A REVIEW OF THE FAULT RIDE THROUGH REQUIREMENTS IN DIFFERENT GRID CODES CONCERNING PENETRATION OF PV SYSTEM TO THE ELECTRIC POWER NETWORK

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ABSTRACT

The growing of Photovoltaic (PV) power generation and integration into the electric power has started to touch on the stability and reliability of the network. As a result, standards have to be defined in guaranteeing a secure and reliable operation of the power system and one of the important topics is the capability of the PV system to ride through fault during the disturbance. This paper provides an overview and comparison study about Fault Ride-Through (FRT) capability requirements in the recent grid codes, which are enforced by transmission and distribution system operators in different Grid Codes (GCs) regarding the penetration of Photovoltaic Power Plant (PVPP) to medium and low voltage level of the network. This study compared the following common requirements such as FRT either Low Voltage Ride-Through (LVRT) or High Voltage Ride Through (HVRT), reactive current injection during and after the fault, restoring active power and frequency variations. In addition, by depending on this comparison and through studying the Malaysian grid standards, there is a similarity to USA standard thus this paper presents a proposal of FRT capability and frequency deviation for the Malaysian electric grid.

Keywords: Fault Ride-Through, Grid code, Photovoltaic system penetration.

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INTRODUCTION

In the years before, the photovoltaic generation of electrical energy has become a reality. Consequently, there are thousands of PVPP integrated with power system in many regions and countries. In the past, the penetration of solar energy was very small compared to the conventional generation system but in recent period, the grid connected to PV system increased dramatically [1].

Figure-1 shows that more and more PV power all over the world is reaching 40 GW in 2010 of installed PV capacity with a remarkable increase of 94% over 2009 [2, 3]. Also, there is a gradual increase in the last four years by about 30 GW or more per year. In 2014, the installation of PV plant around the world reached 177 GW higher than 2013 by around 40 GW [3].

Grid codes are not new topics in the power system utilities. It began to appear 18 years ago. The grid codes differ from country to another according to the characteristics and regulation of the national power system. Firstly, the grid codes were applied to the transmission system as a set of operation specifications and technical guidelines for traditional power plant that is integrated with power system [4]. Next, grid code has been amended and improved in subject to the continuous changes and new technical requirements such as FRT, reactive current injection and restoring active power, which has been newly absorbed to the GCs for large wind power plants (WPP) integration in some countries such as Denmark, Germany, UK, Canada, Ireland and Spain. Nowadays, these requirements are being adapted for PV plants. The issue of grid code requirements for WPP has already been studied in the literature. The most recent comparison of the international regulation of latest national GCs concerned with penetration of wind farm to the grid that were done in [5] and can be used as reference for photovoltaic energy. Finally, from the previous information above, there is a massive growing in PV energy so the disconnections from the grid during disturbances are no longer possible. This led to the elaboration of the same requirements as WPP for the connection of PVPP to the Medium Voltage (MV) and Low Voltage (LV) level networks when more and more PV plants are installed.

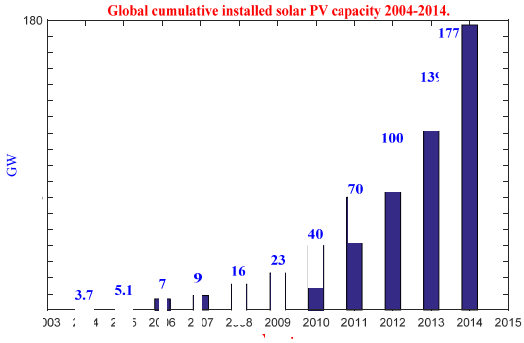

Figure-1. Global cumulative installed solar PV capacity 2004-2014.

Annexation FRT and other requirements to GCs concerning penetration of the PV system to the electric power network is a new topic. Previously, the PV plants connected with the distribution network were not permitted to take any action during the disturbances and had to disconnect directly in case of grid fault. Recently, with the significant rise of the PV farm size, it is required to keep PV units working under either normal or abnormal conditions. Germany and Spain as a leader in the production and installation of PV technology are adopting these new requirements in their GCs [6-8]. On July 2010, German grid code stipulated that PV plant had to be capable to make a limited contribution for the dynamic network support while from January 2011, it was recommended that the PVPP should provide full dynamic network support [2, 6, 9]. Italy has recently adopted a new version of the grid code for distributed generation systems,