4 Solar energy technology: Costa Rica

General information

- **Implementing institution**
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- **Implementation period**
  24 years; ongoing.

- **Costs**
  US$127,200.

Summary

The seeds for solar energy research in Costa Rica were sown in 1977 in Trieste, Italy, when two physicists — one from Costa Rica and the other from India — met at the International Centre for Theoretical Physics (ICTP) where they were attending a course on solar energy. The latter, Dr. S. S. Nandwani, was invited to go to Costa Rica to work on solar energy, and he arrived at National University in Heredia in 1978. There he found practically no facilities or equipment for conducting useful research into solar energy, and there did not seem to be any funding either. An initial request for US$3,500 to buy materials and some basic equipment was turned down because the university could not afford it.

Since then, however, Costa Rica has produced some very useful solar energy research, thanks in part to Nandwani's efforts. Not only has he written numerous articles for national and international publications, but he has also developed a name for himself as an avid public speaker and a stalwart attendee of conferences on solar energy.

National University now has a model solar house in which to carry out research and demonstrations, with solar panels and photovoltaic (PV) devices worth US$60,000 donated by the Government of India. The university continues to lack funds for this work (having officially provided only about US$150 a year to the solar energy research laboratory); however, international support has come from ICTP, India, Sweden, Switzerland, the United States, the United Nations Development Programme (UNDP), the United Nations Educational, Scientific and Cultural Organization (UNESCO) and elsewhere.

This case study shows how creative thinking can lead to useful solar energy research and dissemination even when resources and initial interest are scarce.

Background and justification

When Nandwani arrived in Costa Rica in 1978, National University was only a few years old. The country as a whole had very little research culture, and there was practically no interest in researching solar energy — mainly because the economy of Costa Rica is based on coffee and banana production. In addition, about 85 per cent of electricity consumption was generated from hydropower, yet only about 10 per cent of hydropower potential was being exploited, so there seemed to be no shortage of renewable energy resources for electricity. Also, although Costa Rica was importing all of its oil requirements, multinational corporations were prospecting for oil on its Atlantic coastline and the expectation was that the country would soon also have its own ready supply. At that time, environmental issues were not receiving much attention — the main concern was to find sources of fuel that could be exploited to boost the country's economy. Nandwani failed in his attempts to persuade the authorities that, even if oil reserves were found

in Costa Rica, such reserves would not necessarily lead to economic development and that the development of science, technology and good management would be more important indicators of future success. Nearly a quarter of a century later, oil has still not been found, and Costa Rica is still importing 100 per cent of its requirements.

Solar power can offer some potential benefits to Costa Rica. Despite its high dependence on hydropower, the country's supply of flowing water has not been reliable and there are often water shortages during the dry season (January to June). In the late 1970s, about 75 per cent of the population were connected to the national electricity supply and between 80 and 90 per cent of those people were using it for cooking. However, the Costa Rican Electric Institute was cutting off the electricity supply between the hours of 07:00 and 17:00 two days each week. People therefore started to look for alternative fuels, such as gas and firewood, with which to heat their midday meals.

At this time, Nandwani was looking for ways to justify his presence in Costa Rica — at least for the two-year period of his initial contract — even though he had no resources for research at the university. He looked for any opportunity to promote interest in solar energy and started off by attending the national conference of a physics association in November 1978, where he presented his ideas to more than 50 other physicists. Shortly afterwards, when electricity was being rationed, he developed a way of using heat from the midday sun to warm his family's lunch. Using his own money, he constructed a solar food warmer that reached temperatures of up to 90° C — more than enough for the purpose.

Rather than keeping his invention to himself, Nandwani contacted the local English-language newspaper, *The Tico Times*, which published an article on the solar food warmer in May 1979. Later, he improved his food warmer by adding a glass sheet, a reflector and a system for adjusting its position so that it could exploit the sun more efficiently. The new solar food cooker could reach temperatures of 150°C and was followed by a simple solar water heater. As well as providing his family with clean, free electric power, Nandwani's inventions were also boosting his credibility with colleagues in all four of the universities of Costa Rica.

In the meantime, the university had provided US$300 to buy the materials needed for a thermosyphon water heater, which Nandwani constructed and presented at Sun Week, held by the University at Cartago in June 1979. Awareness of solar energy was beginning to grow in the country.

Description

Nandwani and officials at his university recognized that the best way of generating funds for further research would be to charge other institutions and users for access to the knowledge and expertise that were being developed. At first, this

was not possible: the university did not yet have enough valuable knowledge to make this worthwhile, and there was no existing financial or managerial system in place for raising money in this way. To start with, therefore, awareness-raising days (Sun Day on 3 May and Earth Day on 5 June) were held on the university campus throughout the late 1980s, during which public demonstrations of the new technology were held in collaboration with the Ministry of Energy.

To address the problem of how to raise money for research, the university established a foundation (known as FUNA) in 1982-1983. FUNA operates as though it were a non-governmental organization and, since it is independent of the university, it is not subject to university administrative and financial regulations. University employees who obtain funding or donations for academic activities from other organizations pay FUNA 2.5 per cent of all local currency sums and 4 per cent of all amounts in US dollars as an administrative charge. FUNA reserves the rest of the funds for the research activities of the employees who raise them. Such employees simply need FUNA approval to use the funds, thus cutting out the university's time-consuming approval system. For example, equipment that previously took two to three months to buy can now be acquired in just two to three days.

Collaborating with the ICTP Office of External Activities, Nandwani used FUNA to finance a series of workshops to demonstrate the solar cooker in particular. Participants paid a nominal registration fee. Thanks in part to broad media coverage, national workshops in the late 1980s and early 1990s were well attended. Central American regional workshops followed, and an international workshop was held in 1994, attended by representatives from 30 countries with speakers from Chile, Columbia, India, Italy, Mexico, Sweden and the United States. Excess funds are now used to maintain existing solar devices and to buy equipment for new ones as well as to help participants from developing countries to attend various events.

National University is the only university in Costa Rica with a deparment that is carrying out solar energy research. However, the department is primarily a service department. This meant that it offered basic physics courses but did not have its own research students; however, this changed when the Swedish International Programme in Physical Sciences, in addition to supporting the design and construction of a solar water heater for the university's student hostel, sent two Swedish research students to the department for two months each year from 1990 to 1994. More recently, the Third World Academy of Sciences (TWAS), the Government of Italy and the Costa Rican Ministry of Science jointly financed a Nigerian researcher for another two months.

In 1991, Nandwani launched another initiative to promote solar energy, the non-profit organization *Asociación Costarricense de Energía Solar (ACES)*, whose members receive information about solar energy for an annual subscription of

US$5 (or $2.50 for students). ACES now has 110 members and is associated with the International Solar Energy Society (ISES) based in Freiburg (Germany), which also provides ACES members with its own literature.

So far, solar energy researchers at National University have designed, constructed and studied various models of flat-plate solar collectors for water heating, integrated and thermosyphon solar water heaters, solar ovens, hybrid solar/electricity and solar/gas ovens, solar ovens combined with water heaters or dryers, hybrid solar/electric ovens combined with pasteurizers and dryers, solar stills for water and drying waste material from the sugar industry, a solar-powered microwave oven, and a self-sufficient solar-powered house (currently being studied).

Patenting and commercialization

In 1984, the Costa Rica National Register Office approved a patent for the solar oven, marking the first time that a Costa Rican university had applied for and was granted a patent.

The solar power laboratory sells its testing and design services to local businesses and organizations. For example, it designed solar stills to convert sugar cane waste into animal feed for a small agro-industrial company. It has also tested solar collectors for other companies and has demonstrated and installed solar driers for local communities. In addition, 1,000 copies of a book on how to use solar energy for cooking have been sold. Written by Nandwani and his wife, the publication also includes recipes.

Partnerships

In addition to the ICTP, Indian and Swedish collaborations mentioned earlier, the Costa Rican project works with and is supported by several other public-sector, international and non-governmental organizations, including ISES, SwissContact and the World Health Organization (WHO). Nandwani has presented his work in some 28 developed and developing countries in Asia, Europe and North and South America.

Replicability

The lack of funds and interest that confronted Nandwani in 1978 remains a problem faced by researchers in many other countries, particularly those working in the developing world. This project therefore offers an excellent example of how a patient step-by-step approach can help to develop a research programme and how, by disseminating the results, its effectiveness can be amplified far beyond the constraints imposed by a modest budget.

Lessons learned

Initially, there were difficulties in overcoming the shortage of resources and equipment because of university regulations, which discouraged — or even prevented — innovative ways of raising money and support. The creation of FUNA did much to overcome this problem and demonstrates the benefits of flexible regulations and an open administrative environment.

The value of awareness-raising should also be emphasized. When people from schools, universities, the public, rural communities and national electricity companies learned about the work of Nandwani with respect to solar power, interest in the subject grew and the project was able to expand both its technical and geographical scope.

Dissemination of solar energy research findings in national and local media eventually influenced the Government of Costa Rica, which, in December 1994, passed Law 7447, exempting renewable energy equipment and energy-saving materials from import duties.

Impact

This has been primarily a research and dissemination project, so its impact is more difficult to measure than that of a project aimed at spreading the use of a particular technology, for example. However, given that solar energy received practically no attention when Nandwani first arrived in Costa Rica, several changes and developments can be credited to his work: solar energy is now included in national information material on energy-saving practices and machinery; the use of solar power for cooking is being promoted in rural communities; and even tourism is benefiting through the use of solar energy by hotels and sports centres for cooking, for hot water and to heat swimming pools.

Future plans

The main thrust of the future research and dissemination plans of the project is in the areas of solar cooking, water purification, dehydration of waste and PV applications. Cooperation from the Ministries of Education and Energy is being sought so that literature and equipment can be commercially distributed to schools and universities and short training courses can be offered to students from Costa Rica and other developing countries as part of South-South cooperation initiatives.

In the meantime, Nandwani is constantly searching for outlets through which he can inform more and more people of the technical results and social impact of his research.

PUBLICATIONS

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