OPTIMAL LOCATION OF FACTS FOR ATC ENHANCEMENT BY USING SENSITIVITY ANALYSIS

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ABSTRACT

According to the changes in power structure (deregulation), competitive markets became in urgent need to have ability to satisfy the rise of energy demands. However, it is limited into the existing transmission grids. In order to extend the grid, it accompanies with problems as huge cost and large required time. Therefore, markets pay attention to have optimal utility of the current transmission system. That comes through the Available Transfer Capability (ATC) which is computed using Repeated Power Flow (RPF) technique. In order to have improvement in ATC, Flexible AC Transmission System (FACTS) devices are used to control power flow and improve the voltage and power profiles in the transmission system. In this project, two types of controllers are used Static Synchronous Compensator (STATCOM) and Unified Power Flow Controller (UPFC). The insertion of the controller in the power system comes through determining the specific location in the transmission system; the proposed method is called Sensitivity Analysis. This project is applied on 5, 14 and 24 IEEE bus power systems in Power system Analysis Toolbox (PSAT) software. The proposed method has yielded excellent results in both reducing loss and improvement of ATC in simulated power systems.

ABSTRAK

Menurut perubahan dalam struktur kuasa (deregulasi), pasaran yang kompetitif amat memerlukan keupayaan bagi memenuhi peningkatan permintaan tenaga. Walau bagaimanapun, ia adalah terhad ke dalam grid penghantaran yang sedia ada. Hal ini demikian, ini diiringi dengan beberapa masalah kerana kos yang besar dan peruntukan masa diperlukan. Oleh itu, pasaran menekankan kepada utiliti optimum penghantaran sistem semasa yang mana datang melalui Keupayaan Pindah Disediakan (ATC) yang dikira menggunakan teknik Aliran Kuasa Berulang (RPF). Dalam usaha untuk membolehkan peningkatan dalam ATC, Peranti Sistem Penghantaran AC Fleksible (FACTS) peranti digunakan untuk mengawal aliran kuasa dan meningkatkan voltan dan profil kuasa dalam sistem penghantaran. Projek ini menggunakan, dua jenis pengawal digunakan statik Synchronous pemampas (STATCOM) dan Pengawal Kuasa Aliran Bersepodu (UPFC). Kemasukan pengawal dalam sistem kuasa yang datang melalui menentukan lokasi tertentu dalam sistem penghantaran, yang mana kaedah yang dicadangkan ini dipanggil Analisis Kepekaan. Projek ini diaplikasikan pada 5, 14 dan 24 IEEE sistem kuasa bas dalam perisian Kuasa Sistem Analisis Toolbox (PSAT). Kaedah yang dicadangkan ini telah menghasilkan keputusan yang cemerlang di dalam kedua-dua pengurangan kerugian dan peningkatan ATC dalam sistem kuasa simulasi.

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CHAPTER 1

INTRODUCTION

1.1 Background

Last few decades, power system encounters some new big challenges according to the conversion of some countries from regulating power system structure into deregulating structure due to economic perspective. The first notion of restructure of power system (deregulation) in the U.S. was occurred in the Public Utilities Regulatory Policies Act (PURPA) in 1978. This paper motivated the buying of energy from different power sources which is known as Independent Power Producer (IPP). After some years later, the Federal Energy Regulatory Commission (FERC) has issued the Energy Power Act (1992) establishing the right of open access to the transmission system to any producer who does not possess transmission in order to use it as service and facility. The thought was to boost the number of potential producers that the consumers can buy from which is considered as major factor to be important for the success of a competitive market. However with these good plans of the government agencies, the transition to an open market has experienced to be very difficult. The significant reason for this is the existence of transmission network limited. Building new transmission system is constricted into major factor such as environment concerns, right of way, cost and consuming time and so on [1][2].

Since the electricity is being as commodity, markets have encouraged developing new techniques to improve which is called Available Transfer Capability (ATC) to transfer maximum power over existing utility from the current transmission system. It is calculated by Independent System Operators (ISO) through some methods as such Repeated Power Flow (RPF) and posted on Open Access Same Time Information System (OASIS) [2].

In order to enhance ATC, it should control the Power Flow (PF) of this grid. One of alternative solution to respond to PF or demands is using Flexible AC Transmission System (FACTS) in power system which considers as a smart technique to improve ATC. FACTS are electronic devices that come with better performance than conventional methods. In this project, two types of FACTS are used Static Synchronous Compensator (STATCOM) and Unified Power Flow Controller (UPFC). In order to get better performance and to reduce the number of FACTS used, it is much important to determine the optimum location in the transmission grid. There are several algorithms which can do that function in easy manner; it is named by Sensitivity Analysis. The system is being tested in this project is 5, 14 and 24 bus test systems.

1.2 Problem Statement

In general, power system consists of three major sections; generators, transmission lines and distribution system. Since the structure of power system started changing from monopoly into deregulating form where there are number of power source producers and distributors, this new form of structure in power system led into competitive market. The power has become as commodity for sale. However, the competition in markets could not be achieved successfully, because it is constricted into transmission lines. This problem can be solved by expending the system of transmission, but having more towers and lines relate to many factors that can make it

complicated and much difficult in reality. Building transmission lines are always come with some obstacles such as consuming time, big budget, sites of structure. Therefore, markets have begun to concentrate on having full utilization of the existing transmission grids.

1.3 Research Significant

The idea of this project is to enhance the ATC to have much ability to transfer maximum additional power in the grids by getting the optimal placement of two types of FACTS; UPFC and STATCOM. The performance of the ATC will be computed through RPF technique, while the enhancement of ATC will be done using two type of devices STATCOM and UPFC.

Using FACTS devices are usually based on the optimal location in transmission system and that comes through Sensitivity Analysis based on the reducing total power loss of the entire system. By doing so, we can be able to identify which location of the FACTS needed to be installed, what were the previous researchers have done so far. As we know that, this study has been already done long time ago, Many research and publications have been published it in many classes, conferences and webinars. And what do we need to do is to make improvements and know what are the possibilities that could be added into it.

1.4 Research Objectives

To develop and simulate the optimal location of FACTS in the power system is by using Sensitivity Analysis. By determining the best location of devices, the power

system can perform better than any time before. The proposed technique allows the loss of the system reduced and improves the system profile over all.

It is to enhance the ATC on the simulated system. The change in power system profile from good to better, it leads to increase the transfer capability.

1.5 Research Methodology

In order to accomplish the objectives of the study, the fulfilling works will be performing by using Sensitivity Analysis. This project is started by doing the study literature. The study will cover the ATC, computational methods of ATC, FACTS especially UPFC and STATCOM and optimization location Algorithms.

In order to calculate ATC, that can obtain by RPF which represents how the power flows in lines. It includes and considers the voltage, line and stability limitations. Choosing two types of FACTS (STATCOM and UPFC) are based on having better characteristics than the rest since they have the ability to govern the controlling parameters in power system.

Controlling devices can performs at any place of the system, however optimal location of FACTS by using sensitivity analysis enhance the performance for better where these devices are expensive. Then the performance and analysis with and without FACTS in the system are discussed and this is done using PSAT software.

1.6 Report Outline

This project is splitted into five chapters. The brief over view of each chapter is given. In Chapter 1, it includes an introduction about the idea of the project. The background, problem statement, research significance, objectives, methodology and report outline are discussed and explained.

In Chapter 2, it consists of an introduction of the transfer capability, ATC, computation methods of ATC, FACTS devices (STATCOM & UPFC), optimization location algorithms of FACTS and lastly PSAT software.

In Chapter 3, it represents the methodology that use in this project. RPF technique is used to compute ATC, LSI and CPF are used to determine the optimal location of FACTS and installing & setting of STATCOM and UPFC.

In Chapter 4, it shows the results for three different power systems. It shows LSI technique is better than CPF method while UPFC device performs better than STATCOM device in power voltage profiles and also ATC.

In Chapter 5, it comes with conclusion that proved by using optimal location for FACTS devices based on LSI, the ability of enhancing the ATC' value becomes more

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