PROTOTYPE SOLAR PHOTOVOLTAIC WATER PUMP FOR KENYA RURAL APPLICATION: KISERIAN

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A thesis submitted in part fulfilment for the Degree of Masters of Science in Engineering in the University of Nairobi.

ABSTRACT

A solar photovoltaic water pump for rural domestic water supply to North Kiserian ($1\frac{1}{2}^{o}$S, $36\frac{3}{4}^{o}$E) village is developed. The solar prototype pump consists of a 4.4KW-peak power Solar Generator, having 480 solar modules of ten, 10 x 10 cm, polycrystalline silicon solar cells. The modules are interconnected in series and in parallel to provide direct current at 200V to 350V depending on the solar irradiance and load current. The solar generator is inclined at an angle of 5^{o} (degrees) toward North. Tracking of the solar generator maximum power point at any solar irradiation is obtained via the power conditioning inverter, the solarverter. Solarverter compensate for the solar cell temperature during MPP tracking as well as providing alternating current of variable frequency in a voltage proportional to frequency control by pulse width modulation to the 3kw rating submersible motor-pump set. Water is pumped through 600m of 80mm diameter pipe at a monometric head of 70m to a $45m^{3}$ storage tank from where it is distributed to the village. Chlorination is done on the main rising pipe.

Efficiency of the whole system of between 1% and 2% is obtained with a water output per day ranging from 32 m^3 to 45 m^3 pumped on clear days depending on the actual static water level in the borehole. Static water level varies between 1m and 5m being at 5m for most of the year. Annual mean daily water output is found to be 17.7 m^3/d at a global solar insolation of 4.74 KWH/m^2d for the period from 1983 to 1984.

Low system efficiency observed is heavily affected by the solar generator efficiency which is found to be between 3.5% and 5%. The solarverter exhibits a constant efficiency of 88% for the whole pumping range and the motor-pump set together with pipework and connections has a daily performance efficiency of 32% to 48%. Water output projections for an equivalent solar PV water pump as the prototype at Kiserian indicate that, at 70m head, 19m^3/d to 26 m^3/d annually can be pumped in Kenya rural areas depending on the actual location. These water outputs are enough to supply domestic water to villages with up to 1000 inhabitants.