

# Design and Economic Evaluation of Electrification of Small Villages in Rural Area in Yemen Using Stand-Alone PV System

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**Abstract-** The photovoltaic (PV) technology potential for Yemen is relatively high, based on this fact, there are many isolated and remote locations located far away from the electrical national grid and cannot be integrated in the near future. Therefore, the electrification of these rural areas using PV system is very suitable solution to solve the problem of lighting and access to the development of these areas. This paper presents a study on design and cost estimation of stand-alone photovoltaic PV system (SAPS) to supply the required electricity for these villages. The sizing of the suggested SAPS is achieved, such as radiation data and electrical load for the typical household in the target villages also taken into account during the sizing steps. Furthermore, there are a maximum power point tracking (MPPT), an inverter, charge controller and lead acid batteries were designed. The MATLAB/Simulink was run to simulate the PV array sizing and its characteristics depending on incremental conductance MPPT technique to enhance the efficiency of the modules and get maximum available power. The simulation result has been matched the sizing calculation result. Finally, life cycle cost (LCC) analysis was used to evaluate the economic feasibility of the system. The economical results proved that, there is a difference between the conventional energy systems and PV system in that they have a low operating cost and high initial cost. The findings of the study encouraged the use of PV systems in order to electrify the remote Yemeni areas.

**Keywords-** Rural Electrification, Stand-alone Photovoltaic System, Maximum Power Point Tracking , Decentralize PV System, Life Cycle Cost.

## 1. Introduction

In the last years, there was a sharp increase in both energy consumption and population, while the conventional energy sources were retreating fast with the rise in cost so; the attention is being paid to renewable energy sources that consider more and more attractive alternative energy. Solar energy, which is copious consider with wind energy the best choice as economical energy sources in many applications. The sun has produced free energy for billions of years where the solar radiation that intercepted by the Earth is a massive amount of power reach to around  $1.8 \times 10^{11}$  MW [1]. There are a lot of renewable energy sources such as wave, biomass, wind, solar and geothermal power can be used for generation of electricity, but the Photovoltaic energy has become increasingly important as a renewable source because it is

environmentally friendly, non-polluting, not noisy, free in its availability, requiring little maintenance compared to other resources and easy to expand. Therefore, these advantages make PV generation attractive for many applications, especially in rural and remote areas in most of the developing countries.

Yemeni population is predominantly rural where around 6,733,000 people (27%) of the total population lives in urban zones. From the opposite side, the bulk of the population at about 16,267,000 (73%) are rural spread over various villages live in isolated areas. Additionally, the service of the national electrical network is very poor because of the full load of the national electrical grid just about 1568.36 MW. The rate of individuals profiting from power electricity are only 49%, the vast majority of them live in urban areas by up