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The Politics of Alternative Energy: A Study of Water Pumping Systems in Developing Nations

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Abstract *The provision of potable water is a major problem for the Southern hemisphere. Photovoltaic water pumping is a technology capable of responding to this need. To this point, however, the technology has not been successfully introduced to the hemisphere. This study compares the relative economic viability of a conventional diesel "gen-set" with a PV-powered jack pump; the economic superiority of the latter is demonstrated. It is argued that PV technology can allow the hemisphere to reduce its technological dependence on the West and can be better adapted over time to Southern socio-technical needs.*

Keywords development, water pumping, renewable energy

Introduction

The provision of safe, inexpensive, and readily available potable water is a central concern for many countries of the Southern hemisphere. According to the World Health Organization, over half of the population in the hemisphere have no access to safe drinking water and 75% lack the water supplies necessary to safely dispose of human wastes (Kristoferson and Bokalders 1986). Many in the West, often with the support of Southern analysts, routinely propose to remedy these conditions through complex and expensive technical assistance programs. Large dams, rural electrification projects, and regional grid systems are argued to be the best means to resolve these problems while also ensuring entrance to the advanced tier of the world's nations. Instead of being a propulsive force, however, these projects have often undermined social, economic, and political networks while simultaneously imposing significant financial burdens on already endangered Southern economies.

Reacting to this history, writers such as E.F. Schumacher (1973) urged the South to pursue an alternative path to (and definition of) socio-technical progress. "Appropriate technology" programs, while advocated also for the West, were argued to be especially suitable to the needs of the South. Critics of this technological path, in turn, maintained that appropriate technology amounts to a quit-claim to material prosperity by the South. Appropriate technology was attacked for romanticizing traditional modes of production: the "boy and oxen" may, from the comfort of the West, represent a more harmonious interrelation between nature and human societies, but for appropriate technology's opponents, local technique only contributed to shorter life spans and precarious modes of existence. It was concluded that failure to seek the fullest possible application of large-scale, usually Western, technologies would perpetuate the conditions of Southern poverty. Appropriate technology arguments are consequently dismissed as either harmless and naive or detrimental to the material interests of the South.

Both positions ignore the point that technical artifacts function within a more complex socio-technical system composed of political, economic, as well as ideological elements (Byrne and Hoffman 1987). Finding an appropriate solution to the problem of potable water in the Southern hemisphere does not lie in the advance of a purely technical instrument, but in the adoption of a technology compatible with the various elements of the desired socio-technical system. A solution to the problem of potable water in the South lies neither in the automatic rejection of particular technologies nor in the uncritical acceptance of them.

The purpose of this article is to assess the economic viability of a sophisticated technology—a photovoltaic (PV) powered volumetric water pump (also commonly referred to as a jack pump)—and to locate it within the socio-technical challenges facing the South. The article is composed of two parts. First, the economics of the pump are compared to the more conventional diesel-powered pump systems. Following this analysis, the use of the PV-powered pump is assessed as it pertains to the socio-technical conditions of the South.

Description of the System

The volumetric pump is one of a family of pumps capable of supplying potable water to a community. Pumps fall broadly into one of two categories: *centrifugal* (rotodynamic) and *volumetric* (positive displacement). Centrifugal pumps are ideally suited for conditions of high flow in tube wells, cisterns, or other reservoirs. These pumps are designed for a fixed head (viz., the distance from the top of the water to the surface) and their water output increases with rotational speed. Such pumps have been installed with capacities as high as 1,200 cubic meters per day and can be used for flow rates as low as 10–15 cubic meters per day. However, these pumps are not recommended for suction lifts greater than 5–6 meters.

Volumetric pumps have a water output that is almost independent of head but directly proportional to speed. There are many different types of volumetric pumps, but the most interesting for inclusion in the PV-powered systems are jack pumps and progressive cavity pumps. These pumps, and in particular the jack pump, are ideally suited to conditions of low flows and high heads. As will be discussed, these conditions are characteristic of many potential well sites in the South.

A variety of pumping techniques are also available. In terms of mechanical pumps (i.e., non–hand operated pumps) the most common type of pump is the diesel pump. A well-understood technology, diesel pumps enjoy comparatively low capital costs, are transportable at modest cost, and can be relatively easy to install. While the continuing costs of fuel and maintenance can be substantial drawbacks, diesel motors power the bulk of operating water pumps in the South (Meridian Corporation 1986). This analysis will therefore be limited to a comparison between diesel-powered "gen-sets" and PV units.

Furthermore, only jack pumps will be considered as the analysis is limited to the provision of potable water rather than water for irrigation purposes (progressive cavity pumps are best suited for the latter task).

Cost Effectiveness

To determine the relative cost effectiveness of the alternative systems, a present value analysis was conducted. The discounted costs of a gen-set, a conventional PV-powered jack pump with a fixed stroke, and a hypothetical PV-powered pump with a variable or self-adjusted stroke were compared. The application selected for this analysis was potable water supply for rural communities in the South without access to grid power.

For the analysis, a 10-year life cycle was assumed. Other analysts have employed 20-year cycles (see for example Meridian Corporation 1986 and Matlin et al. 1986). However, technological innovation in this field is substantial and likely to continue. It is improbable that existing techniques will remain competitive for 20 years; indeed the 10-year assumption itself may be overly optimistic. A 6% discount rate was selected. Again, there are differences in judgment about the appropriate value for this parameter (Meridian Corporation 1986 and Matlin et al. 1986). The rationale for a 6% rate is that water supply represents an infrastructure investment with long-term social benefits. Projects of this kind should have higher social value in present value terms than many for-profit investments and therefore should not be expected to produce rates of return comparable to shorter-term business investments. This rate is also consistent with loan policies of the World Bank and other international development lenders. Often, rates by such lenders are 3% or lower and involve 100% financing. For all of these reasons, a 6% discount rate seems ample.

Start-up capital costs, recurring capital costs for component replacements and maintenance, and repair parts costs were included in the analysis. An average annual inflation rate of 5% was assumed for the 10-year period. Not included in the analysis are well and tank costs, shipping and insurance costs, and labor costs to maintain the pumping system. All of these vary to some extent by the type of pump used, but this variation has a negligible effect on the 10-year cost stream (Meridian 1986).

A cost comparison requires that certain pumping parameters be established, including depth of well, flow rate, insolation rate, and the ratio of peak to average water demand. To a significant degree, these in turn depend on the size of the community to be served by the water supply system. Two scenarios were utilized in order that a range of dimensions could be considered. These scenarios were based on two studies: one by the Meridian Corporation (1986) that surveyed 300 organizations for field experience data on 2,700 PV-powered systems in use in the South; and another by IT Power, Inc. (1986) that examined reports and other documents covering the field experience of nearly 2,000 PV-powered pumps in the South. Based on the collected information, each study identified a typical village size, flow rate, well head, and insolation rate. These scenario parameters are presented in Table 1. The hydraulic energy demands and peak wattage requirements for each scenario are calculated in Table 2. The calculations are based on the PV array sizing method employed in the Meridian study. The maximum pump efficiency factor of 0.5 is consistent with SERI's testing results (1982).

Costs of the pumping options were derived as follows. Start-up capital costs for the diesel-powered pump were taken from the Meridian study. Equivalent costs for the jack-pump options were taken from manufacturers' price lists and the Meridian study. Pump and valve set costs were those used by Meridian. DC motor costs were derived from price

Table 1
Parameters for Cost Comparison

Meridian Scenario Parameters:	
Village size:	1,250 people
Water consumption	
per person:	40 liters/day
well head:	25 meters
flow rate:	50 cubic meters/day
insolation:	6 kWh/m^2/day
IT Scenario Parameters:	
Village size:	500 people
Water consumption	
per person:	40 liters/day
well head:	25 meters
flow rate:	20 cubic meters/day
insolation:	6 kWh/m^2/day

General assumptions:
- Wells are capable of yielding the volume and the pump flow rate demanded.
- Peak demand equals 1.5 of average daily water demand.
- System sizing factor equals 1.1 (equivalent to the ratio of photovoltaic power rating (PPR in kW/m^3) to PV system efficiency (SE), including temperature effects, wiring and control system losses).

lists furnished by Chronar Trisolar, Inc. (Bedford, MA). Controller costs were supplied by Balance of Systems Specialists (Scottsdale, AZ); a proposed stroke controller option was also included in the analysis. PV array costs were based on the 1985 estimates of $10 per peak Watt (Wp) (Poulin 1985) and Solec International (Hawthorne, CA) costs of $6 per Wp. It should be noted that some argue that the cost of PV cells will decline substantially over the next decade (McNelis and Derrick 1989; Wilson 1988). Obviously, such a result would favorably affect the cost of the PV system. The Meridian study was relied on for cost factors and replacement cycles for recurring capital costs and maintenance and repair costs for all three pump options. Because the Meridian scenario involves a relatively high flow rate, two jack pumps were assumed to be installed. The cost elements by scenario are presented in Tables 3 and 4.

A present value analysis based on the previous parameters and assumptions indicates that for both the 1,250 and 500 villager scenarios, the PV systems have lower present value costs than the diesel system, an advantage that translates directly into lower costs per cubic meter of water (see Tables 5, 6, and 7). While the self-adjusting pump enjoys the greatest cost advantage, it should be pointed out that this advantage rests upon a speculative set of technical assumptions. Decreasing the insolation rate from 6 to 5 kWh/m^2/day does not alter the outcome.

PV Technology and Southern Futures

The results obtained here and elsewhere (McNelis and Derrick 1989, Singh 1988, Danley and Bucciarelli 1986) indicate that PV power is cost-competitive with diesel options. Normally, such findings would lead to the conclusion that a viable commercial market is available to the suppliers of solar technology. In fact, the World Bank has estimated that

Table 2

PV Array Size Calculation:

Step 1—Hydraulic Energy Demand (HED)—9.8 (m^4)/3600

Step 2—Energy Demand (ED)—HED/MPE

where MPE—(maximum pump efficiency) assumed to be 0.5

$$\text{Step 3—Peak Wattage (kWp)} = \left(\frac{\text{Peak Flow Rate}}{\text{Average Flow Rate}}\right) \times \left(\frac{\text{ED}}{\text{Insolation (kWh/m}^2\text{/day)}}\right) \times \left(\frac{\text{PPR}}{\text{SE}} = 1.1\right)$$

Scenario Requirements:

Meridan—Conventional PV Jack Pump

$$\text{HED} = \frac{9.8\ (1250\ \text{m}^4)}{3600} = 3.4028$$

$$\text{ED} = 3.4028/.5 = 6.8056$$

$$\text{kWp} = 1.5\left(\frac{6.8056}{6}\right)(1.1) = 1.8715$$

IT—Conventional PV Jack Pump

$$\text{HED} = \frac{9.8\ (500\ \text{m}^4)}{3600} = 1.3611$$

$$\text{ED} = 1.3611/.5 = 2.7222$$

$$\text{kWP} = 1.5\left(\frac{2.7222}{6}\right)(1.1) = 0.7486$$

Meridan and IT—Self-Adjusting Jack Pump

Assumed to be 70% of conventional pump requirements

kWp − Meridian = 1.310

kWp − IT = 0.524

energy demand for water pumping in the South is nearly 6 GW (Rosenblum 1978) and UNICEF has estimated this market (conservatively) at $300 billion (Kristoferson and Bokalders 1986, 283). Yet, diesel units continue to dominate this market. This condition persists despite the fact that the South is particularly well suited for solar applications. High levels of solar insolation and the need for Third World countries to limit hard currency expenditures on imported diesel fuel would seem to make for ideal market conditions for solar penetration (Laufman and Hurlbut 1987; Danley and Bucciarelli 1986). The failure of PV-powered water pumping technology to establish itself as a serious competitor to diesel systems, in fact, has little to do with the cost characteristics of the technology. PV's weak market position is explained by a way of thinking that mitigates against the use of the technology and a set of institutional barriers that follow directly from this thinking.

Many in the West and the South believe that the proper way to achieve social and material prosperity is to replicate the developmental paths of the West. In this view, "the only possible future of less developed countries is predetermined by the histories of the more developed countries" (de Janvry 1981, 8). The implications of this thinking are that the South has no real choice regarding technological systems and is compelled to endure the consequences of this imperative.

This thinking bears directly on the integration of PV technology in the energy regimes of developing nations. As Goldemberg and associates (1988) point out, the tradi-

Table 3
Meridian Scenario

	Diesel Gen-Set	Conventional PV-Powered Jack Pump	Self-Adjusting PV-Powered Jack Pump
Capital costs			
Generator	$6,754 (6.4 kW)	—	—
Pump/valves	1,564	$ 3,270 (2 pumps)	$ 3,270 (2 pumps)
DC pump motor (brushless)	—	1,155 (2¾ hp. motors)	975 (2½ hp. motors)
Controllers	—	948 (2 90 v. controllers)	600–948 (2 spec. controllers)
Additional gear motors	—	—	125
PV array	—	11,232–18,720 (1.872 kWp)	7,860–13,100 (1.310 kWp)
Total	$8,318	$16,605–24,093	$12,830–18,418
		(1) (2)	(1) (2)
Recurring capital costs			
Generator replacement	every 6 yrs.[a]	—	—
Pump replacement	every 5 yrs.[a]	every 5 yrs.[a]	every 5 yrs.[a]
Other Recurring Costs			
Engine overhaul	15% of gen-set cost every 3 yrs.[a,b]	—	—
Maintenance and repair	2% of capital cost every yr.[a]	1% of capital costs every yr.[a]	1% of capital costs every yr.[a]
Fuel cost	$552 per yr. (assuming 1,104 ltrs. @ $0.50 per ltr.)[a]	—	—

[a] Plus appropriate escalation due to general inflation (assumed to be 5% per year).
[b] Engine overhauls not performed during replacement years.

Table 4
IT Scenario

	Diesel Gen-Set	Conventional PV-Powered Jack Pump	Self-Adjusting PV-Powered Jack Pump
Capital costs			
Generator	$3,165 (3 kW)	—	—
Pump/valves	822	$1,635 (1 pump)	$1,635 (1 pump)
DC pump motor (brushless)	—	675 (1 hp. motor)	487 (½ hp. motor)
Controllers	—	474 (90 v. controller)	300–474 (spec. controller)
Additional gear motors	—	—	125
PV array	—	4,494–7,490 (749 Wp)	3,144–5,240 (524 Wp)
Total	$3,987	$7,278–10,274 (1) (2)	$5,691–7,961 (1) (2)
Recurring capital costs			
Generator replacement	every 6 yrs.[a]	—	—
Pump replacement	every 5 yrs.[a]	every 5 yrs.[a]	every 5 yrs.[a]
Other Recurring Costs			
Engine overhaul	15% of gen-set cost every 3 yrs.[a,b]	—	—
Maintenance and repair	2% of capital costs every yr.[a]	1% of capital costs every yr.[a]	1% of capital costs every yr.[a]
Fuel cost	$304 per yr. (assuming 608 ltrs. @ $0.50 per ltr.)[a]	—	—

[a] Plus appropriate escalation due to general inflation (assumed to be 5% per year).
[b] Engine overhauls not performed during replacement years.

tional development logic incorporates a view of the energy system that initially rests on the acquisition of engines, furnaces, and heating devices driven by petroleum and other fossil fuel derivatives. This is followed by a more advanced stage of development involving the construction of centralized electricity and grid transmission systems. Given such an expectation, developing countries, rather than investing in stand-alone systems which favor a more decentralized form of energy production, tend to create institutional systems that can support both stages of energy development. The training of technical experts, the funding of schools, the creation of systems capable of delivering spare parts, and national sponsorship in the building of fossil fuel systems all tend to favor diesel-powered systems over alternative energy technologies such as PV. In this respect, the development of a "petroleum network" to service the limited power demands of "engines and other devices" is not simply a choice about competing technologies; it is a choice about alternative energy regimes. The use of diesel-powered water pumping systems, while neglecting viable alternatives such as PV-powered systems, represents the initial phase of the fossilization of the energy system and, in turn, an integration of the Southern economies into the world oil markets.

For the South to overcome the limitations of the conventional development paradigm, the relation between the social order and the technical domain must be shifted. The adoption of PV technology is one means to break the tendency toward social and technical centralization, which too often characterize the recent development paths of the South. The use of this technology to supply energy for such things as water-pumping offers the South the possibility of "genuine development, that is, a need-oriented, self-reliant, environmentally sound and peaceful socio-economic process" (Goldemberg et al. 1988, 221–222). For instance, PV technology would permit the South some relief from its present balance-of-payments problems by reducing the need for oil as a primary and secondary energy source. Since most developing countries are oil importers, the use of diesel fuel to satisfy such basic systems as water-pumping only deepens the balance-of-payments problem so debilitating to their development efforts.

While PV technology can make an important contribution to social development in the South, it is also appropriate to the present realities of the developing world. Unlike the highly urbanized West, a substantial and, in some cases, a large majority of the population resides in nonurban settings. In India, for instance, 76% of the total population resides in rural areas and village settings (Goldemberg et al. 1988, 198), while in many parts of Africa the present nonurban population is even higher, e.g., 84% in the case of Kenya (Flavin 1986, 35). The cost of providing centralized power to these places is enormous. According to Goldemberg et al. (1988, 198 and 234):

> The slow pace of progress with regard to electrification of villages is mainly because it is based on linking the vast number of small, remote and scattered settlements to an electricity grid. Not only does this approach lead to major transmission losses (for which the [Indian] national average is 20%) but it requires load centers with low load factors of about 8%. Besides, with increasing energy costs, the costs of aluminum conductors are escalating and therefore the cost of transmission lines . . . Beyond a certain point from centralized sources, decentralized energy production/distribution units located in villages become an attractive proposition.

The fact that decentralized PV technology applications offer an attractive energy option does not eliminate entirely the need for conventional fossil fuel-based systems. Rather, solar energy offers the South a means to achieve a **balanced** energy system using

Table 5

Meridian Scenario

	1	2	3	4	5	6	7	8	9	10	Total Present Value
Annual capital cost											
Diesel	832	832	832	832	832	832	832	832	832	832	
Conventional PV (1)	1,660	1,660	1,660	1,660	1,660	1,660	1,660	1,660	1,660	1,660	
(2)	2,409	2,409	2,409	2,409	2,409	2,409	2,409	2,409	2,409	2,409	
Self-adjusting PV (1)	1,283	1,283	1,283	1,283	1,283	1,283	1,283	1,283	1,283	1,283	
(2)	1,842	1,842	1,842	1,842	1,842	1,842	1,842	1,842	1,842	1,842	
Other costs											
Diesel	755	792	2,005	873	2,913	10,014	1,011	1,062	2,686	3,718	
Conventional PV (1)	174	183	192	202	4,385	222	234	245	258	5,596	
(2)	253	265	279	293	4,480	323	339	356	374	5,718	
Self-adjusting PV (1)	135	141	149	156	4,336	172	181	189	199	5,535	
(2)	193	203	213	224	4,408	247	259	272	286	5,626	
Total outflow											
Diesel	1,587	1,624	2,837	1,705	3,745	10,846	1,843	1,894	3,518	4,550	
Conventional PV (1)	1,834	1,843	1,852	1,862	6,045	1,882	1,894	1,905	1,918	7,256	
(2)	2,662	2,674	2,688	2,702	6,889	2,732	2,748	2,765	2,783	8,127	
Self-adjusting PV (1)	1,418	1,424	1,432	1,439	5,619	1,455	1,464	1,472	1,482	6,818	
(2)	2,035	2,045	2,055	2,066	6,250	2,089	2,101	2,114	2,128	7,468	
Discount factor (6%)	.943	.890	.840	.792	.747	.705	.665	.627	.592	.558	
Present value											
Diesel	1,496	1,363	2,000	1,350	2,797	7,646	1,225	1,187	2,082	2,339 =	23,485
Conventional PV (1)	1,730	1,547	1,306	1,475	4,516	1,327	1,260	1,195	1,136	4,049 =	19,541
(2)	2,510	2,244	1,895	2,140	5,146	1,926	1,828	1,734	1,648	4,535 =	25,606
Self-adjusting PV (1)	1,337	1,195	1,009	1,140	4,197	1,026	974	923	877	3,804 =	16,482
(2)	1,919	1,715	1,449	1,636	4,669	1,473	1,397	1,325	1,260	4,167 =	21,010

Table 6
IT Scenario

	1	2	3	4	5	6	7	8	9	10	Total Present Value
Annual capital cost											
Diesel	399	399	399	399	399	399	399	399	399	399	
Conventional PV (1)	729	729	729	729	729	729	729	729	729	729	
(2)	1,027	1,027	1,027	1,027	1,027	1,027	1,027	1,027	1,027	1,027	
Self-adjusting PV (1)	569	569	569	569	569	569	569	569	569	569	
(2)	796	796	796	796	796	796	796	796	796	796	
Other costs											
Diesel	403	423	993	467	1,539	4,755	540	567	1,331	1,964	
Conventional PV (1)	76	80	84	88	2,179	97	102	107	113	2,782	
(2)	108	113	119	125	2,217	138	145	152	159	2,830	
Self-adjusting PV (1)	60	63	66	69	2,159	76	80	84	88	2,755	
(2)	84	88	92	97	2,188	107	112	118	123	2,793	
Total outflow											
Diesel	802	822	1,392	866	1,938	5,154	939	966	1,730	2,363	
Conventional PV (1)	805	809	813	817	2,908	826	831	836	842	3,511	
(2)	1,135	1,140	1,146	1,152	3,244	1,165	1,172	1,179	1,186	3,857	
Self-adjusting PV (1)	629	632	635	638	2,728	645	649	653	657	3,324	
(2)	880	884	888	893	2,984	903	908	914	919	3,589	
Discount factor (6%)	.943	.890	.840	.792	.747	.705	.665	.627	.592	.558	
Present value											
Diesel	756	732	1,169	686	1,448	3,634	624	606	1,024	1,318 =	11,997
Conventional PV (1)	759	720	683	647	2,172	582	553	524	498	1,959 =	9,097
(2)	1,070	1,015	963	912	2,423	821	779	739	702	2,152 =	11,576
Self-adjusting PV (1)	593	651	533	505	2,038	455	432	409	389	1,855 =	7,960
(2)	830	787	746	707	2,229	637	604	573	544	2,003 =	9,660

a mix of decentralized and centralized energy technologies. While PV cannot be understood as a "techno-fix" independent of the socio-technical whole, it does provide a technological alternative for the provision of basic material needs. Equally important, PV technology represents an alternative to the inherent tendencies toward social centralization of conventional systems of electrical supply. The technology is capable of modification in scale and interconnection can be scaled to fit social needs, and thereby deployed to preserve rather than disrupt modes of social organization. As noted by Langdon Winner, "a regime of solar energy has a good chance of becoming a flexible, forgiving, humanly agreeable setting under which to live. There is, of course, nothing necessary about that result; solar technologies are not, as some have suggested, inherently democratic. How they will affect society will depend upon the configuration given to both their material and social components" (1982, 275).

PV technology has one other significant advantage over fossil fuel systems. At the present time, the chemical composition of the atmosphere is being altered by continuing emissions at high levels of carbon dioxide, nitrous oxide, and methane. Over half of this pollution is traceable directly to the burning of fossil fuels for energy (Flavin 1989). A Third World development path which seeks to minimize the mistakes of the West, and in particular, which aims to reduce dependence upon fossil fuels, can offer significant environmental dividends and affordable energy. The use of PV technology in the South would create diversity in regional energy systems while greatly limiting the environmental damage which naturally accompanies development based upon combustion of fossil fuels.

Conclusion

According to the World Commission on Environment and Development "renewable energy sources could in theory provide 10–13 terawatts annually—equal to current global energy consumption" (1988, 192). While most of the present world supply of renewable energy is derived from biomass and hydro power, the Commission points out that solar energy can now "compete with conventional electricity production" and that even at current prices "it still provides electricity to remote places more cheaply than building power lines" (1987, 193).

The findings of this study provide further evidence of the suitability of PV technology to the development needs of the South. Adoption of this technology will require short-term borrowing of both money and expertise from the West. But in the long run, PV technology can decrease the South's dependency by enhancing social autonomy and providing a means to moderate the globalizing tendencies of technique. As Goldemberg et al. point out, "developing countries should not retrace the developmental path of the North but should pursue new directions and assume the risks of innovating in some areas

Table 7

Discounted Cost per m^3 of water supply		Scenario: Meridian ($m^3 = 50 \times 3,650 = 182,500$)	Scenario: IT ($m^3 = 20 \times 3,650 = 73,000$)
Diesel		$0.129	$0.164
Conventional PV	(1)	0.107	0.125
	(2)	0.140	0.159
Self-adjusting PV	(1)	0.090	0.109
	(2)	0.115	0.132

of potentially high payoff" (1988, 236). PV technology, including PV-powered water pumps, is one option that the South could pursue to affect the cycle of dependency development.

An encouraging sign of possible change in energy thinking is the recently launched Sahel Solar Electric Pumping Project. Sponsored by the European Community Commission, the project's goal is the installation of 1,740 solar water-pumping, lighting, cooling, and battery charging systems. It is the largest single PV project in the history of the technology (*Photovoltaics Intelligence Reporter*, 1990). Perhaps this initiative will become a model for need-oriented, environmentally sound development.

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