13 Renewable energy for rural areas: Viet Nam

General information

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Summary

In mountainous areas where there are plenty of rivers and streams, the power of flowing water can be harnessed and used to generate electricity. Such hydropower can be particularly beneficial in remote areas in many developing countries, where electricity from other sources is not available. Even very small hydroelectric systems consisting of a propeller turbine, a generator, wires and switches can be placed in mountain streams or rivers and used to generate affordable electricity for individual households. Such very small-scale — or micro- — hydroelectric systems can supply power to remote, mountain communities far more cheaply and reliably than either diesel generators or high-voltage grids and are common throughout the Asia and the Pacific region. Other small-scale options involve local-level mini-grids that use hydropower either on their own or together with power generated from other sources. In addition to using hydroelectricity in their homes, people living in remote, rural communities can use it to fuel a wide range of small-scale agricultural and industrial activities, from which they can derive income.

Over the last few years, people in developing countries have become more aware of just how useful small-scale hydroelectric power systems can be to rural development in their countries, particularly in mountainous areas. The technology for generating micro-hydroelectric energy is not new, but the challenge now is how best to use this technology to supply power at very low annual running costs and in ways that prolong the life of electricity-generating machinery.

To this end, under the Renewable Energy Action Plan (REAP) of the Government of Viet Nam, scientists at the Institute of Materials Science (IMS) of the National Centre for Natural Sciences and Technology (NCST) have developed improved versions of micro-hydroelectricity generators. The success of these generators is demonstrated by their popularity in rural areas and the fact that they are now commercially available in at least six other countries.

Background and justification

The 1990s represented a period of economic development in Viet Nam, which seems likely to continue. Gross domestic product (GDP) is forecast to grow more rapidly than the population, resulting in dramatically increased per capita GDP by 2020. This will allow the country to make economic progress and to tackle some of the issues that underlie poverty. With 78 per cent of the population, including 98 per cent of the country's poor, living outside the cities and towns, reducing rural poverty is a high priority in the five-year and ten-year development strategies of the Government.

The Government envisions a reliable electricity supply as an important tool to help rural people to improve their stan-

dard of living and increase their incomes. Among its electricity-related development plans, the Government aims to use advanced technologies to reduce environmental pollution and to ensure that 90 per cent of rural households have electricity by 2005 (currently, only 70 per cent of rural households are served by the national electricity network). The exploitation of hydropower, which already provides almost 55 per cent of the country's total electricity production of 26,562.10 kilowatts and just over 50 per cent of its 6,281-megawatt capacity, is a priority in these plans.

Although the Government aims to extend the national (Electricity of Viet Nam, or EVN) grid by 2010, some 1,100 remote or mountainous communities, representing 750,000 households or 3 million people, are excluded from these plans because connecting them to the grid would be either too costly or complicated. In addition, a similar number of households in communities that already have electricity cannot be connected to the EVN grid economically. Clearly, these households and communities will have to be supplied from alternative sources of electricity, such as hydro, biomass, wind and solar renewable energy systems. For many remote households, the costs of installing such systems (around US$400-500) are similar to the current costs of connecting a non-remote household to the EVN grid.

Viet Nam is rich in renewable energy sources. The potential supply from small hydropower systems, for example, is 800 to 1,400 megawatts, while biomass-driven systems could provide an additional 250 to 400 megawatts. A feasibility study found that small mini-grids supplying hydroelectricity could meet the power

Figure 1 | "Sit-down" micro-hydroelectric systems

needs of several hundred thousand households in the more mountainous north and central areas of Viet Nam, and improved micro-hydropower systems have the same potential in the north. Studies have also shown that solar photovoltaic (PV) systems could serve about 50,000 households in southern and central parts of the country, although the technology is presently too expensive to be viable. Also, although wind resources are still to be fully investigated, they could have a role in central coastal areas.

A breakdown of the present and potential outputs of renewable energy sources in Viet Nam as well as the numbers of households they already supply and could supply in the future is provided in the following table.

Table | Potential and current use of renewable energy in Viet Nam

Resource	Current	Usage	Potential	Usage	Region
	Megawatts	*'000 hh[1] served*	*Megawatts*	*000 hh served*	
Hydropower	110-155	-	800-1,400	-	North and central
Micro-hydro	30-75	100	90-150	200-250	North and central
Isolated mini-grid	20	n.a.[2]	300-600	300	North and central
Grid-connected mini-hydro	60	n.a.	400-600	n.a.	North and central
Off-grid solar PV	0.6	5	2	50	South and central
Biomass-driven	0	n.a.	250-400	n.a.	South and central
Geothermal	0	n.a.	50-200	n.a	Central
Wind power	0.2	1	TBD[3]	TBD	Central/ coastal

[1] *hh = households*
[2] *n.a. = not available*
[3] *TBD = to be determined*

Unlike other sources of electricity in Viet Nam—such as coal- or gas-fired thermal power plants, gas turbine power plants and diesel power plants—the annual outputs from which are static, the total production of hydroelectric power continues to increase. Hydroelectricity could, therefore, supply some of the current energy shortfall. However, there is a shortage of the technical, economic and managerial resources needed to calculate the full potential of small-scale hydroelectric systems and to decide what machinery to use and how to use it.

Description

The Viet Nam Renewable Energy Action Plan (REAP) was launched with a two-day workshop in June 1999, which was attended by 32 representatives of agencies and organizations involved in the energy sector. The workshop identified the following renewable energy options as having the greatest potential in Viet Nam:

- grid-connected mini-hydropower and biomass systems;
- mini-hydropower systems for isolated community grids, using hydropower alone or in hybrid systems with diesel; and
- household-scale micro-hydropower and solar electricity systems.

Together, these could supply electricity to between 500,000 and 600,000 households — a dramatic increase from the 106,000 households currently served by renewable energy.

Biomass has the potential to provide affordable electricity in Viet Nam, especially in the south of the country. Biomass from sugar cane bagasse, cane trash and rice husks could be used. Approximately 2.5 million tonnes of bagasse and 3.8 million tonnes of rice husks are available. Estimates based on the planned modernization, expansion and construction of existing and new sugar cane mills forecast that they could provide about 120 megawatts of excess power to the EVN grid. However, these sugar-industry expansion plans were halted because of a current sugar surplus. Even so, there is considerable scope for updating the technology and creating excess electricity generation from the existing 43 sugar mills, only three of which presently supply biomass-generated power to the EVN grid (which is used in about 5,000 households). Production of electricity from rice husks is still an untapped resource.

Apart from a small amount of wind-generated electricity supplying about 1,000 households in central coastal regions and the three sugar cane mills mentioned earlier, hydropower is the only renewable energy source that is already being exploited in Viet Nam.

Viet Nam has excellent resources for generating hydroelectricity, especially in the mountainous northern and central areas near the borders with Cambodia and the Lao People's Democratic Republic. There are three types of hydropower system currently in use in Viet Nam: hybrid grid-connected hydropower, small hydropower-based grids, and micro-hydropower.

Hybrid grid-connected hydropower currently generates about 60 megawatts of electrical energy from 48 separate systems whose capacities range from 100 to 7,500 kilowatts. These systems were financed by the Government either directly or through international aid, and most of them are functioning (only six of the 48 have reported equipment failure), but their capacities and generation could be significantly increased by improving them. The potential output from this type of hydropower is estimated to be between 400 and 600 megawatts, i.e., up to 10 times the present amount.

In addition to the hybrid systems, more than 300 small hydropower-based grids have been installed. These have a total capacity of about 70 megawatts, with each system supplying between 5 and 200 kilowatts. However, they are of low quality, and about 200 of the total 300 are not operating so their current total output is only about 20 megawatts. It has been shown, however, that commercially operated small hydropower-based grids are far less likely to fail than community-operated systems. The potential from this type of system is 300 to 600 megawatts for community use.

Micro-hydropower systems—the third small-scale hydropower system used in Viet Nam—are particularly important in isolated rural communities where sufficient water resources are found. Between 100,000 and 150,000 micro-hydro generation kits have been sold in the country, which has one of the largest markets for these systems. Each micro-system provides a supply of between 100 and 1,000 watts to a household or—for larger systems—to commercial activities or a group of households. Each year, an additional 40,000 systems are sold, half of which are bought by new users, while the remainder are bought to replace old or worn-out systems. In fact, an estimated 90 per cent of sales are made up of inexpensive, low-quality systems from China. These micro-systems are relatively affordable, costing between US$15 and $50 each, plus US$50 to $100 for installation, including distribution lines, indoor wires and switches. They provide sufficient power for lighting, radios, low-wattage televisions and fans. They are also relatively easy to obtain from local wholesalers, retailers and traders in northern areas, while local blacksmiths often offer assistance with installation and maintenance. At present, micro-hydropower systems are estimated to generate a total of 30 to 75 megawatts, which is consumed by about 100,000 households. Potentially, they could supply a total of 90 to 150 megawatts to over 200,000 households.

The use of imported micro-hydropower systems has been found to have limitations, however. Their low quality means that they require a great deal of maintenance and many replacement parts. As a result, the annual costs of these systems are often nearly as much as the initial price of the unit. Moreover, the systems can supply electricity only to households and activities that are within 500 or 1,000 metres of a source of running

Figure 2 | A "stand-up" micro-hydroelectric system installed in the Philippines

water; their stated capacity rating is often more than their real capacity; voltage is regulated only by the load, which can result in damage to electrical appliances; and their low-quality wiring is dangerous to users, who risk electrocution.

To solve these problems, the Institute of Materials Science (IMS) at the National Centre for Natural Sciences and Technology (NCST) has designed three new types of micro-hydro systems: the PowerPal MHG-200, MHG-500 and MHG-1000. All are based on the use of new-generation rare-earth permanent magnets. Generators using these magnets offer the highest power density at any cost and are also competitive in small production runs. The PowerPals, therefore, are both efficient and productive and have the advantages of being relatively easy and inexpensive to produce; indeed, they cost about the same as some of the lower-quality imports. IMS has designed two styles of PowerPal to suit two different types of water flow. The "sit-down" micro-hydropower system operates at a head of 6 to 10 metres and a flow of 7 litres per second, while "stand-up" systems are suited to lower heads (1.5 metres) and water flows. They produce 200, 500 and 1,000 watts of power at 50-60 hertz and with 220 volts of output, respectively. Their advantages are that:

- their bearings are made from composite materials and are lubricated by water. These bearings therefore do not need to be greased, making them maintenance-free and prolonging the life of the machinery; and
- they use a new type of low-cost induction generator controller that allows for a wide variety of loads, protecting electrical appliances that are powered by the systems.

Patenting and commercialization

The new Vietnamese PowerPal micro-hydroelectric generators are sold by Asian Phoenix Resources Ltd in almost all of the mountain provinces of Viet Nam as

well as in other countries such as Nepal, New Zealand, Papua New Guinea, Peru and the Philippines. They have also been successfully demonstrated in more than 20 countries worldwide.

Partnerships

The Japan International Cooperation Agency (JICA), the Swedish International Development Cooperation Agency (SIDA), the United Nations Development Programme (UNDP) and the World Bank are among the many national and international organizations that have supported the renewable electricity development projects of the Government of Viet Nam, including REAP.

The Government of Japan has been particularly supportive, providing assistance for renewable energy activities that include the New Energy and Industrial Technology Development Organization (NEDO) demonstration project for a hybrid solar-micro-hydropower system in Gia Lai province and plans for the electrification of 265 communes in 17 northern provinces through the use of such renewable resources as micro-hydro, solar or wind energy.

SIDA has provided support to the Regional Research and Dissemination Programme on Renewable Energy Technology for Asia, which aims to promote the dissemination of technologies and their adaptation to local conditions. This programme is coordinated by the Asian Institute of Technology and implemented by research agencies in six countries.

Other support has come from the International Finance Cooperation (IFC) and the Danish Consultant Trust Fund, which provided resources for a series of projects that resulted in the Master Plan for Rural Electrification for Viet Nam. The Government of New Zealand assisted the preparation of an investment pipeline for new small hydro sites, while the Netherlands Partnership Programme provided resources and materials for the creation of a macro-level wind resource map of Viet Nam and neighbouring countries and for community-level training and awareness-raising in renewable energy. IFC has also supported a commercial solar company that provides solar power generating systems.

Replicability

According to recent estimates, about 2 billion people worldwide do not have access to such modern forms of energy as electricity and fossil fuels. Instead, they burn wood, dung and agricultural waste for cooking and heating and use human or animal power for such tasks as transport, grinding and milling.

This use of traditional energy sources means that people have to collect and process material to burn, which leaves less time for income-generating activities. Traditional energy can also have health

implications: smoke from open fires can cause serious respiratory and eye problems, particularly for the women who cook and the young children who stay close to them for most of the time.

Rural electrification could therefore be very beneficial, and in many developing countries, it has become a political issue that can win or lose elections. However, election promises are often laid aside because inhospitable terrain and remoteness make it much too expensive to supply many rural communities with electric power from a central source. Inexpensive, simple and reliable alternatives that are suited to local conditions are therefore essential for the economic development of many regions. Micro-hydropower is such an alternative energy source, suited to areas where there is a sufficient year-round water supply from streams and rivers and a hilly or mountainous terrain.

LESSONS LEARNED

Although the development of renewable energy has a great deal of potential, it also faces many challenges. At the REAP workshop in June 1999, representatives identified the following barriers in Viet Nam:

- an inadequate policy and regulatory framework for encouraging the use of renewable electricity;
- insufficient awareness of the available technologies, their costs and performances;
- lack of commercial businesses and infrastructure to provide renewable electricity equipment and services;
- limited financing for consumers, businesses and project developers;
- a shortage of high-quality technology at affordable prices; and
- lack of data on resources for the planning of a major programme.

Since the workshop, steps have been taken to overcome these barriers and to establish a policy framework for the large-scale development of renewable electricity. Decision 22 by the Prime Minister in 1999 and the Rural Electrification Policy provide the foundations, but there are still significant challenges. REAP is designed to address these challenges through its objective of using renewable energy to provide cost-effective and reliable electricity to help rural people to improve their standards of living and increase their incomes. Renewable electricity will supply isolated households and communities that cannot be reached economically by the EVN grid and will augment the grid supply in remote areas.

IMPACT

The terrain and water resources of northern Viet Nam make micro-hydropower systems an ideal candidate for providing

a low-cost, reliable electricity supply to many remote rural areas. The systems are simple to install, operate and maintain. They perform well and efficiently and can play an important role in helping local people to improve their standards of living and incomes.

Future plans

Since its launch, REAP has collected data on the more than 1,100 communes that will not be connected to the EVN grid by 2005 and assessed the potential of supplying their needs using small hydropower systems. Other activities in preparation for the Rural Energy 1 Project include: a commune-based micro-hydro-diesel pilot project in Son La province; investment in 15 projects to rehabilitate grid-connected hydro facilities; development of a standardized small power purchase agreement and tariff; and an information-gathering visit by the main Vietnamese stakeholders to village-level hydro, solar and grid-connected renewable energy projects in Sri Lanka.

Not all areas of Viet Nam have sufficient water or the right topography to make hydroelectric systems viable, so alternatives that do not depend entirely on the power of running water need to be developed and introduced. One such alternative is the micro-hydro-solar-diesel hybrid, which can supply electricity to a community. There is a need to set up the organizational and management support that will ensure technical quality control, commercial operation, proper maintenance and after-sales service for this kind of system. This work should be done within the framework of a pilot project on hybrid renewable systems to test and demonstrate a model for supplying electricity to communities in a suitable way.

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