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Investigation and Comparison of the Effect of Facts Devices, Capacitors and Lines Reactance Variations on Voltage Stability Improvement and Loadability Enhancement in Two Area Power System

Navid Ghaffarzadeh*, Haniyeh Marefatjou, Iman Soltani*****
Faculty of Technical and Engineering, Imam Khomeini International University, Qazvin, Iran.

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ABSTRACT

Power systems operation becomes more important as the load demand increases all over the world. This rapid increase in load demand forces power systems to operate near critical limits due to economical and environmental constraints. The objective in power systems operation is to serve energy with acceptable voltage and frequency to consumers at minimum cost.This paper studies the important power system phenomenon and voltage stability by using continuation power flow method. Voltage collapse scenario is presented which can be a serious result of voltage instability and also the parameters that affected by voltage collapse are discussed. In analyzing power system voltage stability, continuation power flow method is utilized which consists of successive load flows.In this paper steady-state modeling of Static VAR Compensator (SVC) and Unified Power Flow Controller (UPFC) and effect of compensator and variation of line reactance on the voltage stability have been studied andComparison between performance of UPFCandSVCand installation shunt capacitor and variation of line reactance for improve voltage stability has been done.Case studies are carried on 11 bus network in two areas. Simulation is done with PSAT in MATLAB.Continuation Power Flow was implemented using Newton Raphson method. Simulation results show the proper performance of UPFC, SVC, installation shunt capacitor and variation of line reactance to improve voltage control and significantly increase the loadability margin of power systems.

Corresponding Author:

Haniyeh Marefatjou
Faculty of Technical and Engineering,
Imam Khomeini International University, Qazvin, Iran.
Email: h.marefat@ikiu.ac.ir

1. INTRODUCTION

In recent years, the increase in peak load demand and power transfers between utilities has elevated concerns about system voltage security [1]. Power systems operation becomes more important as the load demand increases all over the world. This rapid increase in load demand forces power systems to operate near critical limits due to economical and environmental constraints. The objective in power systems operation is to serve energy with acceptable voltage and frequency to consumers at minimum cost. Reliability and security are also important parameters for power systems and should be satisfied. By reliability, it is meant that the system has adequate reserves in the face of changing energy demand. By security, it is meant that upon occurrence of a contingency, the system could recover to its original state and supply the same quality service as before. All these objectives can be achieved by proper planning, operation and control of power generation and transmission systems. Since generation and transmission units have to be operated at critical limits voltage stability problems may occur in power system when there is an increase in load demand. Voltage instability is one of the main problems in power systems. In voltage stability problem some or all buses voltages decrease due to insufficient power delivered to loads. In case of voltage stability problems, serious blackouts may occur in a considerable part of a system [2]. This can cause severe social and economic problems [2]. In fact, more than 50 cases of voltage instability or voltage collapse were reported all over the world between 1965 and 1996. For example, a voltage collapse in the North American Western Systems Coordinating Council system on July 2, 1996, resulted in service interruptions to more than 6 million people [2]. When the necessity of electricity to industry and community in all fields of the life is considered, the importance of a blackout can be understood more easily. Therefore, special analysis should be performed in order to examine the voltage stability in power systems [3]. The only way to save the system from voltage collapse is to reduce the reactive power load or add additional reactive power prior to reaching the point of voltage collapse [2]. Voltage collapse phenomena in power systems have become one of the important concerns in the power industry over the last two decades, as this has been the major reason for several major blackouts that have occurred throughout the world [4]. Point of collapse method and continuation method are used for voltage collapse studies [5]. Of these two techniques continuation power flow method is used for voltage analysis. These techniques involve the identification of the system equilibrium points or voltage collapse points where the related power flow Jacobian becomes singular [6, 7]. The most common methods used in voltage stability analysis are continuation power flow, point of collapse, minimum singular value and optimization methods [3]. With the rapid development of power system, especially the increased use of transmission facilities due to higher industrial output and deregulation, it becomes necessary to explore new ways of maximizing power transfer in existing transmission facilities, while at the same time maintaining the acceptable levels of the network reliability and stability. On the other hand, the fast development of power electronic technology has made FACTS (flexible AC Transmission system) promising solution of future power system. FACTS controllers such as Static Synchronous Compensator (STATCOM), Static VAR Compensator (SVC), Thyristor Controlled Series Compensator (TCSC), Static Synchronous Series Compensator (SSSC) and Unified Power Flow controller (UPFC) are able to change the network parameters in a fast and effective way in order to achieve better system performance [8], [9], [10], [11]. These controllers are used for enhancing dynamic performance of power systems in terms of voltage/angle stability while improving the power transfer capability and voltage profile in steady-state conditions [12], [13], [14], [15], [16].Static VAR Compensator (SVC) is a FACTS controllers based on thyristor controlled reactor (TCRs), the first is a shunt compensator used for voltage regulation which is achieved by controlling the production, absorption and flow of reactive power through the network[17].Unified Power Flow Controller (UPFC), is the most complete. It is able to control independently through active and reactive powers. The UPFC is capable to act over three basic electrical system parameters: line voltage, line impedance, and phase angle, which determine the transmitted power. Also Note that among the available FACTS devices, the Unified Power Flow Controller (UPFC) is the most versatile one that can be used to improve steady state stability, dynamic stability and transient stability [18].

In this study, continuation power flow method, widely used in voltage stability analysis, is utilized in order to analyze voltage stability of power systems. In section (2) of this paper the concept of voltage stability phenomena is described. Voltage stability can be analyzed by using bifurcation theory, so in section (3) we focus on bifurcation theory and in section (4) we focus on Continuation Power Flow method, one of the methods used in voltage stability analyze and in section (5) we focus on modeling of two area power system.The rest of the sections are organized as follows: in section (6) modeling of SVC is presented and in section (7) modeling of UPFC is presented. The Case Study and simulation result are presented in section (8) in the other hand and effects of compensation, transmission line reactance, SVC and UPFC are presented by analyzing bus voltage profiles that show the relationship between power and voltage.Finally conclusion is discussed in section (9).

2. VOLTAGE STABILITY

Power system stability can be divided into two as voltage stability and rotor angle stability. Rotor angle stability is the ability of interconnected synchronous machines of a power system to remain in synchronism [19]. In this kind of stability, power-angle equations are handled since power output of a synchronous machine varies as its rotor oscillates [2]. Voltage stability is the ability of a power system to maintain steady acceptable voltages at all buses in the system under normal operating conditions and after being subjected to a disturbance [19]. Voltage stability can be attained by sufficient generation and transmission of energy. Generation and transmission units have definite capacities that are peculiar to them. These limits should not be exceeded in a healthy power system. Voltage stability problem arises when the system is heavily loaded that causes to go beyond limitations of power system. A power system enters a state of voltage instability when a disturbance, increase in load demand power or change in system condition causes a progressive and uncontrollable decline in voltage. The main factor causing instability is the inability of the power system to meet the demand for reactive power [19].

2.1. Factors Affecting Voltage Stability

The main reason for voltage instability is the lack of sufficient reactive power in a system. Generator reactive power limits and reactive power requirements in transmission lines are the main causes of insufficient reactive power [20].

2.1.1. eactive Power Limits of Generators

Synchronous generators are the main devices for voltage control and reactive power control in power systems. In voltage stability analysis active and reactive power capabilities of generators play an important role. The active power limits are due to the design of the turbine and the boiler. Therefore, active power limits are constant. Reactive power limits of generators are more complicated than active power limits. There are three different causes of reactive power limits that are; stator current, over-excitation current and under-excitation limits. The generator field current is limited by over-excitation limiter in order to avoid damage in field winding. In fact, reactive power limits are voltage dependent. However, in load flow programs they are taken to be constant in order to simplify analysis [20].

2.1.2. Transmission Lines

Transfer of active and reactive power is provided by transmission lines. Since transmission lines are generally long, transfer of reactive power over these lines is very difficult due to significant amount of reactive power requirement[2].

2.2. Voltage Collapse

Voltage collapse is the process by which the sequence of events accompanying voltage instability leads to a low unacceptable voltage profile in a significant part of system. When a power system is subjected to a sudden increase of reactive power demand, the required demand is met by the reactive power reserves supplied from generators and compensation devices. Most of the time, this can be achieved since there are sufficient reserves. Sometimes, it is not possible to meet this rapid increase in demand due to combination of events and system conditions. Thus, voltage collapse and a major breakdown of part or all of the system may occur [19]. There are some countermeasures that can be taken against voltage instability. Automatic voltage regulators (AVRs), under-load tap changers (ULTCs) and compensation devices are common ways to keep bus voltage magnitude in acceptable ranges [19].

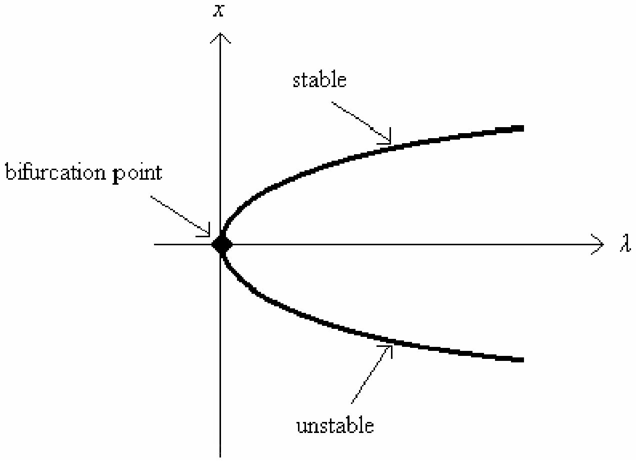

Figure 1. Bifurcation diagram for f(x,λ)[3]

3. BIFURCATION THEORY

Bifurcation theory is used to describe changes in the qualitative structures of the phase portrait when certain system parameters change. Local bifurcations can be studied by analyzing the vector differential equations near the bifurcation equilibrium points. Voltage collapse in power systems can be predicted by identifying parameter values that lead to saddle-node bifurcations. In order to present the characteristic of bifurcation, Equation 1 is considered.

$$F(x,\lambda) = \dot{x} = \lambda - x^2 \tag{1}$$

In differential Equation 1, x is the state variable and λ is a parameter. There is a point called equilibrium point where $F(x_0,\lambda_0) = 0$. For this value of λ the linearization of $F(x,\lambda)$is singular.
Figure 1 is obtained for $F(x,\lambda)$, as λ changes. When $\lambda = 0$ there is a saddlenode point. For $\lambda < 0$, there is no equilibrium whereas for $\lambda > 0$ there are two equilibrium points as stable and unstable points[21,22].

4. CONTINUATION POWER FLOW

The conventional power flow has a problem in the Jacobian matrix which becomes singular at the voltage stability limit. This problem can be overcome by using continuation power flow [23]. Figure 2.shows the predictor–corrector scheme used in the continuation power flow.

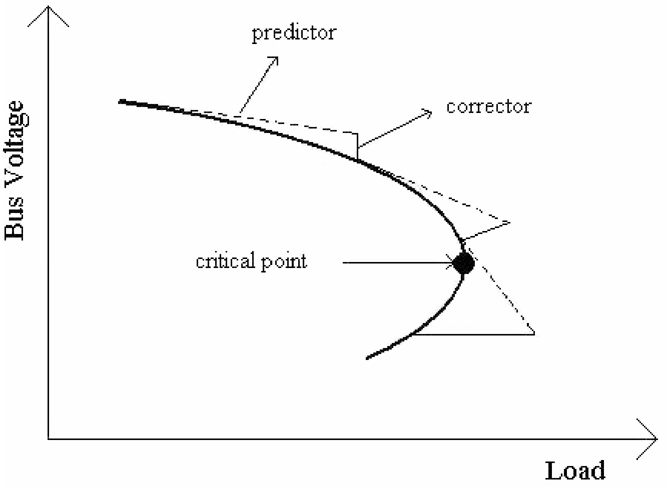

Figure 2. The predictor – corrector scheme[23]

From the Newton-Raphson, load flow equations can be written as:

$$P_i - \sum_{j=1}^{N} Y_{ij} V_i V_j \cos(\delta_i - \delta_j - \theta_{ij}) = 0 \tag{2}$$

$$Q_i - \sum_{j=1}^{N} Y_{ij} V_i V_j \sin(\delta_i - \delta_j - \theta_{ij}) = 0 \tag{3}$$

The new load flow equations consist of load factor (λ) are expressed as:

$$P_{Li} = P_{L0} + \lambda(K_{Li} S_{\Delta base} cos\emptyset_i) \tag{4}$$

$$Q_{Li} = Q_{L0} + \lambda(K_{Li} S_{\Delta base} sin\emptyset_i) \tag{5}$$

Where:
P_{L0},Q_{L0}=original load at bus i, active and reactive power respectively
K_{Li} = multiplier to designate the rate of load change at bus i as λ changes
$S_{\Delta base}$ = a given quantity of apparent power which is chosen to provide appropriate scaling of λ
The power flow equations can be written as:

$$F(\delta, V, \lambda) = 0 \tag{6}$$

whereλ denotes the vector of bus voltage angles and V denotes the vector of bus voltage magnitudes. The base solution for λ =0 is found via a power flow [24].
Then the active power generation term can be modified to:

$$P_{Gi} = P_{G0}(1 + \lambda \mathrm{K}_{\mathrm{Gi}}) \quad (7)$$

Where:
P_{G0} = The initial value of active power generation
P_{Gi} = the active power generation at bus i
KG i = the constant of changing rate in generation

To solve the problem, the continuation algorithm starts from a known solution and uses a predictor-corrector scheme to find subsequent solutions at different load levels [25].

5. TWO AREA POWER SYSTEM MODEL

Consider a two-area power system (Area-1 & Area-2) with series and shunt FACTS devices and shunt Capacitor, connected by a single circuit long transmission line as shown in Figure 2 , Figure 3 and Figure 4. Here, the shunt FACTS device such as SVC and shunt capacitor are equipped at bus-8 and the series FACTS devices such as UPFC (combination of STATCOM and SSSC), is equipped between bus-8 and bus-9. The direction of real power flow is from Area-1 to Area-2. In the two-area power system model, the Area-1 consists of Generator 1 (G1) and Generator 2 (G2) and the Area-2 consists of Generator 3 (G3) and Generator 4 (G4).Slack bus is located in Area 2.

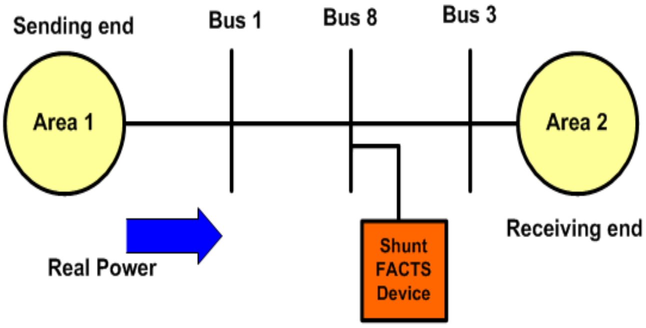

Figure 3. Two-area power system with shunt FACTS device

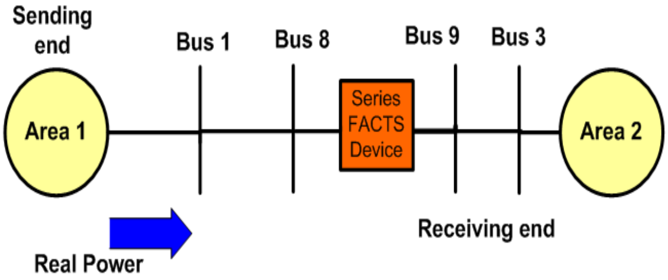

Figure 4. Two-area power system with series FACTS device

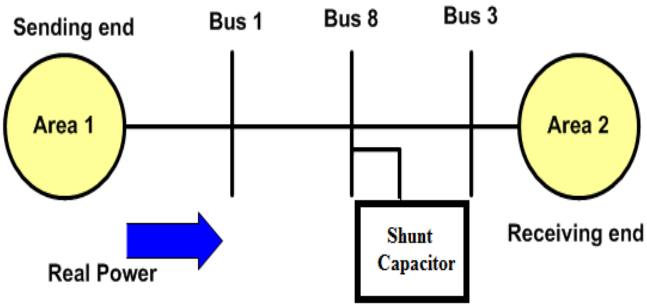

Figure 5. Two-area power system with shunt capacitor

6. STATIC VAR COMPENSATOR (SVC)

A static var compensator (or SVC) is an electrical device for providing fast-acting reactive power on high-voltageelectricitytransmissionnetworks [26], [27]. SVC are part of the Flexible AC transmission system device family, regulating voltage and stabilising the system [28],[29]. Unlike a synchronous condenser which is a rotating electrical machine, a "static" VAR compensator has no significant moving parts (other than internal switchgear). Prior to the invention of the SVC, power factor compensation was the preserve of large rotating machines such as synchronous condensers or switched capacitor banks[30].The SVC is an automated impedance matching device, designed to bring the system closer to unity power factor. SVCs are used in two main situations:

- Connected to the power system, to regulate the transmission voltage ("Transmission SVC")
- Connected near large industrial loads, to improve power quality ("Industrial SVC")

In transmission applications, the SVC is used to regulate the grid voltage. If the power system's reactive load is capacitive (leading), the SVC will use thyristor controlled reactors to consume vars from the system, lowering the system voltage. Under inductive (lagging) conditions, the capacitor banks are automatically switched in, thus providing a higher system voltage. By connecting the thyristor-controlled reactor, which is continuously variable, along with a capacitor bank step, the net result is continuously-variable leading or lagging power. In industrial applications, SVCs are typically placed near high and rapidly varying loads, such as arc furnaces, where they can smooth flicker voltage.

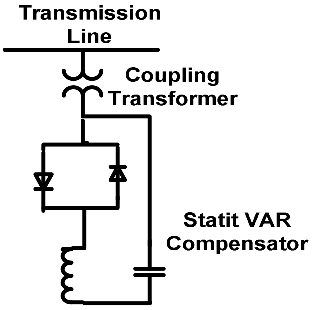

Figure 6. Configuration of SVC

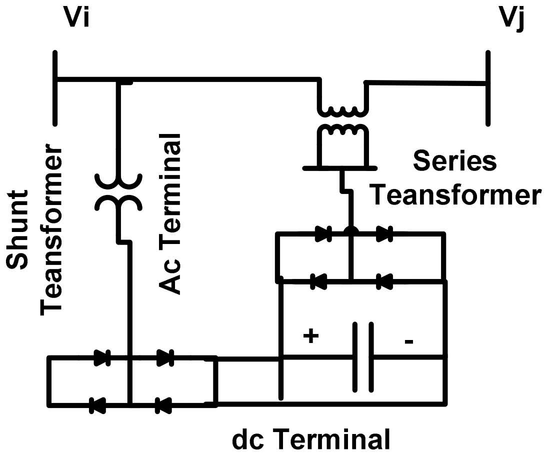

Figure 7. Configuration of UPFC

7. UNIFIED POWER FLOW CONTROLLER (UPFC)

A Unified Power Flow Controller (or UPFC) is an electrical device for providing fast-acting reactive power compensation on high-voltageelectricitytransmissionnetworks. The UPFC combines together the features of two FACTS devices: the Static Synchronous Compensator (STATCOM) and the Static Synchronous Series Compensator (SSSC). The DC terminals of the two underlying VSCs are now coupled, and this creates a path for active power exchange between the converters. Hence, the active power supplied to the line by the series converter, can now be supplied by the shunt converter. The UPFC can be used to control the flow of active and reactive power through the line and to control the amount of reactive power supplied to the line at the point of installation. It uses a pair of three-phase controllable bridges to produce current that is injected into a transmission line using a series transformer. The controller can control active and reactive power flows in a transmission line. The UPFC uses solid state devices, which provide functional flexibility, generally not attainable by conventional thyristor controlled systems. The UPFC concept was described in 1995 by L. Gyugyi of Westinghouse [30].The UPFC allows a secondary but important function such as stability control to suppress power system oscillations improving the transient stability of power system.

8. CASE STUDY AND SIMULATION RESULT

11-bus two area test system is used to assess the effectiveness of capacitor, reactance and placing SVC and UPFC developed in this paper. Figure 8. show the single line diagram of system, with 230 kv and 100MVA base has been considered. In this test system, bus3 is chosen as slack bus, bus 1 and bus2 and bus4 are voltage control Bus and other buses are load buses. Sample test system consists of 2 areas those 11 buses, 4 generators, 8 transmission lines, 4 transformers and 4 loads. Continuation power flow method is applied to sample test system using PSAT program and voltage profiles of 11 buses are obtained. Bus voltages are plotted with respect to the load parameter in Figure 9. As the load parameter is increased, bus voltages of load buses decrease as it is expected. The Continuation power flow result given in table 1. Four cases are considered, SVC is connected at bus 8, UPFC connected between bus8-9, capacitor connevted at bus 8 and variation transmission line reactance.

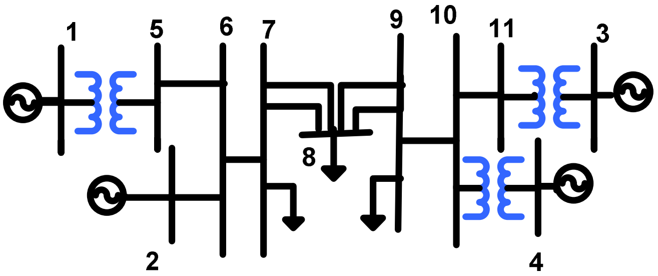

Figure 8. Single line Diagram of 11-Bus Two area System

Table 1. Voltage magnitude and phase angle and Contination Power flow for test system without SVC and UPFC

Bus	Without FACTS		From-to bus	Contination Power Flow	
	Voltage(Pu)	Angle(rad)		P(pu)	Q(pu)
1	1.03	1.208	**5-6**	8.996	2.6748
2	1.01	0.972	**6-7**	17.7589	5.1857
3	1.03	-0.118	**7-8**	3.1675	1.1498
4	1.01	-0.126	**8-9**	2.9933	-0.46599
5	0.9725	1.057	**8-9**	2.9933	-0.49405
6	0.9082	0.808	**11-10**	6.7032	1.9036
7	0.8529	0.583	**9-10**	-15.284	-1.0001
8	0.7635	0.043	**7-8**	3.1675	1.1848
9	0.8974	-0.465	**1-5**	8.996	4.2268
10	0.9408	-0.284	**2-6**	8.996	6.9042
11	0.9918	-0.109	**4-10**	8.996	4.9054

When Table 1 is examined it can be seen that the most reduction in bus voltages occurs in 8,7,9 and 6 buses. It can be concluded from this result that bus 8 is the weakest bus in this sample system. The bus with the highest voltage sensitivity factor can be thought as the weakest bus in a system. Weakest bus is more sensitive to load changes. In other words, the load connected to this bus is affected more than other loads in case of an unexpected load increase. Sample system loses its voltage stability at the critical point where the load parameter value is 1.2851 as seen in Figure 9 .The critical point can be taken as voltage collapse point. System becomes voltage unstable beyond this point and voltage decreases rapidly due to requirement of reactive power in the system.Inthenext part, effect of SVC and UPFC installed and effect of linereactance,compensator on voltage stability are study.

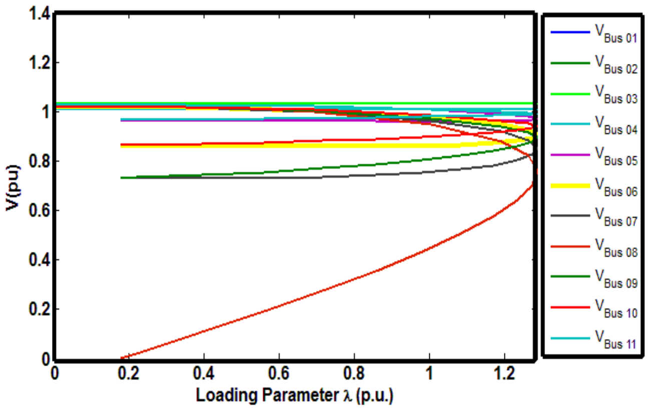

Figure 9. Voltage profiles of 11-Bus Test System

8.1. Effect of SVC at bus 8 on Voltage Stability

In order toillustrate the effectof SVC in voltage stability, SVC installed at bus 8(weakest bus) and continuation power flow is performed. We expectto increase maximum loading parameter. Figure 10 shows the voltage profiles for buse 8, 9, 7 and 6 in continuation power flows. It is obviously seen that maximum loading point increases. The new maximum loading level in this condition is λmax =1.7748 *p.u.*

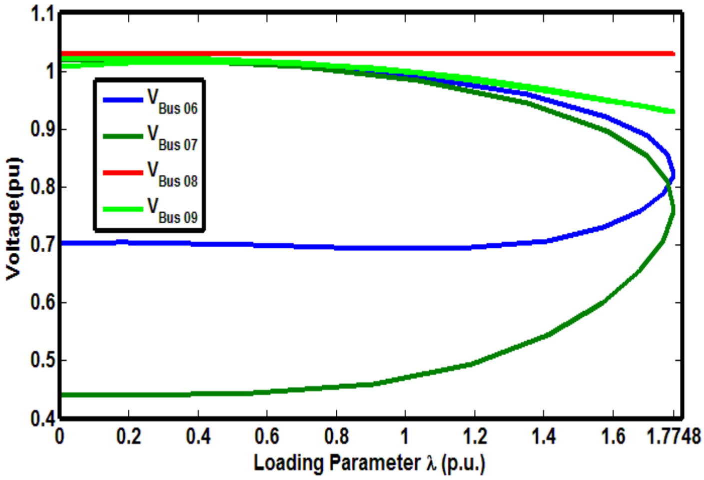

Figure10. PV curves for 11-bus Two area test systemwith SVC at bus 8

Table 2. Contination Power flow for 11-bus Two area test system with UPFC

Line	From-To bus	Contination Power Flow	
		P(pu)	**P(pu)**
1	**5-6**	11.9608	4.8358
2	**6-7**	23.4287	7.9453
3	**7-8**	4.8481	0.24331
4	**8-9**	4.3211	1.6104
5	**8-9**	-4.1812	1.3194
6	**11-10**	8.5262	1.9633
7	**9-10**	20.2903	2.7726
8	**7-8**	4.8481	0.24331
9	**1-5**	11.9608	8.1189
10	**2-6**	11.9608	13.1831
11	**4-10**	11.9608	5.5831
12	**3-11**	1.317	2.689

8.2. Effect of UPFC between bus 8 and 9 on Voltage Stability

After presenting the effect of Placing SVC, placing UPFC effect on voltage stability is presented by performing continuation Power flow. In order to analyze the effect of placing UPFC again Choosethe weakest bus. UPFC installed between bus 8 and 9 (weakest bus) and continuationpower flow is performed. We expectto increase maximum loading parameter. Figure 11 shows the voltage profiles for buse 8, 9, 7 and 6 in continuation power flows. It is obviously seen that maximum loading point increases. The new maximum loading level in this condition is λmax =1.6273 p.u.Table 2 show theContination Power flow for 11-bus Two area test system with UPFC.

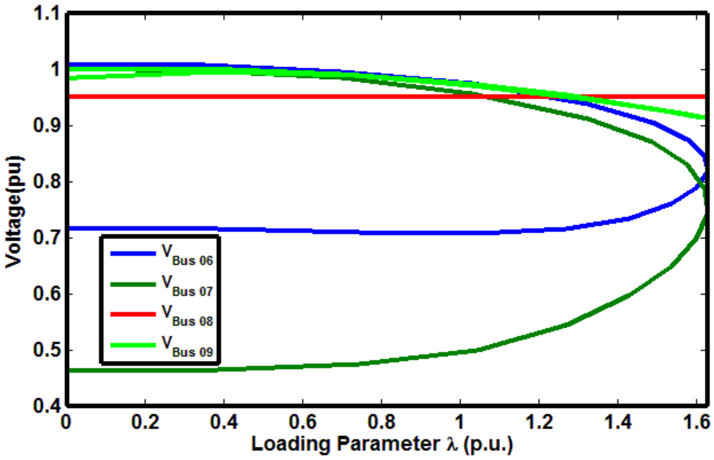

Figure 11. PV curves for 11-bus Two area test systemwith UPFC between bus 8-9

Real power flow in line 8-9 increased from 299.33 MW to 432.11 MW with installation UPFC.

8.3. Effect of Compensation on Voltage Stability

In order to illustrate the effect of compensation in voltage stability, shunt capacitor banks ranging from 0.1 to 0.5 pu in 0.1 pu steps are connected respectively to bus 8 (weakest bus) and continuationpower flow is performed for all cases. It isexpected to see the critical point at the highest loading level in capacitor bank with 0.5 pu case. Figure 12 shows the voltage profiles for base and other five cases of bus 8 obtained in continuation power flows. It is obviously seen that maximum loading point increases as compensation value increases.

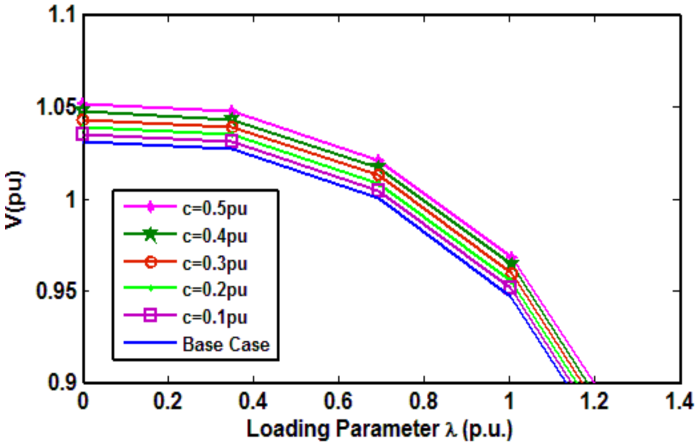

Figure 12. Voltage profiles of Bus 8 for different compensation cases (0.1pu-0.5pu)

In the base case, load parameter 1.2851 whereas in 0.5 pu shunt compensation case it increases to 1.2995. Adding shunt capacitor to power system enhances the voltage stability limits. Therefore, for some situations it prevents voltage collapse. Adding a shunt capacitor to bus 8 improves the voltage stability limit not only in bus 8 but also in other buses. Table 3 shows the voltage at bus 8 and loading parameter for the all shunt capacitor cases.

Table 3. Voltage at bus 8 and loading parameter for the all shunt capacitor cases

	Loading Parameter (p.u.)	Volt bus 8(pu)
Base-case	1.2851	0.7635
Cap=0.1pu	1.288	0.76703
Cap=0.2pu	1.2908	0.77055
Cap=0.3pu	1.2937	0.7741
Cap=0.4pu	1.2966	0.77768
Cap=0.5pu	1.2995	0.78128

When voltage in Table 3 compare with base-case it is seen that voltages in bus 8 increase in all shunt capacitor cases which shows the enhancement in voltage stability.

8.4. Effect of Line Reactance on Voltage Stability

Transmission line reactance effect on voltage stability is presented by performing continuation Power flow for different line reactance values. In order to analyze the effect of transmission lines reactance, again the weakest bus in the system, bus 8 is observed by performing continuation power flows for different line reactance values between bus 8 and bus 9, X8-9. Similar to compensation cases analysis, five continuation power flows are done for X8-9, 0.8X8-9, 0.6X8-9, 0.4X8-9 and 0.2X8-9 and voltage profiles of bus 8 are observed for these cases. In these cases, it is expected to see a better voltage profile as line reactance decreases since transmission line reactance cause significant amount of reactive power requirement in systems. Figure 13 shows the voltage profiles for different line reactance values for X8-9 which is the line reactance of transmission line between 8 and 9 buses. As it is seen in Figure 13, load parameter in critical point increases as line reactance X8-9 decreases. Load parameter for 0.2X8-9 case is approximately 1.5353. It means that bus 8 lose its voltage stability after this critical point which is greater than the base case.

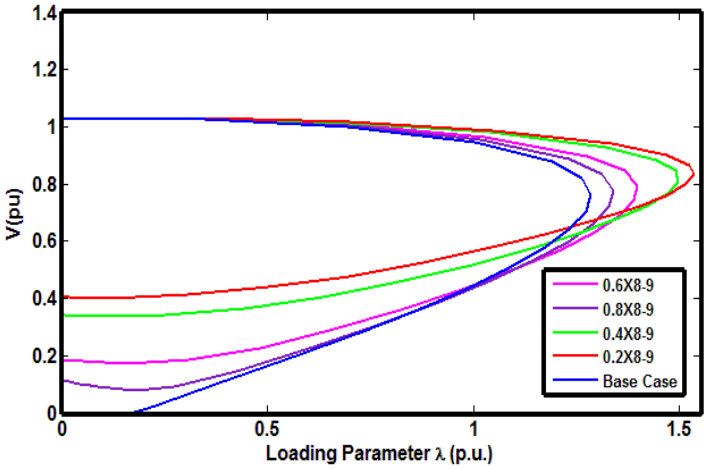

Figure 13. Voltage profiles of Bus 8 for different reactance cases between bus 8 and 9

Table 4. Voltage at bus 8 and loading parameter for the all line reactance cases

	Loading Parameter (p.u.)	Volt bus 8(pu)
Base-case	1.2851	0.7635
Reac=0.8X	1.3382	0.77724
Reac=0.6X	1.3964	0.79585
Reac=0.4X	1.4597	0.80673
Reac=0.2X	1.5353	0.83269

Table 4 shows the voltage at bus 8 and loading parameter for the all line reactance cases.

Table 5. Loading parameter for11-bus Two area test systemfor different cases

	Loading Parameter (p.u.)
Base Case	1.2851
With SVC	1.7748
With UPFC	1.6273
Cap=0.5pu	1.2995
Reac=0.2X	1.5353

When voltage in Table 4 compare with base-case it is seen that voltages in bus 8 increase in all line reactance cases which shows the enhancement in voltage stability.

Table 5 show, loading parameter for different cases and Table 6 show Voltage magnitude for 11-bus Two area test system.

Table 6. Voltage magnitude for 11-bus Two area test system

Bus	Without FACTS	SVC at bus 8	UPFC 8-9	Cap=0.5pu at bus 8	Reac=0.2X
1	1.03	1.03	1.03	1.03	1.03
2	1.01	1.01	1.01	1.01	1.01
3	1.03	1.03	1.03	1.03	1.03
4	1.01	1.01	1.01	1.01	1.01
5	0.9725	0.919	0.919	0.97292	0.94426
6	0.9082	0.823	0.816	0.90993	0.85813
7	0.8529	0.762	0.744	0.85676	0.78942
8	0.7635	1.03	0.95	0.78128	0.83269
9	0.8974	0.929	0.912	0.90273	0.85183
10	0.9408	0.946	0.938	0.94369	0.91346
11	0.9918	0.989	0.986	0.99299	0.98169

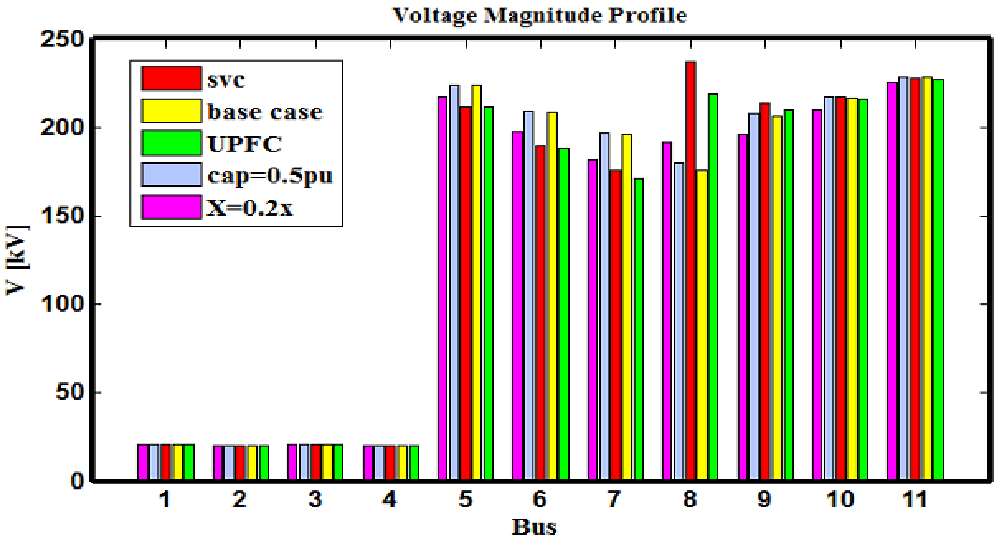

Figure 14. Volatage magnitude profile for 11-bus Two area test for different cases

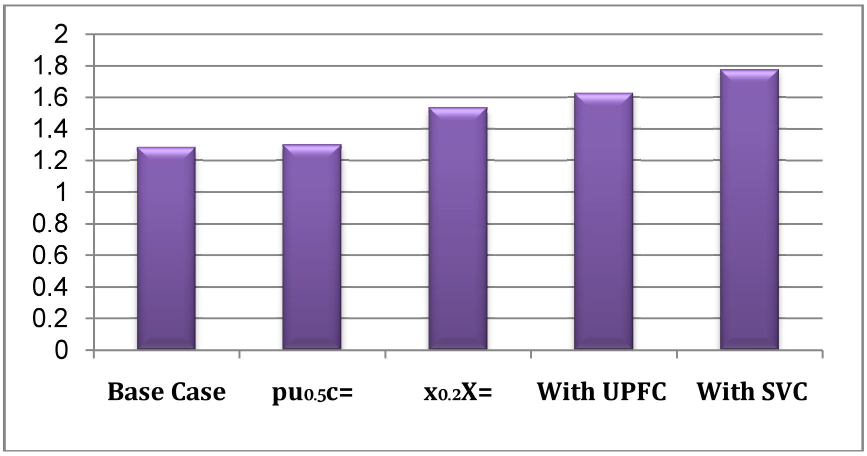

Figure 15. Maximum Loading Point for Different Cases

9. CONCLUSION

In this paper, voltage stability phenomena and continuation power flow method, used in voltage stability analysis of power systems, are presented, also this paper presented the modeling and simulation of two types of FACTS devices, UPFC and SVC for voltage stability. The presented method is applied to 11-Bus two area sample test system. Voltage magnitude and bus voltage versus load parameter curves are obtained for several scenarios by using a PSAT software which is a one of the toolbox of MATLAB software. The effect of compensation is discussed by adding shunt capacitors in different per unit values to the bus defined in sample system. It is observed from voltage profiles and voltage magnitude that adding shunt capacitor to a bus cause to enhances the voltage stability of whole buses in sample system. Since the shunt capacitor injects reactive power to system. Thus, critical point occurs in higher loading levels and the magnitudes of bus voltages will be increased. In the other hand by installing capacitor at bus 8, at the best extension the bus voltage is increased from 0.7635 to 0.78128 and maximum loading parameter increased from 1.2851 to 1.2995. In addition, the effect of variation of line reactance on voltage stability is studied by performing five continuation power flows to the proposed system. Voltage profiles for different line reactance cases prove the enhancement in voltage stability. With decreases of line reactance, reactive power demand decreases and profile of buses voltages is improved. By variation of line reactance, at the best extension, bus voltage is increased from 0.7635 to 0.83269 and maximum loading parameter increased from 1.2851 to 1.5353.The Numerical result for the standard 11 bus network has been presented how SVC and UPFC can be used to increase system stability in practical power systems with the use of simulink model. The effects on static voltage collapse or maximum loading level are presented.Simulation results show that by installing SVC at bus 8, the bus voltage is increased from 0.7635 to 1.03 and maximum loading parameter increased from 1.2851 to 1.7748.This mean effect of SVC in the network. UPFC is connected between bus 8 and bus 9, the objective control is increase the active power of that line, real power flow in line 8-9 increased from 299.33 MW to 432.11 MW and maximum loading parameter increased from 1.2851 to 1.6273. This means the effect of UPFC in power system. The method used Newton Raphson algorithm for load flow studies. It was found that the SVC and UPFC regulates the voltage of the bus as well as UPFC regulates the active and reactive power of the buses and the lines within specified limits. In the end wedida comparison between the four cases studied, andwe find that installing SVC to network have a greater impact on voltage stability and loadability increasing compared to step-up capacitor, step down the line reactance, installing UPFC.

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BIOGRAPHIES OF AUTHORS

Dr. Navid Ghaffarzadeh is an assistant professor of electrical engineering at Imam Khomeini Internatial University (IKIU). His special fields of interest include power systems protection, transient in power systems and power quality. He is the author and the coauthor of over 50 technical papers. Email: ghaffarzadeh@ikiu.ac.ir

Ms. Haniyeh Marefatjou is an M.Sc student of electrical engineering at Imam Khomeini Internatial University (IKIU). Her special fields of interest include PowerSystem Dynamics, , power electronicsOptimizationofPower System. She is the author and the coauthor of over 5 technical papers. Email: h.marefat@ikiu.ac.ir

Mr. Iman Soltani is an M.Scstudent of electricalengineering at Imam Khomeini Internatial University (IKIU). His special fields of interest include power systems, power electronicsand RenewableEnergy.He is the author and the coauthor of over 7 technical papers.
Email: i_soltani@ikiu.ac.ir