RSVP Renewables for Sustainable Village Power

PROJECT BRIEF

Desalination for Villages

by David Corbus 7/98

Background

As the world's population grows, so will its demand for potable water. Communities in arid coastal regions or regions with brackish groundwater, especially island communities, are already experiencing shortages of potable water. Many of these communities are small and remote, such as villages on the islands in the Caribbean and Mediterranean, in arid Australia, coastal South America, and the Middle East. Several of these communities can meet their water needs through demand management and conservation. However, for many of them, desalination is the most appropriate solution.

Desalination consumes a large amount of energy. Many remote villages rely on costly, often limited supplies of diesel fuel for their energy needs. Finding methods of using renewable energy to power the process is, therefore, desirable and to encourage communities in their use. Desalination is an ideal application for a hybrid power system. The desalination system can be operated as a deferable load and improve the load management of the hybrid system.

Scope

NREL researchers conducted a survey to examine the various ways in which renewable energy has been used for desalination, including photovoltaic-powered electrodialysis units, small scale solar thermal-powered multiple effect distillation systems, and direct-drive, wind-powered reverse osmosis systems. The survey compared the systems based on capital cost, life-cycle cost, energy consumption, pretreatment requirements, and operational complexity.

NREL also sought to identify the possible ways in which renewable energy could be used for desalination and to decide areas of further research. Because few companies or communities will invest in an unproven application, ideas for key pilot projects to show the feasibility of renewable energy-powered desalination were analyzed.

Results

The survey overview was published in April 1997 and identifies several areas where further research is needed (see Status Table). Many pairings of renewable energy and desalination processes that seem quite viable in concept remain untested. These pairings are shown by empty spaces on the chart. Prototypes and pilot scale testing are needed to decide the viability of such systems and to learn how they compare with other combinations. Both PV- and wind-battery electrodialysis systems have been operated successfully. A mechanical wind pump-reverse osmosis system using pressurized water storage has been tested in Australia, but a similar electrical wind pump system has not, although several researchers have concluded that electrical wind pumps are superior to mechanical pumps in high wind regimes. Recent improvements suggest that vapor compression is potentially the least expensive and lowest energy consuming form of sea water desalination, but a renewable energy-powered system has not been tested.

NREL has tested one of the more promising combinations. An electrodialysis reversal (EDR) system was tested using a wind-electric power source. The EDR processed 1.1 liters per minute (lpm) of brackish water (900 ppm) using an 850-Watt wind turbine from Bergey Windpower Company attached to a 48-Volt, 350 Amp-hour battery bank. The power consumption for the test averaged 114 Watts. The low (1.1 lpm) flow rate was due to a bypass valve leak on the system pump, which was discovered after the test was concluded. The system is part of a Bureau of Reclamation project focusing on desalination units suitable for use on Native American reservations and other remote area locations in the United States. The Bureau has tested this system in Spencer Valley, New Mexico, on the Navajo reservation in a PV/battery design. In addition, the Solar Thermal Division of NREL initiated an investigation into small scale solar thermal-powered multiple effect distillation systems.

Planned Activities

NREL will continue to investigate vapor compression units suitable for use in villages.

Testing of independent hybrid PV/wind/battery systems with and without backup generators is continuing. A cooperative project between Australian researchers and NREL is being discussed with members of CASE/Australia, developers of a commercial prototype of a PV-reverse osmosis system.

Development Status of Renewable Energy-powered Desalination

(Italic text indicates research areas of greatest interest for near-term commercialization. Blank cells represent renewable energy-desalination combinations which have not been tested. n/a means that the particular technology cannot be powered with this form of energy.)

Renewable Energy Source	Desalination Technology				
	Multiple Effect Distillation	**Multistage Flash Distillation**	**Vapor Compression**	**Reverse Osmosis**	**Electrodialysis**
Solar thermal	Pilot plants (Spain, 1988; U.A.E., 1984) *Rugged ME*	Pilot plants (Kuwait, 1984; Mexico, 1978)	n/a	n/a	n/a
Solar thermal electric or mechanical		Pilot plant thermal plus Stirling engine (Texas, 1987)		Pilot plants mechanical direct drive (France, 1978)	
PV-battery inverter	n/a	n/a		Commercial	Pilot plant (Japan, 1988)
PV, no inverter	n/a	n/a		Commercial direct drive (Australia, 1996)	Commercial prototype battery/all-DC (New Mexico, 1995) *PV-direct drive*
Wind-battery	n/a	n/a	Pilot plant (Spain, in progress) *Wind-battery-inverter*	Pilot plants (France, 1990; Spain, in progress) *Wind-battery-inverter*	Pilot plant (Spain, in progress) *Wind-battery*
Wind-diesel			*Wind-diesel-load management*	Pilot plants in progress (Spain, Greece) *Wind-diesel-load management*	
Wind-mechanical	n/a	n/a		Pressurized water storage pilot plant (Australia, 1990)	n/a
Wind-electric direct drive	n/a	n/a		Cut in/cut out control pilot plants (Germany, 1979; France, 1987) *Pressurized water storage*	

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Produced by the National Renewable Energy Laboratory, a U.S. Department of Energy national laboratory.

Printed with renewable source ink on paper containing at least 50% wastepaper, including 20% postconsumer waste.

NREL/FS-520-24629