Solar Water Pumping in Namibia

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Recommendations to overcome barriers and possible mechanisms to be applied to implement an economically and socially beneficial benefit program to facilitate the use of photovoltaic pumping (PVP) in Namibia

Summary

The Ministry of Mines and Energy of Namibia through the Namibian Renewable Energy Programme (NAMREP) commissioned a consultancy group (EMCONGROUP) to assess the current status of photovoltaic water pumping (PV) in Namibia and to investigate the feasibility of replacing diesel water pumps with photovoltaic water pumps. This technical and economic assessment also aimed to increase affordable access to sustainable energy services through the further development of a market for Renewable Energy Technologies in the off-grid areas in Namibia. The comparison between the two water pump technologies was undertaken through a cost benefit analysis (life-cycle-cost comparison).
The outcome illustrates a significant improvement of the potential of photovoltaic pumps (PVP) and an increase in the technologies market potential on commercial, communal farms and rural facilities.

	End-user area		**Target Audience**		**Technical**
	New buildings	X	Citizens		Energy efficiency
	Refurbishment of buildings		Households		Heating
	Transport and mobility	X	Property owners		Cooling
	Financial instruments	X	Schools and universities		Appliances
	Industry	X	Decision makers		Lighting
X	Legal initiatives (municipal regulations, directives, etc)	X	Local and regional authorities		CHP
X	Planning issues		Transport companies		District Heating
X	Sustainable communities		Utilities	X	Solar energy
	User behaviour		ESCOs		Biomass
X	Education	X	Architects and engineers		Wind
X	Other: Marketing, Agriculture	X	Financial institutions		Geothermal
		X	Other: Farmers		Hydro power
					Other

Introduction

Due to the semi-arid climate and lack of surface water, rural areas in Namibia need to obtain water from wells or boreholes. There are an estimated 51,500 boreholes in the country. The most frequently water pumping technologies used are diesel pumps and, to a smaller extent, wind water pumps. Solar water pumps have, at present, a very small market share.
The Namibian Renewable Energy Programme aims to facilitate the adoption of Photovoltaic Water Pumps, and has commissioned an investigation into the economic feasibility of solar water pumps.

The investigation assessed recent trends in the use, costs and improvements (reliability, maintenance, operating complexity) of PVP, and compared these with the performance and cost of diesel water pumps.
The study showed that the economic and technical performance of PVP has improved dramatically, and the technology is highly competitive now.
Through the study results a number of positive socio-economic impacts could also be identified. These range from greater security of water supply to significantly reduced agricultural production costs. Positive environmental impacts include more sustainable rangeland management and greater conservation of underground water resources.

Objectives

The specific objective was to investigate the feasibility of the replacement of diesel water pumps with Photovoltaic Water pumps. This was done through analyzing recent trends in the use and costs of photovoltaic pumps and a comparative cost benefit analysis between diesel and PVP, based on the life costing approach.

Methodology

The PVP investigation included the number of installations presently in Namibia, price developments over the last five years, the technical specifications and features at various pumping configurations and their performance.
The results were assessed through a life cycle costing software algorithm.
Social elements such as perceptions and experiences with PVP and Diesel Water Pumping Systems were gathered through interviews with several stakeholders.

Target Audience

Agricultural Sector:
The outputs of the cost benefit analysis identified the operating and performance conditions under which a change from diesel to solar pumping is most economically feasible. Due to the low maintenance and operating costs, the largest (most boreholes in Namibia are on commercial farming land) group of beneficiaries are commercial farmers, followed by communal farmers and community- based conservancies.

Public Sector:
Schools, clinics, police stations and other infrastructure in remote off-grid areas will benefit from solar water pump systems because of high reliability and low maintenance. This will particularly alleviate the financial burden currently experienced by relevant line ministries in maintaining the water infrastructure in remote areas.
Furthermore, the Namibian government pursues an approach of establishing Water Point Committees in rural areas. Under the scheme, communities establish a formal committee, select their pumping technology of choice (which is supplied by the government), and are responsible for operating and maintaining the system. The Water Point Committee charges for access to water, and the income generated is used to cover operating and maintenance costs.

Financial resources and partners

The Namibian Renewable Energy Programme (NAMREP), hosted by the Ministry of Mines and Energy, commissioned the study. NAMREP is funded through the Global Environment Facility (GEF) and the United Nations Development Programme (UNDP).

Finding/ Outcome

Table 1 indicates the number of years to breakeven for photovoltaic pumps, compared to Diesel Water Pumps in Namibia. The conversion is technically feasible for certain pumping depths (heads) and certain daily water requirements (yields). For example assuming a head of 60 m and a daily need of 13 m^3 (= 13000 l) a photovoltaic water pump (PVP) would be paid back in 1.2 years. This is a remarkably short payback period for heads up to 80 - 120 m and daily pumping volume 8-13 m^3 per day.

Graph 1 illustrates that over a period of 20 years for $10m^3$/day pumping volume and 80 m head the cost of using a diesel pump (at current fuel prices N$ 6.70/l) is almost triple the cost of solar water pumps. In most cases, the diesel water pump is more expensive over a 20 year period than an available Photovoltaic Pumping System. Assuming a fuel price increase of up to N$ 10/l during the next years, the overall cost would quadruple compared to a Photovoltaic Pump.

Table 2 demonstrates the Unit water cost (in N$) for photovoltaic pumps where they are technically and economically feasible over a certain operational range. Pumping water from greater heads results in higher Unit water costs. The investigations also showed a trend that the higher the daily volume flow is, the cheaper the water cost per unit.

Graph 2 demonstrates a breakdown of the overall costs over a period of 20 years. Solar water pumps and diesel pumps are compared for a daily volume flow of $10m^3$ at an 80 m head. The initial costs for PVPs are higher than for the conventional solution, but the operational and maintenance costs are tremendously lower.

Market potential:
A reasonable scenario, for how many boreholes equipped with photovoltaic pumps could technically fulfil daily requirements, resulted in a significant installation rate increase of 20% for the next ten years.

There is an immediate potential to replace 1000 – 2000 diesel pumps on commercial farms which operate at an average hydraulic load of 1000 m^4/day. This is the optimal range for PVP.

Additional advantages:

Photovoltaic pumps require lower maintenance (3-5 years), and much less attention than diesel water pumps because PVPs are self-starting. Solar pumps can be used in combination with a petrol/diesel generator during times of higher demand.

Other benefits

CO_2 reduction:
A diesel pump using a 3 kW engine to provide power (assume for 2.8 m3/h at 100 m head) will consume approximately 0.77 liter/h. This results in a fuel consumption of 984 liters per annum which is equivalent to 2.6 tons of CO_2 per annum for 1000 replacements and 5.2 tons of CO_2 saved for 2000 replacements.

Borehole conservation:
Diesel water pumps are designed to extract the maximum amount of water in a short period. This high pumping rate causes cavitations, and erosion of underground waterways, and results in the eventual collapse of the borehole. PVPs however pump a minimum amount of water over a maximum amount of time (i.e. the whole day). This reduced the pumping flow minimises erosion and consequently ensures longer stability of the underground waterways.

Rangeland management:
Solar pumps allow the utilization of low to medium delivery boreholes. This means that additional boreholes can be economically utilized in a given area, creating more flexibility for range management. If animals are moved between these waters in such a way that grazed plants have an adequate recovery period, then significant increases in grass and animal production can be expected.

Lessons learned and repeatability

The purpose of the NAMREP investigation was to encourage the use of solar water pumping in Namibia. The results conclusively show that in commercial farming PVP has very positive economic implications. Consequently, these technologies should be replicated as soon as possible.

Only one major barrier was identified through the study:
Communal farming communities and the prevalent unsustainable rangeland practices demand high water volumes for large herds of livestock. Often diesel water pumps are operated for 24-hour periods, seven days per week. Traditionally livestock is not sold on the market and are allowed to increase as a reflection of the owner's wealth. PVPs cannot satisfy the excessive water demand, and are thus not regarded as an option by communal farmers.

Contact Detail for more information

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Printed reports or other literature available:

- Feasibility assessment for the Replacement of Diesel Water Pumps with Solar Water Pumps
- Fact Sheet on Solar Water Pumping
- Article on Solar Water Pumping