Method of Placement of FACTS Device

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Abstract

The electric power sector comprises of generation, transmission and distribution of power within its domain of operation.These utilities are referred to as vertically integrated utility (VIU). With the continuous increase in industrialization and urbanization there is need of electrical energy is increasing. This gives rise into rapid development of the power system. Currently the focus of engineers is to reshape above three components of VIU and upgrade their working and operation. The restructuring is done to increase customer focus, improve power system performance and reduce the capital cost of operation. Congestion is one of the technical problemsassociated with power system restructuring. Transmission congestion is a condition in restructured power system when there is less transmission capacity to transmit the power. The purpose of this paper is to relieve congestion using FACTS device and location of its implementation is found using reduction of total system reactive power loss sensitivity indices analysis method based on electrical IEEE-14 bus and MATLAB software is used here for simulating the experiment and verifying the result.

Keywords

Congestion management, restructured power system, FACTS, sensitivity indices, IEEE-14 bus.

Introduction

With increasing demand for electricity, the amount of power transfer is increasing, consequently the power system are becoming increasingly more difficult to control and operate, and more unreliable with unscheduled power flows and higher losses. The rapid development of self-Commutating power electronics devices, called Flexible AC Transmission Systems devices it has become easy to control the power flow in transmission line [1] [2]. These devices help in increasing the usable transmission line capacity to its Maximum line loading limits [3]. These devices, can also control the phase angle, firing angle, the voltage magnitude at chosen buses and /or line impedances of a transmission system [4]. These FACTS are one of the most attractive and popular method for increasing the transfer capability of the transmission system for enhancement of the stability and make voltage profile of the line stable and for reduction of the transmission losses and for improving the dynamic characteristics of power system[5]. However, for achieving the above benefit, the FACTS device needs to be appropriately placed in the network using appropriate parameters. There are different concepts present fordeciding the placement and sizing of the TCSC, GA, PSO and DA Algorithms in different papers. There are many different load flow analysis with incorporated FACTS controllers at different operating conditions in multimachine power systems for optimal power flow control [6]. In the paper

Newton Raphson Methods has been proposed for different types of Modeling of Series and shunt FACTS controllers [7]. A system is said to be “congested“, when producers and consumers of electric energy are producing and consuming in amounts that would cause transmission system to operate beyond the limits of its safe operation. To overcome the problem of congestion proper action is required tobe taken, this action is called as congestion management. If congestion is not eliminated then it can cause the tripping of the overloaded lines which may cause the tripping of other lines and in some cases this can lead to voltage stability related problems. Hence to avoid this problem congestion need to be solved. In this unregulated power market independent system operator (ISO) has to eliminate thecongestion, so that the system is remains in secure state at all the time. To relieve the congestion ISO can use mainly two Types of methods which are as follows [8]:

1) Cost free method

i. Out-ageing of main congested lines ii. Operation of transformer iii. Series devices Operation of FACTS devices

2) Cost based methods:

i. It is possible to Re-dispatching the generation amounts. By using this method, some generators increase their output while back down others.

ii. Curtailment of loads and the exercise of load interruption options.

Cost free methods is more economical compare to cost based such as without disturbing economic of the operation. FACTS device, like Thyristor Controlled Series Capacitor (TCSC) and Static VAR compensator [9] use this method.

Result

The sensitivity indices obtained using proposed sensitivity indices analysis method is shown in the table given below. By considering the criteria for given sensitivity analysis method, the line no. 19 (column 3rd) is more sensitive and it is suitable for placing the FACTS device.

LINE NO.	LINE(i-j)	SENSITIVITY INDICES (aij)
1	1 -2	-0.0500978
2	1 -5	-0.00172195
3	2 -3	-0.0116109
4	2 -4	-0.561089
5	2 -5	-0.015215
6	3 -4	-0.786861
7	4 -5	-7.10478
8	4 -7	-0.00229181
9	4 -9	-4.74885e-05
10	5 -6	-7.11635e-06
11	6 -11	-0.218704
12	6 -12	-0.131154
13	6 -13	-0.467266
14	7 -8	-0.389977
15	7 -9	-0.00315425
16	9 -10	-0.00169992
17	9 -14	-0.00169992
18	10 -11	-0.000148184
19	**12 -13**	**9.49569e-06**
20	13 -14	-3.49601e-07

Conclusion

From the power system stability and system security point of view, congestion management is very importantas per expected goal for the optimal placement of FACTS devices to relieve congestion. It is important and this goal can be achieved by using reduction of total system reactive power loss sensitivity indices analysis method.

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