Uluslararası İleri Doğa Bilimleri ve Mühendislik Araştırmaları Dergisi
Sayı 7, S. 47-51, 9, 2023

Araştırma Makalesi

IJANSER

https://as-proceeding.com/index.php/ijanser
ISSN: 2980-0811

International Journal of Advanced Natural Sciences and Engineering Researches
Volume 7, pp. 47-51, 9, 2023

Research Article

CONGESTION MANAGEMENT IN DEREGULATED POWER SYSTEM BY SVC USING POWER WORLD SIMULATOR

M. Gnanaprakash[*1], S. P. Mangaiyarkarasi[2], V. Jeevabethan[3] and M. Vallarasu[4]

[1,2,3,4] *Department of EEE, University College of Engineering Panruti , Tamil Nadu, India.*

[*]*(gp@ucep.edu.in)*

(Received: 20 September 2023, Accepted: 05 October 2023)

(3rd International Conference on Innovative Academic Studies ICIAS 2023, September 26-28, 2023)

ATIF/REFERENCE: Gnanaprakash, M., Mangaiyarkarasi, S. P., Jeevabethan, V. & Vallarasu, M. (2023). Congestion Management in Deregulated Power System By Svc Using Power World Simulator. *International Journal of Advanced Natural Sciences and Engineering Researches*, 7(9), 47-51.

Abstract – Competition in the power market, as well as production and consumption, will all expand as a result of privatization and deregulatory efforts. The problem of managing congestion is one of the most essential aspects of gearbox management. In order to calculate power flow, the utility company makes use of a sophisticated programmer called Power World Simulator. In order to simulate the power market and verify the strategy, the tool performs an analysis on the power flow data and analyses large case studies in batches using the IEEE 30-bus system. According to the findings, the addition of a Static Var Compensator results in a significantly lower amount of re-dispatched power, which ultimately leads to an ideal operating point that is closer to the market settlement. It has also been determined that the Static Var Compensator is technically feasible and cost-effective as a method of congestion reduction.

Keywords – Power World Simulator, IEEE 30 Bus System, SVC And Line Sensitivity Factor

I. INTRODUCTION

In this study, Optimal Power Flow is determined for a 30-bus system using a number of controllers. Each bus in an IEEE bus system has its own voltage. In some instances, however, bus voltage deviates from its rated value due to an increase in load demand. Voltage stability in a power system is the retention of the rated voltage of the bus even after load demand [1]. This study proposes OPF in the IEEE bus system to maintain voltage stability on each bus. OPF is a crucial tool for power system operators in the planning and administration of modern power systems. Carpentier first discusses Optimal Power Flow in 1962 [2].

The Optimal Power Flow (OPF) problem is defined as a static nonlinear optimization problem to determine all adjustable variables such as real power generation, transformer tap positions, angle of the phase shifter, shunt capacitor capacity and or reactor etc. for minimizing the operating costs, transmission line losses, or other suitable objective functions [3]. While shunt capacitors and the angle of the phase converter transformer tap positions are discrete variables, actual power generation and bus voltages are continuous. Due to the increased number of variables and boundary constraints, this problem must be solved using nonlinear programming techniques. The OPF solution provides the optimal active and reactive power dispatch for a statically loaded power system. Concerns about system voltage security have resulted from the increase in peak demand and power transfer between two utilities. Multiple significant disturbances have been attributed to voltage collapse, and significant research efforts are currently underway to better comprehend voltage phenomena. This research is primarily focused on the steady state aspects of voltage stability. Numerous authors have proposed voltage indices based on an analysis of power transmission.

The objective of the OPF is to identify the stable state function point that reduces production expenditure and loss or increases load capacity in energy structures, thereby enhancing the functionality of the structures by satisfying certain constraints. Typically, various maximization techniques are used to address OPF challenges in research publications. In certain research papers, the maximization procedure is carried out by factoring in total fuel expenditure or environmental pollution resulting from energy production. Other review articles state that Flexible Alternating Current Transmission System (FACTS) controller devices are used to increase energy flow without regard to energy production costs [4]. The various varieties of FACTS controller devices and their respective locations offer various benefits.

II. OPTIMAL POWER FLOW PROBLEM

The primary objective of the optimal power dispatch problem has been limited to reducing the overall generation cost of a power system as much as possible. Emission control, on the other hand, has emerged as one of the most essential operational goals in recent years in order for businesses to remain in compliance with environmental standards. In addition to the passage of the Clean Air Act Amendments of 1990 as a result of an increasing public awareness of the importance of environmental protection, the minimum cost function must be modified in the design or operational strategies of utilities in order to lessen pollution and atmospheric emissions produced by thermal power plants [Kothari D.P. 2011]. System security is another essential consideration in the operation of power systems and in the construction of new systems. As a result, it is of the utmost importance to keep appropriate voltage profiles and to restrict line flows to levels that are within the prescribed limits. The ideal Power Flow problem (OPF) [Wood J. 1996] is a nonlinear programming problem that is used to calculate the ideal outputs of generators, bus voltage, and transformer tap setting in the power system. The objective of an OPF algorithm is to find a steady state operation point that either maximizes social welfare and load ability or minimizes loss while maintaining an acceptable level of system performance in terms of limits on the real and reactive powers of generators, line flow limits, and the output of various compensating devices. The physical principles that regulate the power generating and transmission networks as well as the operational restrictions of the equipment all contribute to the constraints that are present [5].

A. *Objectives of OPF*

This section discusses the objectives that the OPF will need to achieve in order to be successful. The basic objective of a generic operational policy framework, or OPF, is to reduce the costs associated with satisfying the load demand of a power system while simultaneously preserving the system's integrity. The costs that are linked with the power systems may vary depending on the circumstances; nevertheless, in general, they can be attributed to the cost of producing electricity (measured in megawatts) by each generator. When seen from the perspective of an OPF, the upkeep of system security necessitates maintaining each component of the power system within its desired operational range when the system is in steady state. This will comprise the maximum and lowest outputs for the generators, the maximum MVA flows on the transmission lines and transformers, as well as maintaining the system bus voltages within the prescribed ranges. It is important to keep in mind that the OPF only discusses the operation of the power system in its steady state [4].

B. *Optimal Power Flow Formulation*

The minimization of the overall cost of real power generation is the objective that is utilized in the OPF issue formulation process the vast majority of the time. The individual expenses of each generating unit are considered to be functions, only due to active power generation, and are depicted by quadratic curves of the second order. This is done for simplicity's sake. The optimal power flow problem can be characterized by identifying each of the five properties that are listed below, and it can be explained as follows as: 1. The controls 2. The dependent variables 3. The equality 4. Objective function 5. Inequality Constraint.

III. Static Var Compensator

A Static Var Compensator (SVC) is a type of power electronic device used in electrical power systems to control and manage voltage and reactive power (VAR) levels. It is part of a family of devices known as Flexible AC Transmission Systems (FACTS), which are used to enhance the controllability and stability of power grids. SVCs are primarily employed to regulate voltage and improve the power factor of the electrical system.

Here are some key features and functions of a Static Var Compensator (SVC):

Voltage Regulation: SVCs can dynamically adjust the voltage levels within the power grid. They can either boost voltage (upward regulation) or reduce voltage (downward regulation) to maintain it within specified limits. This helps in ensuring a stable and reliable power supply to consumers.

Reactive Power Control: One of the primary functions of an SVC is to provide or absorb reactive power to control the power factor of the system. Reactive power is necessary for the operation of inductive loads like motors and transformers. By injecting or absorbing VARs, SVCs help maintain the power factor close to unity (1) or a desired target value, which reduces power losses and increases system efficiency.

Rapid Response: SVCs can respond quickly to changes in the system's voltage and VAR requirements, typically in milliseconds. This rapid response capability makes them valuable for mitigating voltage flicker, managing load fluctuations, and maintaining system stability during disturbances.

Thyristor-Based Technology: SVCs use thyristor-based semiconductor devices (typically thyristor-controlled reactors and thyristor-switched capacitors) to control the flow of reactive power. These devices can be controlled electronically to provide smooth and continuous VAR compensation.

Location Flexibility: SVCs can be strategically placed at various points within the power grid, such as substations or along transmission lines, to address specific voltage and VAR control needs in different parts of the system.

Grid Stability: By improving voltage regulation and power factor control, SVCs enhance the overall stability and reliability of the power grid. They can help prevent voltage collapses, reduce line losses, and improve the system's ability to handle disturbances.

Cost Savings: The installation of SVCs can lead to cost savings for utilities by reducing the need for additional infrastructure, such as new transmission lines and substations, to accommodate growing power demand.

A Static Var Compensator (SVC) is an essential device in modern power systems, providing real-time control of voltage and reactive power to ensure a stable and efficient operation of electrical grids. It plays a crucial role in maintaining grid reliability, minimizing power losses, and improving the quality of electricity supplied to consumers.

IV. Case Study

Fig. 1 is a depiction of the Single line diagram for a system that uses Power World Simulator and has 30 IEEE buses. It has been noticed that a few of the lines are congested, as may be seen in Figure 1. Therefore, we test the LINE sensitivity of each and every bus, which can be observed in fig 2

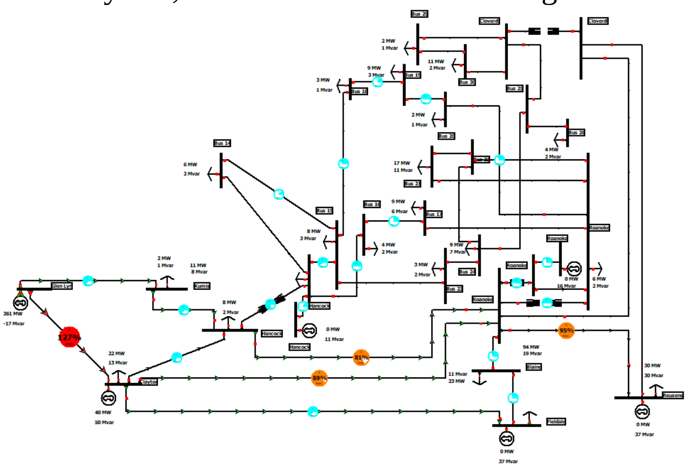

Fig 1 (a). IEEE 30 Bus Systems

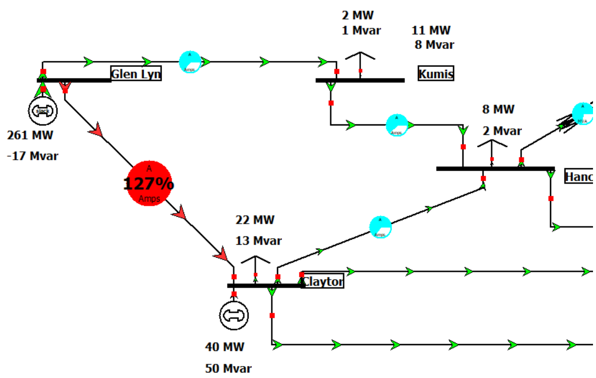

Fig 1 (b). IEEE 30 Bus Systems – Bus 2 closer view

According to the figure, the line sensitivity of bus 2, bus 5, and bus 7 are correspondingly 0.162, 0.16, and 0.159. This demonstrates that bus 2 is more sensitive than the other buses, while bus 5 is more sensitive than the other buses combined. As a result, to get started, we are going to implement SVC on bus 2, and then we are going to look at the voltage profile.

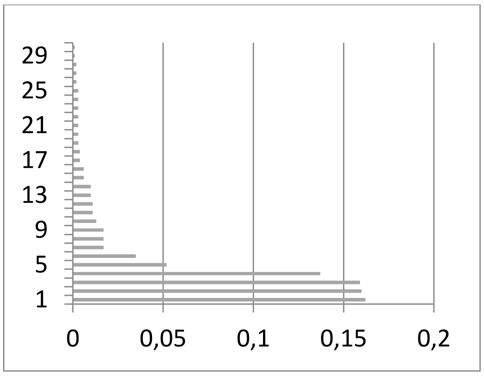

Fig 2 . Bus sensitivity values

It has been observed that after using SVC, the voltage profile of that particular bus is improved, and approximately more than 90% of the congestion is alleviated. This has been confirmed by the findings of the aforementioned study.

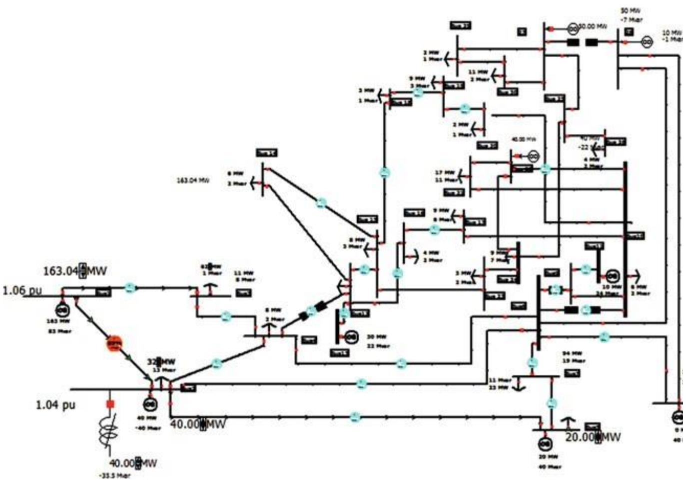

Fig 3. IEEE 30 bus system after svc placement

The figure 3 shows the SVC placement of IEEE 30 bus system. After SVC placement the MVA flow in percentage of all the 41 lines are listed in table 1

V. CONCLUSION

This research proposes Static Var Compensator (SVC) as an efficient first approach for economic load market congestion management. The method for congestion management benefits from using Static Var Compensator (SVC). By SVC after market re-dispatch, contracts are similar because power distributors and consumers value the anticipated schedule. The IEEE 30-bus system is analysed. Here, TLR sensitivity is determined to determine where to use Static Var Compensator (SVC) to solve congestion and verify simulation results. Simulation results on several systems show a definite chance of optimised Series

Table 1. LINE Flow values in percentage

Branch no.	From number	To number	Before SVC MVA rating in%	After SVC MVA rating in %
1	1	2	121.2	89
2	1	3	61.4	69.3
3	2	4	26.8	18.2
4	2	5	57.1	43.6
5	2	6	28.5	20.1
6	3	4	15	10.6
7	4	6	9.3	9.9
8	4	12	13	13.8
9	5	7	22.1	17.8
10	6	7	42.6	35.9
11	6	8	21.6	21.2
12	6	9	6.7	6.2
13	6	10	3.3	3.7
14	6	28	22.4	23.6
15	8	28	10.6	10.7
16	9	10	18.5	19.1
17	9	11	24.9	24.9
18	10	17	8.3	8.3
19	10	20	9.7	9.6
20	10	21	25.2	25.8
21	10	22	16.2	16.6
22	12	13	36.5	36.1
23	12	14	7.9	7.9
24	12	15	17.6	17.7
25	12	16	9.2	9.2
26	14	15	2.5	2.5
27	15	18	6.8	6.8
28	15	23	8.6	8.6
29	16	17	6.2	6.3
30	18	19	3.7	3.7
31	19	20	7.3	7.2
32	21	22	29.7	29.9
33	22	24	4.2	4.1
34	23	24	8.3	8.4
35	24	25	11.9	11.9
36	25	26	4.3	4.3
37	25	27	14.3	14.4
38	28	27	24.3	24.5
39	27	29	6.4	6.4
40	27	30	7.3	7.3
41	29	30	3.8	3.8

Compensation and congestion easing. Perfect Series Compensation site reduces congestion and benefits technology and economy. SVC position at bus 2 improves IEEE 30-bus congestion control. Series compensation improves with location. Power World Simulator confirms results.

REFERENCE

[1] Pandya, K. S. and Joshi, S. K., "A Survey of Optimal Power Flow Methods," Journal of Theoretical and Applied Information Technology, Vol. 4, No. 5, pp. 450-458, 2008.

[2] Kumari, M. Sailaja and Maheswarapu, S., "Enhanced Genetic Algorithm Based Computation Technique for Multi-objective Optimal Power Flow solution," International Journal of Electrical Power & Energy Systems, Vol. 32, No. 6, pp. 736–742, 2010.

[3] Hingorani, N. G., "Power electronics in electric utilities: role of power electronics in future power systems", Proceedings of the Institute of Electrical and Electronics Engineers, Vol. 76, No. 4, pp. 481-482, 1988.

[4] Abessi, A., Vahidinasab, V. and Ghazizadeh, M. S., "Centralized Support Distributed Voltage Control by Using End-Users as Reactive Power Support", Institute of Electrical and Electronics Engineers Transactions on Smart Grid, Vol. 7, No. 1, pp. 178-188, 2016.

[5] Yang, F. and Li, Z., "Improve Distribution System Energy Efficiency With Coordinated Reactive Power Control", Institute of Electrical and Electronics Engineers Transactions on Power Systems, Vol. 31, No. 4, pp. 2518-2525, 2016.