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A multipurpose problem-based learning platform for education and research under smart grid umbrella

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Abstract

Developing user-friendly learning platform tailored to illustrating the integrative nature of specific subjects can be very effective in enhancing the involvement of students in the classroom. The focus of this paper is twofold; first, highlighting a specific project from a teaching perspective for the design and implementation of a multipurpose experimental test facility for plug-in electric vehicle, renewable energy and energy storage management in the smart grid context. Second, proposing the application of this project as an interactive tool to assist in demonstrating the system behaviour, when teaching the new emerging subjects in power engineering courses particularly, Smart Grid. Indeed, the scope of the test facility with the developed simulation tool is specially structured and oriented to education, training and research studies, where problem-based learning can be easily implemented. The electrical test hardware in this design can be operated independently as a multipurpose experimental setup for plug-in electric vehicle. In addition, it can also be interconnected with a small size wind or photovoltaic system to facilitate a complete hybrid integrated platform for testing and model verification. A variety of illustrative examples are presented to show the features of the test facility with its operation and how the components of this facility were selected. Additionally, several test scenarios are depicted using the developed simulation tool,

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which cover the assessment of grid integration with its components in the event of unforeseen circumstances. A recommendation that can be drawn from this paper is to motivate academics who are actively involved in conducting research on smart grid, to make use of their hardware or software designs in the process of teaching and learning so that undergraduate students can get the opportunity of observation and experimentation. In this sense, suggestions for future work are proposed.

Keywords
Smart grid education, problem-based learning, plug-in electric vehicle, power conversion, energy storage management system

Introduction

Motivation

In many countries, there is an on-going re-structuring of the electric power industry towards Smart Grid (SG) implementation, which is in fact emphasizing the need to harmonize the power engineering education. The SG is a new perception that integrates electricity and communication on power system networks for enabling the use of renewable energy resources (RER).[1] The trend of introducing SG course in the power engineering program has vigorous momentum in the last few years. Unlike other courses in which the available laboratory facilities can provide an alternative approach to experiment with the hardware in an engineering environment, SG course is currently taught through text descriptions and software simulations.[2,3] Teaching students with a lack of direct interaction between theory and practice can lead them in an unexpected direction, with less ability to learn and remember the concepts.[4] The paper describes a modular approach for grid integration that can be used in the application of knowledge to practical tasks. In particular, the paper focuses on the experimental setup platform, namely the Multipurpose Experimental Test Facility (METF) with a developed simulation tool. This test facility is oriented to education as well as practitioner training and research under SG umbrella. The platform can also be easily modified and extended to fit data from different resources.

Project background

The plug-in electric vehicle (PEV) project was initiated at the Australian Power Quality and Reliability Centre, University of Wollongong, Australia. The development of simulation tool to be associated with the METF for representing the renewable energy integration has been carried out at the Universiti Malaysia, Sarawak. The PEV project not only focuses on charging, monitoring and management systems, it also aims to achieve bidirectional charging, by developing efficient