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The PV-Hydrogen MYRTE platform - PV output power fluctuations smoothing

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Abstract

The MYRTE platform consists of a photovoltaic array, a fuel cells, an electrolyzer, tanks (H_2, O_2 and H_2O), a thermal management system and electricity converters associated to various sub-systems. The aim of this platform is to study how hydrogen could be a good solution for storage energy associated to intermittent renewable energy sources systems, like photovoltaic plant, for electrical grid application, in an island context.
This article describes the platform's way of operating and specifically the photovoltaic output power fluctuations smoothing, with the trapezoid profile shape, using storage methodology and his association with solar forecasting. The used approach is consistent with the specifications of the invitation to tender of the French Energy Regulation Commission, in September, 2011. Note that during the simulations, we have firstly used measured and not predicted meteorological data, and at this end of this paper the first estimation with our solar forecasting methodology.
The main result shown in this paper is that the platform is compatible with this operational mode based on the power fluctuations smoothing. However, to minimize the use of hydrogen stored it is necessary that the supply of the trapezoid profile comes from the PV production rather than the fuel cells. A minimum part of 76 % seems necessary

Keywords: photovoltaic plants; hydrogen; fuel cell; electrolyser; smooting; grid connected

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1. Introduction

Today, the development of renewable energy sources like wind farm or photovoltaic plant is more and more associated to smart-grid, and more particularly on energy storage. In this frame, the technologies available are various: lead-acid batteries, ion-Li batteries, redox, batteries, flywheel, air compressed and hydrogen…. They are also various degrees of maturity, and various technical characteristics (efficiency long or short term storage…), and their choice are depending of the use we want to make with these units of storage.

So, to be able to increase the insertion rate of the renewable energies on the electrical grid, solutions are studied and applied. In France for example, the CRE (French energy regulation commission) studies the means to check the fluctuations in these intermittent energies [1]. The CRE is a French independent authority, created on March 24th, 2000, asked to watch the energy market and to arbitrate the disputes between the electricity users and the producer.

The objective of this article is to determine if the MYRTE platform (mission hydrogen-renewable for the integration to the electric network) [2,3], and more particularly hydrogen, is able to make the PV output power fluctuations smoothing (according to the method of the CRE) knowing the meteorological data of the next day.

2. Presentation of the platform MYRTE

2.1. Description and objectives of the MYRTE Platform

The MYRTE platform [2,3] comes from a partnership between the University of Corsica, AREVA Storage of Energy and the CEA (atomic energy and alternative energies commission). It was approved by the cluster CAPENERGIES in February 2007. The budget of the platform is 21 M€ and it's financed by the Corsica region, the French state and FEDER (regional development European fund). The finalized platform occurred at the end of 2011.The MYRTE platform is a technological platform dedicated to the PV/H_2 coupling study and connected to the electrical grid by the end of 2011 [4]. The main objective is to test the hydrogen technology in real use, and to develop optimal operating strategies between a PV array (solar panels and electric inverters) and a H_2 chain (electrolyzer; H_2, O_2 and H_2O tanks; and fuel cells).

Initially, the objective of the MYRTE platform is to allow a controlled and intelligent injection of the photovoltaic production into the electrical grid. For this, MYRTE instrument must be a local support able to provide power to electrical grid for daily demand peak. This operating way is also called "peak shaving mode". Another interesting way to consider for the MYRTE station is related to the "smoothing mode". This one consists to control the PV output power fluctuations send to the electrical grid in order to secure the electrical distribution grid stability. A transverse mode will soon be studied; it is the "predictive mode". It comes upstream to two other modes and to allow predicting the meteorological data.

The smoothing mode is the one presented in this article, and use the ORIENTE© software we have developed [5,6].