



2013 ISES Solar World Congress

Grid Connected Photovoltaic Systems to the Urban Environment of Argentinian Northeast

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Abstract

The last 20 years have presented a favorable scenario for the incorporation of renewable energy sources into the energy matrix of developing countries. This situation promoted grid connected photovoltaic generation systems (GCPVS) to become one of the main protagonists in this new concept of energy matrix. In some developing countries the use of such systems is in its beginning. Promotion policies and technical as well as regulatory conditions for their installation have just started to be defined. In this context, there exists in Argentina a legal and regulatory framework for the implementation of large photovoltaic plants but there is a lack of such legal framework for distributed generation (DG) by means of grid connected photovoltaic into the medium and low voltage distribution networks. This situation led research centers, together with private and provincial Energy Agencies to install pilot systems in order to identify and characterize their impact on the low voltage distribution network, taking into account the local grid capacity and characteristics of each province. In this paper the implications of different degrees of penetration of solar photovoltaic power generation evaluated using technical parameters of the network is presented. A set of examples of residential users connected to a distribution substation in the city of Corrientes is analyzed by means of a simulation using real grid data with the incorporation of GCPVS generation. The simulation results show that both the level of penetration of GCPVS systems as well as location where these distributed energy sources should couple to the distribution grid must be carefully assessed to maximize the benefits of the inclusion of distributed generation in urban environments.

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Selection and/or peer-review under responsibility of ISES.

Keywords: grid connected photovoltaic systems; distributed generation; energy quality

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1. Introduction

Developed countries present the highest capacity of grid connected photovoltaic systems due to promotion programs and policies such as financial incentives or fiscal credit that impulse its growth. This initiative promoted the inclusion of photovoltaic generation into the power matrix and through its evolution was observed a decreasing in technology costs. These facts along with the increase in the cost of energy and feed-in-tariff programs (electrical tariff higher than conventional sources) changed the common preconception about economic viability leading to an equilibrium between conventional rates of energy and photovoltaic generation (energetic parity).

The Latin America Situation is different, subsidiary policy to photovoltaic generation was aimed at covering basic energy needs in rural areas becoming thus the activity developed with major intensity in recent years [1] whereas option in grid connected systems gave theirs first steps in 2000 through experimental installations in academic environments [2].

Nowadays, a new stage of photovoltaic solar energy is arising in Latin America driven by standards and policies of incentives which are mainly promoted and engaged by the governments. Moreover, present situation shows main countries in Latin America with incidence of solar radiation higher than that in countries which lead the market, have developed regulations and certain photovoltaic capacity installed, ergo, we are witnessing the birth of GCPVS in these countries,.

Taking into account grid conditions in developing countries the growth of GCPVS requires evaluating in the most adequate way the insertion of decentralized photovoltaic generation in urban environments.

In Argentina, as well as other developing countries, there is a big difference between energy stability and energy quality in relation to developed countries, and this fact is replicated in different zones country (great asymmetries between further zones and the central part of the country). Furthermore, Argentina presents some other special characteristics such as: the electric energy tariff is four times lower than that in Brazil and lower than that in most Latin American countries [3]; there exists a legal and regulatory framework for the implementation of large photovoltaic plants but there is a lack of the legal framework for distributed generation (DG) by grid connected photovoltaic into the medium and low voltage distribution networks. These conditions have led the Grupo en Energías Renovables of the Universidad Nacional del Nordeste (GER-UNNE), to study the implementation of GCPVS in a urban neighborhood in the city of Corrientes (Latitude 27^a 27^a S Longitude 58^a 49^a W). This study will serve as a basis for the analysis and evaluation of GCPVS implemented in other provinces of Argentina.

1.1. Background

The GER-UNNE was the first research group in Argentina to install GCPVS in a public institution. Results from analysis of this system and its interaction with the low voltage electric grid (analyzed since 2009) have allowed the development of mathematical models to simulate different degrees of penetration of the solar photovoltaic generation distributed in the grid. The results of these simulations provide an insight on technical grid parameters such as electric losses, voltage levels and power factors [4].

1.2. Electric loads in the city of Corrientes

Unlike most conventional generation technologies the GCPVS it is not a source capable to supply energy according to the demand profile of the user. When subject to certain conditions of irradiance and temperature the GCPVS operates efficiently delivering to the network all the generated power [5]. This generation capacity varies continuously along the day with weather conditions limiting the power that can

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