Photovoltaic water pumping and its potential for application in community water supply in South Africa

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Abstract

Photovoltaic pumping (PVP) is an established international technology with over a decade of operational use in the developing world. It can be an attractive technology due to its high reliability, low recurrent costs and utilisation of renewable energy. To date, application of PVP in South Africa has been minimal, with most systems operating on privately owned farms and game reserves. Reasons for this are: relatively high initial capital costs coupled with inadequate financing arrangements, general suspicion of a new technology which lacks a comprehensive support network and the high risk of theft and damage.

However, in the range where PVP has been shown to be economically competitive, there are an estimated 8 500 South African unserviced communities where this technology could be applied. To facilitate sustainable application of PVP for community water supply, it is necessary that a programme of pilot projects be initialised; a Set of standards be established within the industry; more detailed research on economic viability be undertaken; and a comprehensive support network be developed.

Introduction

The utilisation of solar energy to power water pumps is a relatively new technology in South Africa. Investigation into the use of solar power for water supply was initiated by the United Nations Development Programme in 1978 (Kenna and Gillet, 1985). This study included literature reviews, field trials and laboratory tests. It was concluded that "there are some conditions under which solar pumps already can provide the best solution to local water needs". Several different solar technologies were investigated, including solar thermal devices. However, the most technically reliable and utilised solar technology today is photovoltaics (PV).

Photovoltaic pumping (PVP) involves the conversion of solar irradiance into electrical energy within an array of PV cells, usually constructed of monocrystalline silicon. This DC electricity is then used to drive an electrical motor and pump.

PVP for rural water supply has been utilised with varying degrees of technical and institutional success in Southern Africa. This is particularly the case in Namibia, Botswana, Lesotho and Zimbabwe. PVP projects have also been undertaken extensively in Francophone West Africa, South East Asia and South America. Furthermore, a comprehensive field testing PVP programme has been undertaken by the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) in seven developing countries. However, application in South Africa has been mostly limited to privately owned farms and game reserves with a few rural water supply applications in KwaZulu-Natal and the former Transkei.

Technical description of PVP systems

PVP systems are available in various forms and can be utilised in a range of applications. Most systems are designed for use in boreholes, but there are a few systems designed to pump water from surface sources.

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The typical PVP system consists of four components: the PV array which is the power source, the controller or power conditioner which matches the power source to the load, the electrical motor and the pump (Fig. 1).

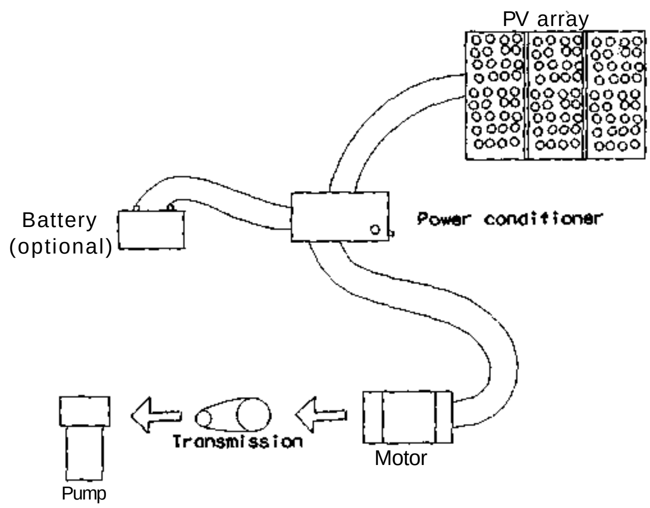

***Figure** 1*
A typical PVP system (from Davis, 1993)

PVP systems can be categorised into DC and AC motor systems. DC motor systems run directly on the DC energy generated by the PV modules. They are more applicable in high-head low-flow situations. DC systems are the most commonly utilised in Southern Africa. AC motor systems include an inverter, which converts the DC energy to AC. This powers an AC motor and these systems are more applicable for higher flow requirements.

The units used to measure PVP systems are daily duty (m^4/d) and peak watt (Wp). The unit of daily duty is the daily water demand (mVd) multiplied by the total head (m). Wp is the peak power output at full solar irradiation of a PV array at noon.