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Distributed control system for frequency control in a isolated wind system

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Abstract

High wind penetration wind diesel hybrid systems (WDHS) have three modes of operation: diesel only (DO), wind diesel (WD) and wind only (WO). The control requirements for frequency control in WO mode are analysed and a distributed control system (DCS) is proposed for this frequency control, describing the actuation of its sensor and actuator nodes. A power system for WO mode consisting of a wind turbine generator (WTG), a synchronous machine (SM), the consumer load, a battery based energy storage system (ESS) and a discrete dump load (DL) along with the associated DCS have been simulated. By means of a 400 Hz reference power message that establishes the active power necessary for frequency regulation and a prescribed active power sharing between the ESS and DL actuators, graphs for frequency, voltage and active powers for consumer load and wind speed changes are presented. The results of the simulation show maximum settling times and frequency per unit variation of 1.5 s and 0.16% respectively, for the previous input changes. The DCS solution presented could constitute a proposal for the standardization of the control for WO mode in high wind penetration WDHS which rely on a SM to generate the voltage waveform in that mode.

Keywords: Wind diesel; Energy storage systems; Distributed control systems

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1. Introduction

A wind diesel hybrid system (WDHS) is any autonomous electricity generating system using wind turbine generators(s) with diesel generator(s) to obtain a maximum contribution by the intermittent wind resource to the total power produced, while providing continuous high quality electric power [1]. If the WDHS is capable of shutting down the diesel generators during periods of high wind availability, the WDHS is classified as high wind penetration. The main goal with these systems is to reduce fuel consumption and in this way to reduce system operating costs and environmental impacts. These fuel consumption savings are maximum with high wind penetration WDHS although this type needs a more complex control system (this WDHS type will be the one treated in this paper). Fig. 1 shows the WDHS used in this paper where the components stated in the definition of the WDHS can be seen: diesel generator (DG), wind turbine generator (WTG) and load. The synchronous machine (SM) generates the voltage waveform and its voltage regulator controls the voltage when no DG is running in the WDHS. The dump load (DL) [2] consists of a power converter and a bank of resistors. The DL converter modulates the active power dissipated in the DL. The energy storage system (ESS) consists of a energy storage and a power converter that stores or retrieves power as needed and interfaces the energy storage to the autonomous grid. A survey on storage systems can be seen in [3]. Although not strictly necessary in WDHS, short term ESS

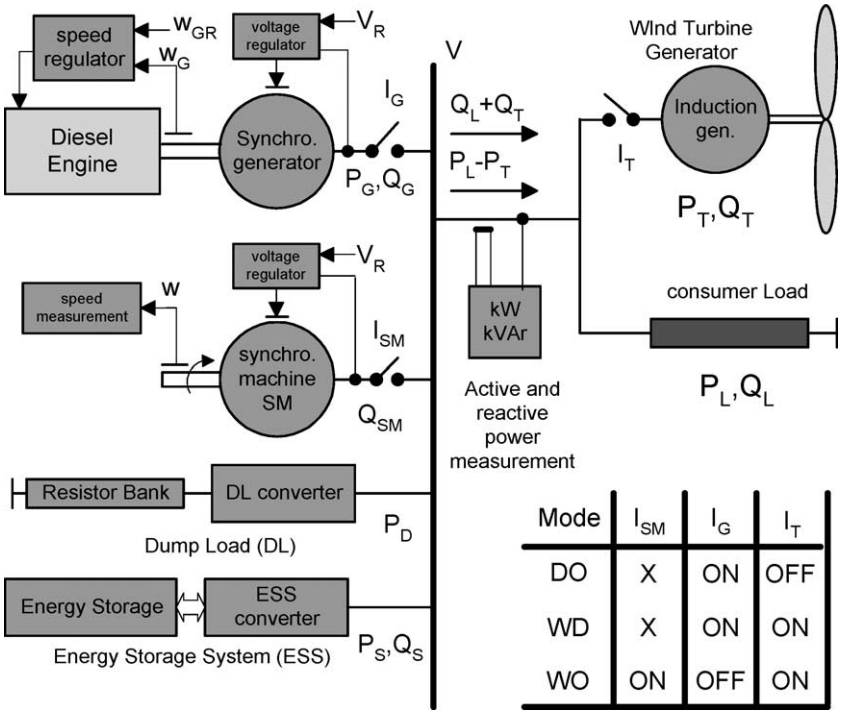

Fig. 1. Layout of the WDHS considered.