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Installation of PV systems in Greece—Reliability improvement in the transmission and distribution system

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ABSTRACT

Photovoltaic (PV) power systems are becoming one of the most developing investment areas in the field of Renewable Energy Sources (RES). A statement of the status quo of PV power systems in Greece, and their contribution towards the improvement of power system reliability, is the scope of the present paper. Siting and installation of PV power systems is performed according to a recent Greek law, along with environmental and geographical constraints. Meteorological data are computed, formulated and imported to appropriate software in order to simulate the PV units and generate their power output. Data for unserved loads, resulting from load shedding during peak hours, are compared to the above estimated power production. Assuming that a proportion of the eventually unsupplied power could be provided by the accessed power generation of the PV units, the reliability of both transmission and distribution system is improved. The impact on the transmission system is shown by an improvement of LOLP and LOEP indices, whereas peak shaving for the Interconnected Greek Transmission System (IGTS) is also illustrated. For the distribution system the impact is quantified using the distribution system reliability indices SAIDI, SAIFI, and CAIDI. Finally, the resulting improvement is also expressed in financial terms.

1. Introduction

Electric power systems (EPS) have been developed over the past decades based on the scheme of centralized generation, transmission and distribution of electric energy. However, recent trends have reformed this scheme by integrating various distributed energy resources (DER), among them power generation units using renewable resources, such as wind generators and PV systems. The penetration of these new distributed generation (DG) units has posed important technical issues, such as protection coordination, islanding, harmonics, short-circuit levels, etc. However, it also brings a number of technical, economic and environmental benefits, such as feeder relief, power quality improvement, peak shaving, minimization of losses and emission-free power generation. Researchers are trying to overcome the technical issues, while at the same time governments around the world are launching projects in order to give investors incentives for installation of new equipment, to enter this new market. Such a project was launched by the recent Greek law "Generation of Electricity, using Renewable Energy Sources and High-Efficiency Cogeneration of Electricity and Heat and Miscellaneous Provisions" [1].

The installation of a great number of new PV power systems is therefore a reality for the immediate future in Greece. Their spatial siting is bound to follow the provisions of the above mentioned law, concerning the allocation to 11 different regions and the categorization into four types according to their power capacity [2]. The final installation sites within a region are also expected to meet with environmental and geographical constraints, as well as to have an optimal power output. It has to be noted that the voltage level where these PV units are going to be connected to will depend on their nominal power. Their total power capacity is specified to be 590 MW, as far the IGTS is concerned, and it is scheduled to be fully available until the year 2010.

Reliability concerning an EPS is a measure of its ability to constantly meet the energy demands of all its consumers. In the present work a methodology is provided, in order to evaluate the contribution of PV units to the reliability of the Greek power transmission and distribution system. According to the siting of PV units across the country and using meteorological data about radiation and temperature, the estimated PV power production is compared to data concerning load shedding, assuming that a specific proportion of the eventually unsupplied power could be supplied by the accessed power generation of the PV units. The contribution of PV power systems in the reliability of the IGTS is expressed by a reduction of indices LOLP and LOEP, whereas the peak shaving is also depicted. On the other hand, the improvement in the distribution system reliability is shown by means of the well-known distribu-

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