Renewable Energy and Power Quality Journal (RE&PQJ), ISSN 2172-038 X, No.9, 12th May 2011, Reference Paper: 346

Sizing stand-alone hybrid generation for seasonal irrigation pumping

Javier Carroquino[1], Rodolfo Dufo-López[2] and José L. Bernal-Agustín[2]

[1] C.P.S.-E.U.I.T.I.Z., University of Zaragoza
Calle María de Luna, 3. 50018-Zaragoza, Spain
e-mail: 125930@unizar.es

[2] Electrical Engineering Department, University of Zaragoza
Calle María de Luna, 3. 50018-Zaragoza, Spain
Phone: +34976761921, fax: +34976762226, e-mail : rdufo@unizar.es, jlbernal@unizar.es

Abstract. This paper studies the generation to feed three stand-alone existing pumping systems in the province of Zaragoza (Spain), in the same area but with different consumption and irrigation needs. All of them are used only for half the year. We look for the optimal size of the generation mix, both economically and in reducing emissions.

For simulation and optimization the program used is HOGA (Hybrid Optimization by Genetic Algorithms). It is considered diesel generation, photovoltaic and wind as well as storage. As renewable resources are almost identical in the three locations, the magnitude of energy demand and schedule are the distinctive parameters of each facility. We considered how to choose the optimum angle of the PV array, the preference between the solar and wind and the desirability of whether or not the diesel generator.

The results show the importance of seasonality and time consumption profile to determine the generation mix and to choose the optimum inclination of the field of photovoltaic conversion. Results also show that most emissions reductions are not always obtained by removing the genset.

Key words

Hybrid optimization, stand-alone pumping, seasonal demand, photovoltaic sizing, emissions reduction, genetic algorithms.

1. Introduction

Facilities that use water pumps in irrigation systems are very often isolated from the electrical grid and rely on diesel generators for power. Hybrid generation may be a good option for them [1]. The three stand-alone pumping irrigation facilities Masatrigos I, Masatrigos II and Merla are situated in the province of Zaragoza (Spain). In all of them, irrigation is carried out for six months a year, between April and September, as in many crops in the Mediterranean area. This implies that renewable generation is not useful for another six months and it also implies the difficulty of sizing. The decision to reform the existing facilities or the installation of new ones faces the problem of comparing the different options for generation and storage. However, when demand is markedly seasonal, the best orientation for solar PV panels, the size of the storage and the possibility of hybrid power are not sufficiently studied. As it is very usual the utilization of diesel generators as the only source, it is desirable to study the feasibility of renewable energy integration, as well as improvements in the level of emissions of greenhouse gases can be obtained.

Genetic algorithms have been used lately as a means for optimization of photovoltaic systems and hybrid systems [2], [3]. HOGA software [4] is used to optimize both the sizing and control variables of the system, by mono and multi objective optimization [5].

The economic comparison was made by calculating the Net Present Cost (NPC) in a project horizon of 25 years. Solutions are sought less NPC. The following economic parameters have been introduced: current market prices, both components and operation and maintenance, fuel cost 0.7 € / l, general inflation rate 2%, interest rate 6% and fuel inflation rate 6%. Subsidies or CO_2 emission rates were not considered.

2. Load and resources

A. Electrical load

Consumption and pumping schedules are shown in Table I. The relationship between the size of existing pumps and water needs involves more or less time for daily use.

Table I. - Pumps of the three installations

	Pump power (kW)	Working hours per day
Masatrigos I	15	24
Masatrigos II	9.2	24
Merla	4 and 5.5	1.33 and 2.08

For Merla, it is possible to vary the time of day when pumps work. The optimizations have shown that the best result is obtained when the two pumps are not operated simultaneously and concentrating consumption in the middle of the day, coinciding with the peak hours of sunlight.

B. Wind resource

Wind conditions are favored because they are located on land areas free of obstacles. The annual average wind speed at 30 m high are 4.75 m/s and 5.25 m/s for Masatrigos and Merla respectively. In both cases the roughness of the terrain is very low.