DEVELOPMENT OF HYBRID ENERGY SYSTEM FOR RURAL AREA

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ABSTRACT

The economic and technological innovations have led human beings to mould energy in our own footprints. The energy requirements are growing rapidly, this lead mining and oil companies to extract more and more fossil fuels, which liberate large amount of CO_2 and other greenhouse gases. However, renewable sources are abundant in nature and cause low hazardous impacts on environment. Hybrid energy system is a suitable combination of renewable and non-renewable energy systems which keeps into account the advantages of both these systems. Proper sizing of the components involved in hybrid energy system will achieve reduction in cost of implementation and maintenance of the system, limiting emission levels, while improve the reliability.

Designing a hybrid energy system for locality and its implementation is an uphill task, as parameters such as incident solar radiation, availability of hydro discharge etc. vary randomly with time and are independent of the load requirements. To make the operation of the system self-sustainable, various important factors are needed to be considered. This includes appropriate configuration, criteria selection, sizing methodologies, selection of energy dispatch strategy and designing of power distribution network based on evaluated cost and power loss, while designing a hybrid energy system.

Seven un-electrified villages located in the Dhauladevi block of Almora, a district in Uttarakhand state of India, have been selected for the development of hybrid energy system. It comprises of renewable energy generating systems along with the addition of diesel generator, for meeting the energy deficit. The present work includes sizing of hybrid energy system using various energy dispatch strategies. The dispatch strategies considered in the present work are cycle charging strategy, load following strategy and peak shaving strategy.

Sizing of hybrid energy system for all the mentioned strategies are carried out using genetic algorithm, particle swarm optimization and biogeography based optimization techniques by keeping energy index ratio at 1. Energy index ratio is defined as the ratio of total energy supplied to the total energy demand of the system. The model also incorporates net present cost, cost of energy, renewable factor and emission of carbon di-oxide from diesel generator, as important factors. From the analysis, it can be concluded

that the 15^{th} combination of cycle charging strategy, which includes type 1 of SPV and type 3 of battery and diesel generator is most cost effective as compared to load following and peak shaving strategies.

The second part of the work involves designing of distribution network in the area. A digital elevation map (DEM) of the study area is generated using MATLAB and ArcGIS softwares. The optimal sizes of generators are placed in DEM according to the availability of resources and demand of the area. As the load/generating centers are located in the mountainous terrain, determination of shortest path will reduce the construction cost associated in laying distribution network. The shortest path between all the load/generating centers is determined using biogeography based optimization (BBO) and compared with Dijkstra algorithm (DA).

The shortest distance, thus evaluated is used to calculate the power loss in the distribution system. Here, Newton Raphson method is used for load flow analysis. It helps to find and select the type of aluminum conductor steel-reinforced cable (ACSR) for the present network. The overall system cost of energy is calculated by including net present cost of hybrid energy system along with distribution network cost and CO_2 emission cost saving.

Finally, the sensitivity analysis is performed by varying the change in solar radiation, fluctuation in demand, variation of diesel prices and reliability index ratio.