Available online at www.sciencedirect.com

ScienceDirect

Procedia Technology 25 (2016) 751 – 758

Procedia Technology

Global Colloquium in Recent Advancement and Effectual Researches in Engineering, Science and Technology (RAEREST 2016)

Seasonal Loading Impact on Performance of Solar DG for Loss Reduction Based On Capacity Factor

Ritu Sharma[a], Atma Ram Gupta[b*]

[a,b]Department of Electrical Engineering,National Institute of Technology Kurukshetra, Kurukshetra-136119, India

Abstract

This paper proposed a methodology to study the seasonal impact on the performance of solar based Distributed Generator (DG) for loss reduction as a main objective. The random behavior of solar irradiance is modeled using beta probability density functions. IEEE RTS (Reliability Test System) data is used for load modeling. Different modules of solar have been studied and appropriate selection is made using capacity factor approach and VSI method is used for finding the optimum location for placement of SPV (Solar Photo Voltaic). An iterative forward backward/BIBC load flow method is used for analysis. The proposed technique has been applied to IEEE 33, IEEE 69 and IEEE 12 bus system and significant reduction of active power losses has been achieved for different seasons of the year.

Peer-review under responsibility of the organizing committee of RAEREST 2016

Keywords: Solar photo voltaic; Wind power; Realiability test system; Voltage stability index

1. Introduction

With rapidly increasing demand of electrical energy electric utilities are utilizing special technologies to meet the load demand without violating the system constraints; these new technologies include usage of decentralized plant for generation of electricity. Decentralized plants which include non conventional sources like wind and solar energy are generally adopted by utilities due to large abundance of these sources. Intermittent nature of wind and solar is a great challenge for the reliability of system. In literature different papers have been proposed to study this random behavior of the renewable energy sources. Beta modeling is employed to model the solar irradiance in [1].

* Corresponding author. Tel.: +91-9896279046.
E-mail address: argupta@nitkkr.ac.in

Peer-review under responsibility of the organizing committee of RAEREST 2016
doi:10.1016/j.protcy.2016.08.169

Weibull distribution function is used in [2]. Optimal placement of DG units affects the system characteristics as explained in [3] therefore; this aspect should be included in the system. VSI and PSI method is used to place the DG optimally in the system as described in [4, 5]. Various optimization methods for loss reduction are presented by different authors like genetic algorithm in [6] and PSO is used in [7]. Effect of penetration levels of DG on annual energy losses is studied in [8]. Forward-backward load flow method is explained to study the system performance in [9]. BIBC based load flow technique is explained in [10].

In this paper beta probability distribution function (PDF) is used to model the hourly solar irradiance for different solar modules. To calculate parameters of beta PDF historical data of Jaipur site is used [11]. Optimal module is selected out of several modules based on highest capacity factor [12]. VSI method is used to place the DG optimally in the system and losses are calculated for different seasons of the year.

2. Modeling of solar DG and load

In this section models of SPV and load data are presented. Beta modeling is used for solar module and IEEE RTS data is used for load modeling.

2.1. Hourly historical data processing.

A 15 year (1986-2000) hourly historical data of the Jaipur site is used to determine the hourly solar irradiance. The data has given as per L.A.T (Local Apparent Time) for sunny hours i.e. from 6 am to 7 pm of that site. For performing this task one year is divided into four seasons, where each season consist of three months and further each season is represented by any day within that season. Now this typical day is divided into 24 segments representing each hour from (12am to 12pm) of the day, therefore one segment will consist of 90 irradiance data points (3month*30 days per month) approximately. From this data mean and standard deviations are obtained for each hour which will be utilized in beta modeling of SPV system.

2.2. Solar irradiance modeling

It is a widely used function to model the randomness of solar irradiance; the equation which describes the solar irradiance modeling using beta PDF is given by [13]

$$f_b(s) = \frac{s^{\alpha-1} * (1-s)^{\beta-1}}{\Gamma(\alpha) * \Gamma(\beta)} \left(\Gamma(\alpha+\beta)\right) \tag{1}$$

$$\alpha = \frac{\mu * \beta}{1-\mu} \tag{2}$$

$$\beta = (1-\mu) * \left(\mu * \left(\frac{1+\mu}{\sigma^2 - 1} \right) \right) \tag{3}$$

2.3. Load Modeling

The load data used for this system is IEEE-RTS data which supply hourly peak load in percent of daily peak load for each season for weekdays and weekends [14].

3. Calculation of Output Power from a Solar module

This model is one of best method and widely used to model the output power of a PV module. The output power of a PV module is given as follows [13]

$$Ppv = N*FF*Vy*Iy \tag{4}$$

$$FF = V_{mpp} * I_{mpp} / V_{oc} * I_{sc} \tag{5}$$

$$V_y = V_{oc} - K_v * T_{cy} \tag{6}$$