CHAPTER ONE

INTRODUCTION

1.1 Background

An important factor in the operation of an electric power system is the desire to maintain system security. System security involves practices designed to keep the system operating when components fail due to out of hand reasons such as serious problems in electrical power system networks. Insecurity such as transmission lines being overloaded or/and bus voltages and generators VAR limit violations or due to scheduled or planned outages of units for maintenance or power system expansion. For example, a generating unit may have to be taken off-line because of an auxiliary equipment failure. While this generator is forced out, the remaining generators on-line must have enough excess capacity to make up for the loss without need to shed any load. This excess capacity is called spinning reserve because it is available on the on-line machines. Similarly a transmission line may be damaged by a storm or due to a fault and taken out by automatic relaying. If in committing and dispatching generation, proper regard for transmission flows is maintained, the remaining transmission lines can take the increased load and still remain within limits [1].

Now-a-days power systems have become very complex with interconnected long distance transmission lines. The interconnected Grids become unstable as the heavy loads vary dynamically in their magnitude and phase angle and hence power factor. Therefore, in order to meet increasing power demands, utilities must rely on power export/import arrangements through the existing transmission systems. The capacitor banks are used to improve power factor but having a number of disadvantages. Power electronic devices are gaining popularity for applications in the field of power transmission and distribution systems. The reactive power (VAR) compensation and control have been recognized as an efficient and economic means of increasing power system transmission capability and stability. The FACTS (Flexible AC Transmission Systems) devices, such as STATCOM has been introduced more recently which employs a Voltage Source Inverter (VSI) with a fixed DC link capacitor as a static replacement of the synchronous condenser. A fixed set of capacitor provides the required VAR control, with a rapid control of bus voltage and improvement of utility power factor. It offers several advantages over conventional thyristorised converters in terms of speed of response [2].

1.2 Problem Statement

In interconnected power systems, such as Sudan transmission power system, it has become important to fully utilize the existing transmission facilities instead of building new power plants and transmission lines that are costly to implement and involve long construction times. Flexible Alternating Current Transmission Systems (FACTS) controllers have been introduced in power systems to solve the above problems. FACTS make it possible to control the voltage magnitude of a bus, active and reactive power flows through transmission line of a power system. There are different types of FACTS controllers configurations, but those based on voltage sourced converter (VSC) concept have several attractive features such as faster control responses, lower output distortion and being able to improve dispatch flexibility by circulating active power between their AC and DC terminals[3]. Amongst the widely used VSC based FACTS controllers are Static Synchronous Compensator (STATCOM), High Voltage Direct

Current – Voltage Sourced Converter (HVDC-VSC) and Unified Power Flow Controller (UPFC).

1.3 Objective

As the Sudanese Government is finalizing the eventual deregulation of its power system it is important that the investing companies be avail with information of the technical benefit derivable from the incorporation of FACTS controllers within the system. The purpose of this thesis is the incorporation static VAR compensator (STATCOM) within the Sudan power system to enhance and improve the network stability. Power flow analysis program is used to determine the suitable place for STATCOM installation places in the network. The specific objectives of the project are to improve system reliability and quality of service. Reduce technical losses. And equip NEC with modern tools to improve customer service delivery and commercial operations.

1.4 Motivation

The future plan of Sudanese electricity to extend the network towards Darfur and Kordfan required robust and rigged network to ensure continuous service within international standards. The increase of transmission line capacity required continuous regulation of transmission reactive power and this can be done using synchronous reactive power compensators such as SVC, TCSC and STATCOM. The intension of government to replace conventional power grids into smart grids required intensive use of distributed reactive power compensators to self-healing the problems of voltage stability.

1.5 Thesis layout

The thesis organization is summarized as follow:

Chapter one about research background, thesis problem, objectives and motivation.

Chapter two about the national grid enhancement and reinforcement with several techniques including the use of STATCOM to improve voltage stability.

Chapter three discusses the dynamic model of STACTOM and the incorporated control system.

Chapter four summarized the software simulation of the STATCOM during several conditions

Chapter five gives thesis conclusion and recommendations.