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Solar photovoltaic water pumping for remote locations

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Abstract

Many parts of the world as well as the western US are rural in nature and consequently do not have electrical distribution lines in many parts of villages, farms, and ranches. Distribution line extension costs can run from USD 10,000 to USD 16,000/km, thereby making availability of electricity to small water pumping projects economically unattractive. But, ground water and sunlight are available, which make solar photovoltaic (SPV) powered water pumping more cost effective in these areas' small scale applications. Many western states including Wyoming are passing through the sixth year of drought with the consequent shortages of water for many applications. The Wyoming State Climatologist is predicting a possible 5–10 years of drought. Drought impacts the surface water right away, while it takes much longer to impact the underground aquifers. To mitigate the effect on the livestock and wildlife, Wyoming Governor Dave Freudenthal initiated a solar water pumping initiative in cooperation with the University of Wyoming, County Conservation Districts, Rural Electric Cooperatives, and ranching organizations. Solar water pumping has several advantages over traditional systems; for example, diesel or propane engines require not only expensive fuels, they also create noise and air pollution in many remote pristine areas. Solar systems are environment friendly, low maintenance, and have no fuel cost. In this paper the design, installation, site selection, and performance monitoring of the solar system for small-scale remote water pumping will be presented. This paper also presents technical, environmental, and economic benefits of the SPV water pumping system compared to stand alone generator and electric utility.

Keywords: Solar photovoltaic; Water pumping; Remote locations; Environment

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Contents

1. Introduction

Solar photovoltaic (SPV) water pumping (SPVWP) has been implemented around the globe as an alternative electric energy source for remote locations since SPV was invented [1–9]. The SPV system are cost effective in many remote applications such as water pumping for households, livestock and wildlife, space heating, lighting remote vacation homes, and emergency traffic applications [10–12]. The photovoltaic (PV) is a mature technology to convert sunlight into electricity. The efficiency of the PV cell has increased significantly in the last 25 years. About 1460 MW of solar PV systems were installed in worldwide in 2005 that represents a growth of 34% over 2004 installations. Annual PV domestic shipments in the USA in 2005 were 104 MW, which is 33% more than 2004 [13]. But, still the PV system cannot compete with the traditional energy resources such as coal, oil, natural gas and conventional hydro for the large-scale commercial, industrial and residential applications. A PV system is suitable for a small scale remote application where 24 h electrical service is not necessary and maintenance is an issue. Wyoming is the least populated state in the USA and most of the ranching areas are in remote locations. The grid electricity supply is not available to all ranches throughout the state that makes the situation worse during summer to pump underground water. The state of Wyoming stepped into the sixth year of drought and most surface water is drying up in early June. Fig. 1 shows drought condition in the USA and Wyoming is one the most affected states [14].

Long-term drought has severe impact on the surface water, which is the only source of water for the wildlife and in many cases for the livestock. To help the drought affected remote livestock and wildlife, Governor Freudenthal started a solar water pumping initiative in cooperation with the University of Wyoming Motor Testing and