UAEU جامعة الإمارات العربية المتحدة United Arab Emirates University

The College of Graduate Studies and the College of Engineering Cordially Invite You to a

Master Thesis Defense

Entitled

SYNCHRONOUS MACHINE EMULATION OF VSC FOR INTERCONNECTION OF RENEWABLE ENERGY SOURCE THROUGH HVDC TRANSMISSION.

by

Mohamed Asker Kanakkayil

Faculty Advisor

Dr. Hussain Shareef, Department of Electrical Engineering

College of Engineering

Date & Venue

10:00 AM

Wednesday, 20 November 2019

Room 1164, F1 Building

Abstract

The major part of energy demands was met by centralized generating stations in the past years. However, due to increased energy demand, the integration of decentralized renewable energy sources (RES) to the power system network is inevitable although they affect the stability of the grid due to their intermittency and use of various power converters. The transmission of power over long distance from RES is commonly accomplished either by AC transmission or by DC transmission. The reason for opting HVDC over HVAC is due to numerous and complex reasons such as lower investment cost for longer transmission cables, lower losses, controllability, limited short circuit currents etc. Several control methods of grid-connected VSCs such as power-angle control and vector-current control are adopted in RES interconnections. However, they have several issues when these techniques are used for a weak grid interconnection application. This thesis aims to develop a control strategy for a VSC based HVDC transmission system based on the synchronverter concept. In the proposed method, the sending-end rectifier controls emulate a synchronous motor (SM) and the receiving end inverter emulate a synchronous generator (SG) to transmit power from one grid to another. The two converters connected with a DC line provide what is called a synchronverter HVDC (SHVDC) link. Since, there is a high demand for sustainable energy, it is essential to have integration of renewable energy sources to the long haul HVDC link which has the possibility for extension to wind based resources. Therefore, in this work a windfarm of Type 4 permanent magnet synchronous generator is also integrated to the HVDC link through a rectifier. Depending on wind speed, the proposed control strategy shares and manages wind generator power of the DC side automatically with a battery energy storage system connected to the HVDC link to stabilize the power fluctuations produced by the wind farm intermittency. The performance of synchronverter based HVDC transmission was verified using MATLAB Simulink model. The results show that the controller can effectively control the power flow from one grid to the other. It also shows that effect of wind fluctuation on the grid can be mitigated by a battery energy storage system (BESS) introduced at DC link. Therefore, it can be concluded that by properly controlling SHVDC, BESS system and RES connected to HVDC system, the power from remotely located renewable energy sources can be connected to a weak AC grid in a stable way.

Keywords: Voltage Source Converter (VSC), Synchronverter, High Voltage DC (HVDC),Renewable Energy Sources (RES),Battery Energy Storage System (BESS).