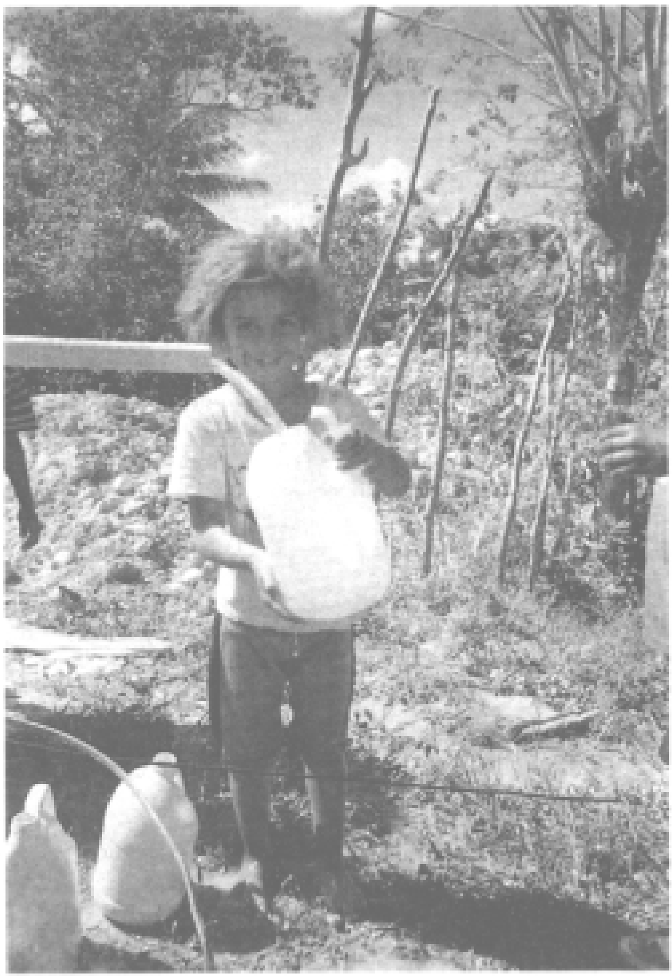
Photovoltaic systems provide many environmental advantages over other electricity supply options. The small stand-alone photovoltaic systems are highly energy-efficient and have little or no land use impact. In rural households, the systems typically replace kerosene lamps with electric lights. Kerosene lamps degrade indoor air quality by emitting carbon monoxide, sulfur dioxide, and oxides of nitrogen. They also present a serious fire hazard. By replacing kerosene lamps with solar-powered electric lights, each photovoltaic system displaces an estimated three to six tonnes of the greenhouse gas carbon dioxide over its twenty-year life. Widespread use of photovoltaics for rural electrification could prevent the release of millions of tonnes of carbon dioxide.

4. Development benefits

Solar-based rural electrification improves the quality of rural life in many ways. Most notable among the quality of life benefits is the improved lighting from electric lamps over the traditional sources, kerosene and candles. A 1988 World Bank study found that one 15 watt fluorescent lamp (or one 60 watt incandescent lamp) provides the same amount of light as 18 kerosene wick lamps or 60 candles (van der Plas and de Graff, 1988). In addition to improved household lighting, several solar electric systems now light rural Dominican schools, health clinics, and community centers.

Solar-based rural electrification also complements and aids economic development efforts. In the Dominican Republic, two dozen local technician/entrepreneurs now make a living assembling, installing, and maintaining solar-electric systems. While the comparatively small amount of energy generated by 35 to 50 watt photovoltaic systems is not sufficient to power motors for machinery or other traditional "productive use" applications, a number of the 2,000-plus systems in the Dominican Republic do provide limited power and light for a range of small cottage industries, farm-related activities, and rural stores.

Once a workforce of trained local technicians gains employment installing small solar-electric systems, the installation of more technically sophisticated solar-powered community water pumping systems becomes possible, with added confidence in the availability of local maintenance services. While an estimated 40% of the rural Dominican population lacks access to potable water, photovoltaic-powered water pumping systems can effectively deliver fresh water in many areas from subterranean sources. Enersol and ADESOL have incorporated water pumping into the curriculum of their training courses for more experienced solar energy technicians, and have assisted with the installation of four community water systems to date. Over time, the use of renewable energy powered water systems is expected to increase substantially.



Bella Vista resident, Carmen Mercado, confirms the results of a community water pump test during a solar technician training course.

5. Expansion potential

Photovoltaic systems are now the lowest-cost option for satisfying many of the electric energy needs of areas not served by distributed electricity, particularly in developing countries where the amount of sunshine is generally high and rural household electricity demand is comparatively low (see, for example: Empresa Electrica de Guatemala, 1993; Inversin, et al., 1991). Their cost-effectiveness for small-scale power supply in off-grid areas, coupled with the demand for basic electric service which two billion people currently lack, suggests a large role for photovoltaics for rural household electrification.

Initiatives are now under way to expand the use of photovoltaics for rural electrification in a number of countries. Enersol is working to replicate SO-BASEC in Honduras and Guatemala. Several other initiatives are in progress elsewhere in Latin America, and in Africa and Asia. Some of these initiatives, including projects in Brazil, India, Indonesia, and Zimbabwe, are receiving substantial support from bilateral and multilateral development sources. The success of these initiatives should further open the door to international financing for solar-based rural electrification and thus help to remove a critical barrier to the widespread use of solar electric technology in rural areas.

6. Conclusion

Solar-electric systems have proven reliable and cost-effective in the Dominican Republic, where thousands of people are now enjoying the benefits of electricity for the first time. The program's success can be largely attributed to the strength of local participation and a targeted strategy to make the technology available and affordable. ■

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Development of an appropriate biomass briquetting technology suitable for production and use in developing countries

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1. Introduction

Biomass energy currently plays a major role in meeting the present energy needs of developing countries. A number of authors (see for example, Beyea et al., 1991), have also expressed the view that biomass has the potential to meet the additional energy demands of urban and industrial sectors, thereby making a significant contribution to the economic advancement of developing countries. If this new role is to be achieved within the context of sustainable development, it is important for a developing country such as India to achieve both sustainable biomass fuel production and the more efficient utilisation of biomass. However, in order for biomass to make a significant impact as a fuel there is a need to improve and promote state-of-the-art technologies.

Of the various renewable energy sources, bio-residues, of which agricultural residues form a major component, can be most easily utilised to reduce the consumption of woodfuel (blamed partly in some areas as a factor in deforestation) (Hosier and Svenningson, 1987). Since most developing countries' economies are still primarily agriculturally based, they produce huge quantities of agricultural residues which provides an enormous untapped fuel resource. For example, in India there is a large, underutilised supply of agro-processing residues: around 49 million tonnes per annum (National Productivity Council, 1987). For a number of reasons, mainly social and environmental, it is not practical to consider using crop residues, such as rice straw, as a fuel (Clancy, 1991).

A major disadvantage of agricultural residues as a fuel is their low bulk density, which makes handling difficult, transport and storage expensive, and gives rise to poor combustion properties. However, these problems can be overcome by compacting, with a compression ratio of approximately 7:1, the loose biomass to form briquettes. The opportunity to utilise more efficiently agricultural residues, with a reduction in pollution levels, has in recent years aroused the interest of developing countries, as well as some industrialised ones, in briquetting.

Briquetting is a relatively new technology for developing countries. Although there are a number of different briquetting technologies commercially available, the challenge is to find a technology which is suited to the local market, both in terms of the briquetting press itself for local manufacture and the briquettes. In this short communication we wish to report on our initial experimental results in trying to develop an appropriate briquetting technology which meets both the technical and socio-economic criteria to be a sustainable technology, as well as bringing environmental benefits.

Although there are many briquetting plants installed by entrepreneurs in India, which have mainly used the piston extrusion presses, they have not been a complete success because of the variation in raw materials and a number of socio-economic constraints. The technologies used have also been expensive and unreliable. They generally require high maintenance and use excessive amounts of power. Sometimes the briquettes have been found difficult to ignite or burn slowly, with high levels of smoke. Also, because of irregular production patterns, arising from the intermittent breakdowns of the briquetting machines, the briquettes have not been able to penetrate the fuel market in the industrial sector. However, the potential does exist, due to the problems of intermittent solid fuel supplies in India, for a correctly designed and engineered process to allow a reasonably attractive energy recovery from bio-residues. The plant capital for the operation should be