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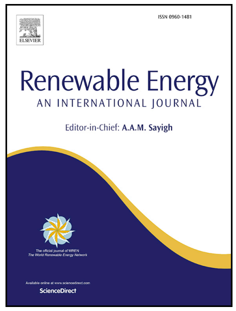

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Design and Implementation of a Power-Hardware-In-Loop Simulator for Water Electrolysis Emulation

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Abstract

A modular power-hardware-in-loop (PHIL) simulator for water electrolyzers is developed to study the electrolyzer as part of a smart grid and to examine the characteristics of various electrolyzer power supply electronics. A PHIL simulator up to 405 A of continuous current is built using commercially available power electronic converters. The design and operating principle of the emulator are analyzed. The experimental dynamics tests are performed to verify the PHIL simulator operation and suitability for water electrolysis emulation considering the effect of supply power quality. Finally, the PEM stack model is implemented, and the PHIL simulator is used to emulate a commercial PEM electrolyzer following the measured solar photovoltaic (PV) output power.

Keywords: PEM Electrolyzer, Energy storage, Power-hardware-in-loop, Power electronics, Renewable hydrogen.

1. Introduction

In the Paris UN Climate Change Conference, held in December 2015, the global mean temperature rise was agreed to be limited under 1.5 degrees Celsius above the preindustrial level. This means in practice that the CO_2 net emissions of the whole energy sector should be close to zero by 2050 [1]. To achieve this goal, the total electricity demand in 2050 could easily reach a factor of 3 to 4.5 of today's total electricity demands in the EU area [2]. The main part of the electricity would be used for water electrolysis to produce hydrogen, which is used as a raw material of the net CO_2 free fuels for