UNIVERSITI TEKNOLOGI MARA

POWER QUALITY PREDICTION OF LOW VOLTAGE GRID CONNECTED PHOTOVOLTAIC POWER SYSTEM USING MATHEMATICAL MODEL

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ABSTRACT

With the rapid growth of Grid Connected Photovoltaic (GCPV) System interconnection brings new challenges that linked to the solar irradiance intermittency as well as limited on the behaviour predictability towards utility grid. Hence, the power quality assessment becoming increasingly important as the impact of this interconnection increased significantly. This occurrence might lead to power quality parameter could be out of acceptable limits. However, there is a lack of literature on power quality prediction associated with GCPV system and a method of prediction in identifying the relationship between power quality parameters and solar irradiance variation. In this study, the prediction of power quality of GCPV system is executed under Malaysia climate variation. Three objectives have been identified which are a development of Mathematical model GCPV system on power quality parameters mainly on the total harmonic current distortion, short term flicker, long term flicker, power factor and AC voltage. Then, verification of accuracy proposed model empirically and prediction of power quality on utility grid by comparing the proposed model with actual data. In this study, the proposed Mathematical model is developed to predict the total harmonic current distortion, flicker, power factor as well as AC voltage based on the fundamental equation that utilizes the solar irradiance as it input meanwhile the power quality parameters as it output. The process of model verification is based on the real data measurement on the GCPV system that involved in this study as well as on the utility grid which follows the IEC Standards requirement. Based on the analytical analysis between power quality parameters with environmental under different brands of the inverter, it revealed that the solar irradiance and the features of inverter give a significant influence on these power quality parameters that involved. Based on the comparative study and statistical approach, it shows a good agreement between simulation results of actual and prediction data. It shows that the proposed model provides an effective method for prediction mainly on the power quality parameters of GCPV system and feasible in time under the same accuracy. Furthermore, by developing a model for power quality prediction as well as exploring this relationship will illustrate an outline of their interconnection for power quality improvement schemes. By conducting a proper analysis and prediction also allow their use in any amount while maintaining the required standards of power quality.

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CHAPTER ONE

INTRODUCTION

1.1 RESEARCH BACKGROUND

The renewable technologies provide a feasible alternative of generating electricity which inexhaustible, clean and can be used in a decentralized way. For example, solar energy supplies electricity on sunny days while on cold and windy days, the wind generators are in position to supply more electrical energy [1]. Considering the geographical position and climatic characteristic of Malaysia, there is a great potential of renewable energy development in photovoltaic systems. The photovoltaic system used photovoltaic cells to convert sunlight directly into electricity without creating any air or water pollution. Photovoltaic systems can be classified into two types which are Grid Connected Photovoltaic (GCPV) and Stand Alone Photovoltaic System (SAPV). The GCPV system is a power generator system that connected to an electricity transmission and distribution system (referred as utility grid), meanwhile stand alone system does not connected to a grid which provide power directly to the load. In Malaysia, a great deal of efforts has been undertaken to promote wide application of GCPV system such as Feed in Tariff (FiT) mechanism introduced by the Sustainable Energy Development Authority (SEDA) [2]. The Distribution Licensees which the company that holding the license to distribute electricity for example Tenaga Nasional Berhad (TNB), shall pay to customer for renewable energy supplied to the electricity grid for 21 years. Hence, the renewable energy would become a viable long-term investment for industries and individuals by implementation of FiT mechanism. Generally, the output of Photovoltaic system is influenced by two mains environmental factors which are solar irradiance and module temperature [3]. The effect of GCPV system subjected to climate variations on utility grid has been considered a potential concern by the electricity industry as the capacity of the Photovoltaic system growing significantly [4]. The power quality issues related to utility network such as harmonics, power factor, over/under voltage and flickers could reduce the reliability of distribution network performance in providing