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Sensitivity Analysis of a Standalone Photovoltaic System Model Parameters

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Abstract: The values of input variables of any model are cause to undergo changes due to influence of environmental conditions. These changes can be investigated by conducting the sensitivity analysis of input variables with respect to output variables. Sensitivity analysis increases the validity, credibility and assurance of model estimates. The purpose of this study was to identify the most important and sensitive input variables and to prioritize the parameters based on their influence on the model outputs of a standalone photovoltaic (SAPV) system. For that, a normalized local sensitivity analysis and sensitivity index of seven input variables of a SAPV system model with reference to three output parameters namely amount of absorbed solar radiation, maximum photovoltaic (PV) module power output and optimum PV array area has been carried out. It was revealed from the analysis that the most important and sensitive input variable was the amount of total solar radiation and the least important variable was solar azimuth angle and the lowest sensitive variable was wind speed.

Key words: Sensitivity analysis, input variables, output parameters, photovoltaic system, mathematical model

INTRODUCTION

The physical examination of highly complex systems and processes are expensive or sometimes even impossible. Therefore, the investigators turned to use mathematical or computational models to predict or approximate the behavior of systems (Fellin *et al*., 2004; Saltelli *et al*., 2006). The cause of uncertainties in the model inputs are not known which results the ambiguity of model outputs. The role of every input variable in the changing of model outputs is needed for the evaluation of model suitability and understanding of the system behavior (Isukapalli and Georgopoulos, 2001). Various terms could be found in literature for the expression of input parameters such as sensitive, important, most influential, major contributor, effective or correlated (Iman and Helton, 1988). However, the term important is used for those parameters whose uncertainty contributes considerably to the uncertainty in the output results and the word sensitive referred to those variables which have a significant influence over output results (Saltelli *et al*., 2010). The main parameter is always sensitive because the parameter changeability will not appear in the results unless the model is sensitive to the input (Cacuci *et al*., 2005). A sensitive parameter is not necessarily important because it may have little contribution in the output variability (Hamby, 1994). So, the object of the study was to investigate the most important input variable of a standalone photovoltaic system.

METHODS OF SENSITIVITY ANALYSIS

Different scholars rather used different sensitivity methods according to the nature of analysis and required accuracy. In brief, these methods include one-at-a-time design, differential analysis, subjective analysis and factorial design (Hamby, 1994). The sensitivity of parameters can also be examined by the construction of scatter plots, calculation of relative deviation ratios, determination of rank transformation, rank correlation and partial correlation coefficients and also by means of regression techniques (Hamby, 1995). Various statistical tests such as Smirnov statistic, Cramer-von Mises, Mann-Whitney and the squared rank can also be adopted for sensitivity analysis of model parameters (Cukier *et al*., 1978; Iman and Hora, 1990; Bell and Otto, 1992;

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