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Dynamic Interaction of Renewable Hybrid Power Plant with Grid

R. Das[1], P. Bajpai[2] and A. K. Sinha[2]

[1] Department of Electrical and Electronics Engineering
Don Bosco College of Engineering and Technology
Azara, Guwahati – Assam, 781017 (India)
Phone/Fax number: +91-03612841949, e-mail: dasrandas@gmail.com

[2] Department of Electrical Engineering
Indian Institute of Technology Kharagpur
Paschim Midnapore-721302, West Bengal, India
Phone: +91-03222-282261, fax: +91-03222-282262, e-mail: pbajpai@ee.iitkgp.ernet.in, aksinha@ee.iitkgp.ernet.in,

Abstract. Distributed generation can appear in different forms ranging from conventional technologies (internal combustion engine, photo-voltaic cell etc.) to advanced ones (micro turbine, fuel cell etc.). Among them, wind generation is widely utilized with a hybrid energy storage technology. In hybrid systems fuel cell generator may be used as a supplement because wind generator output fluctuates with weather conditions. Fuel cells are very attractive to be used with intermittent sources of energy, because of high efficiency, fast load response, modularity and fuel flexibility. Simulation studies have proved the feasibility of coordinating fuel cell with wind generator to supply constant or dynamic load for either grid-connected or stand alone applications. In this paper, a dynamic model of grid integrated wind generator-fuel cell hybrid system connected to the test system of distribution network is developed. Dynamic behavior of voltage, power, torque, frequency etc. have been studied at the time of starting of wind generator and faults in the network. The developed model, being simple, could provide a useful tool for the planning of distributed generation.

Key words

Dynamic model, Fuel cell, Hybrid system, Wind generator.

1. Introduction

Need for installation of modular, renewable or non-renewable generation plants near load centers has come up to reduce the transmission losses and avoid power congestion. These small-scale generators when embedded in the distribution network are called embedded generation or Distributed Generation (DG). Wind Generation has emerged as most promising among these generation technologies. Wind exists everywhere on the earth, and in some places with considerable energy density. Emerging awareness of the finiteness of the fossil fuel reserve and the adverse effects of burning those fuels for energy has caused to look for alternatives. This awareness is hastening the deployment of eco-friendly wind generator systems. Wind Generator (WG) may experience large variation in its output power under variable weather conditions. One method to overcome the above problem is to integrate WG with other reliable power sources.

Hybrid generation of WG-FC is studied in [1] in the non-interconnected grid. A part of the energy produced by the WG is expensed to produce hydrogen required by the FC. When wind power is less or not available, FC can supply the power needed by the network. This type of hybrid system works satisfactorily under variable nature of wind. FC can be installed with WG to contribute the primary frequency control [2]. A new control system for WG-FC hybrid system has been proposed in [3]. This control is needed to make the system operate correctly under different operating conditions. However, the study is made on a small network having only one bus, dynamic behavior of the system due to disturbances in the distribution network are not studied.

A simulation methodology for a wind energy conversion system incorporating fuel cell as a back up generator is proposed in [4]. Each component of the WG-FC hybrid system is modeled but the paper focuses only on the steady state analysis of the system. Transient responses of the WG-FC hybrid system for a step change in the electrical load and wind speed are presented in [5]. Hybrid photovoltaic-wind-diesel generation system is introduced for supplying a remote power load in [6].

A dynamic model of FC is developed and integrated with a distribution network in [7]. Variation of FC voltage with the load has been studied, however network side studies, like changes in real and reactive power flow in the network, are not discussed. In [8], squirrel cage induction machine used in WG has been compared with the others types of induction machine. This comparison shows that though squirrel cage machine limits the energy output of