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Improvement Voltage Profile of Kurdistan Power System By Using SVC/STATCOM

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ABSTRACT

The surge in demand for electricity has driven the power system to operate at a lower efficiency level. With the many actions taken to improve the electric grid, voltage unbalance and line overload have become challenging problems to address. Voltage control can be determined in generation, transfer, and electricity usage. When the power system is under stress, reactive current unbalance significantly contributes to voltage instability. To maximize the efficiency of a power system, flexible transmission systems system (FACTS) devices must be used most effectively and feasible. FACTS devices like Static VAR Compensators (SVCs) and Static Synchronous Compensators (STATCOMs) can reduce instability in heavily burdened lines, resulting in lower system losses and more excellent network reliability.

In this paper, FACTS controllers such as SVC and STATCOM are incorporated in the Kurdistan power system simulated by using PSAT software based on MATLAB for the improvement of voltage profile, minimization of the system losses, and cost of the system. Also, the graphical comparisons of the results are presented to investigate the effectiveness of the proposed methods.

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1. Introduction

A Static VAR Compensator (SVC) is a group of electronic components used in elevated electric distribution systems to provide an incredibly quick power factor. SVC belongs to the group of Versatile AC distribution network devices that regulate amplitude, voltage level, harmonics, and network stability. There are no substantial mechanical devices in a static VAR compensator except the internal switchgear. Before the SVC's creation, boost converter adjustment was the exclusive domain of huge rotating machinery such as synchronized compressors or shifted facts devices. The SVC is an automatic resistance equalization device used to put the system's power factor closer to unity (Adware & Chandrakar, 2022)

On the other hand, the SVC is used to adjust the grid voltage in transmitting operations. When the impact resistance of the power grid is inductive, the SVC consumes VARs from the network via current-limiting reactors, decreasing the voltage level. When the system is resistive, the power systems are switched on, resulting in a larger power system. The outcome is constantly adjustable following or trailing current by coupling the variable frequency inductor reactor to a power converter stage. (Chakraborty, Mukhopadhyay, & Biswas, 2021) When connected to an electrical network, a Static Synchronous Compensator (STATCOM) delivers or absorbs volatile voltage and adjusts the amplitude at the point of interconnection. It is known as a static synchronous compensator because it comes within the category of alternating current power distribution. The design uses flexible multi-level VSCs with semi-conductor actuators to achieve its goals. This study seeks to compare the two aspects to identify how Voltage profile improvement of the power system could be possible using the two models.

2. Literature Review

(Li-jie, Yang, Yi-qun, & Automation, 2010) presented that both SVC and STATCOM are crucial reactive compensation equipment; they were compared in terms of voltage support, transient stability, transmission limit, and damping low-frequency oscillation. Their results showed that STATCOM outperforms SVC in terms of enhancing transient stability and transmission limit.

(Kamarposhti & Alinezhad, 2010) showed the important impacts of employing both the SVC and STATCOM as a voltage profile booster in wreaked buses, they showed a greatly improving effect, the magnitude of the bus voltage in the weakest bus increased from 0.68833 *p.u.* to 0.88987 *p.u.* and to 0.99237 *p.u.* by using SVC and STATCOM respectively.

(Thapa & Mohan, 2013) analyzed the effects of STATCOM on the voltage profile and both active and reactive power of different buses before and after fault occurrence in the power system.

(Khdr, 2013) presented the voltage stability of the KR network for summer 2013 using two types of simulators (BIZON and PSAT). parallel and series compensations have been studied to improve voltage stability, some buses are nominated to locate both parallel and series FACTS to improve stability in the system. To find optimal location by using CPF and QV curves techniques.

(Acha & Kazemtabrizi, 2013)presented a new model of the STATCOM aimed at power flow solutions using the Newton–Raphson method. The STATCOM is made up of the series connection of a voltage-source converter (VSC) and its connecting transformer.

(Husein, AbdulFatah, & Sciences, 2016) simulated and analyzed the KR network, and used PSS™E software. The load flow analysis results appeared that the voltage at most nodes is below the permissible value (for example the lowest voltage is at Soran bus 0.8629 *p.u.*). To apply the SVC device; weak buses are founded and the SVC device is placed at this bus. Results show great improvement in the voltage profile (for example the lowest voltage after application of SVC is 0.9423 *p.u.*), and also reduce losses.

Reactive power support at local load centers may be provided by controllers for flexible alternating current transmission systems, according to (Singh and Agrawal, 2018). FACTS maintaining the voltages within the permissible operating limits would be much easier as a result. Because Facts controllers are expensive, the position of these devices inside the network must be carefully planned. The purpose of this paper is to minimize the real, active, and reactive system losses of the power system to improve the voltage profile and voltage profile distribution. The (SVC) in the FACTS Distribution System (DDS) helps to enhance the voltage stability of the system. This paper covers how to maximize voltage profiles, remove system losses, and manage fluctuations through the use of SVC and STATCOM technologies, both are described in detail in the following sections. The proposed approach was tested on both standards IEEE-9 and IEEE-30 bus systems to verify the accuracy of the PSAT simulator, which was both identical to previous results works on both systems. It has been optimized and validated that the major case loading points are the correct ones. A Newton–Raphson Power Flow equation was developed to maximize the voltage profile while simultaneously lowering losses.

(Motlanthe & Muremi, 2019) focused on the application of static var compensator (SVC) with shunt filters which improved the voltage level and reduced the total harmonic where non linear loads are connected. Power quality scans were performed. The network was modeled and analyzed using the DIgSILENT software. The THD was reduced below 5% with an improvement in voltage waveform. The use of SVC with localized shunt filters within the heavy industry environment reduced equipment failure.

3. Model of SVC/STATCOM Controllers

3.1. Static Var Compensator (SVC)

The Static VAR Compensator (SVC) is a shunt-connected static Var generator/load that adjusts its output to match the needed capacitive or inductive current. Figure 1 illustrates the basic structure of SVC. The model of an SVC can be viewed to consist of a controlled reactor and fixed capacitors. The bus reactive power injected (or absorbed) by the SVC can be continuously varied through appropriate coordination of the capacitors and the controlled reactor to control the voltage or maintain the desired power flow in the transmission network under normal operating or disturbance conditions (Musunuri & Dehnavi, 2010). Figure 2 shows the steady state characteristic of SVC, which indicates that if the value is between Bc max (for capacitor) and BI max (for inductor), the voltage is controlled at Vref. In practice, voltage drops of 1% to 4% at maximum reactive power production are used (Sengar, et al., 2015).

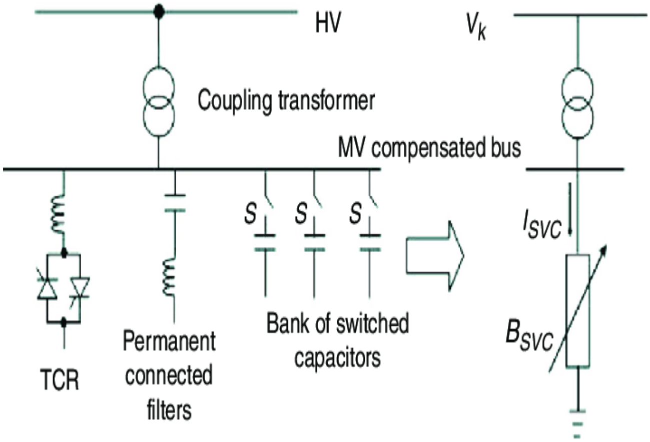

Figure (1): Basic structure of SVC

and V-I characteristic has the slope indicated in Figure 2 is described by the following three equations(Mali, Mahajan, & Science, 2017).

$$V = V_{Ref} + X_S . I \ldots\ldots\ldots\ldots\ldots\ldots \ldots\ldots (1)$$

SVC is in regulation range ($-B_{cmax} < B < B_{lmax}$)

$$V = -\frac{I}{B_{C\,max}} \ldots\ldots\ldots\ldots\ldots\ldots \ldots\ldots (2)$$

If SVC is fully capacitive ($B=B_{c\,max}$)

$$V = \frac{I}{B_{I\,max}} \ldots\ldots\ldots\ldots\ldots\ldots \ldots\ldots (3)$$

If SVC is fully inductive ($B=B_{l\,max}$)

where:

V: Positive sequence voltage (p.u)

V_{ref} : Reference voltage (p.u)

I : Reactive current (p.u/Pbase) (I > 0 indicates an inductive current)

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X_s: Slope or droop reactance (p.u/Pbase).

B_{Cmax}: Maximum capacitive susceptance

(p.u/Pbase) with all TCSs in service, no TSR or TCR.

B_{maxl}: Maximum inductive susceptance (p.u/Pbase) with all TSRs in service or TCRs at full conduction, no TSC (Bekri & Fellah, 2008).

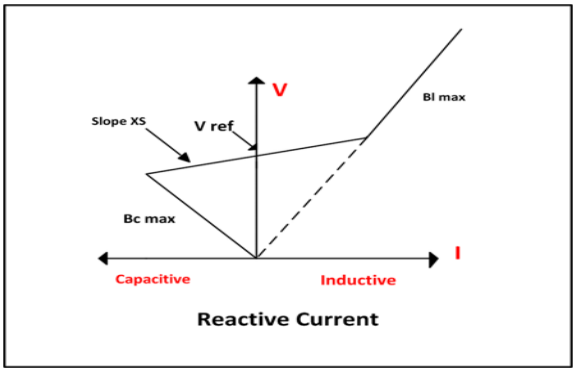

Figure (2): V-I characteristics of SVC

3.2. Static Synchronous Compensator (STATCOM)

The simplest structure of STATCOM is shown in Figure 3. For the DC side, the STATCOM comprises a coupling transformer, a voltage converter, and a storage source. The coupling transformer works as follows:

- Linking the system AC with STATCOM
- The link inductor has the advantage that the source DC is not short-circuited

A power inverter (CSI: current source inverter) can be used in the STATCOM, but because the current is unidirectional, it is recommended to use a voltage converter, which is essentially the most common. GTO or IGBT inverters can be used to make the STATCOM inverter (MERINI & GHERBI, 2014). Figure 4 shows the static V-I characteristic of STATCOM. When the voltage is low/high, STATCOM has a constant current characteristic. In comparison to SVC, this permits STATCOM to offer continuous reactive power at the limits. The STATCOM controls the current magnitude and angle from the DC source to the grid. The switches turn on and off to create an AC current. The angle of the current is a function of the ratio of the transmission line voltage to the STATCOM voltage. If the voltage on the transmission line (Vac) is less than the output voltage of the STATCOM bus(V), the current *Iac* will lead (Vac) by 90 degrees. The current will lag (*V)* if *Vt* is greater than *V*. The power delivered by the STATCOM is also a function of the difference between(V) and (Vac) (Mokhtari, Gherbi, Mokhtar, Kerrouche, & Aimer, 2014). The equations for the power transfer can be seen below.

$$P(\delta) = \frac{Vac\, V}{Xs}\delta \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

$$Q = \frac{Vac\,(Vac - V)}{Xs} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Where real power is *P*, reactive power is *Q*, transformer inductance is *Xs*, and the power angle between *Vac* and *V* is *δ*. Real power is a function of the phase shift between the two voltages. The *δ* is typically small and can be neglected in the reactive power transfer equation. As explained previously, the reactive power transfer is a function of the voltage difference between *Vac* and *V* over the transformer inductance.

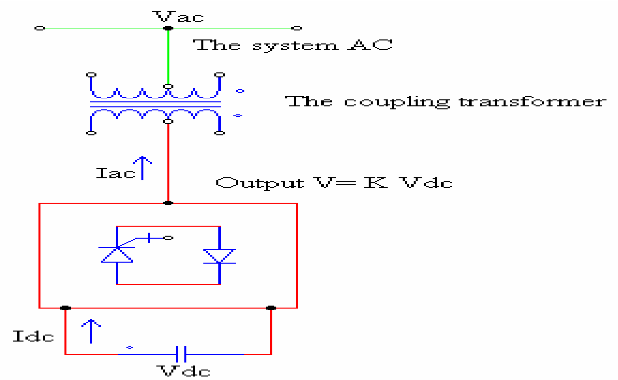

Figure (3): Basic structure of STATCOM

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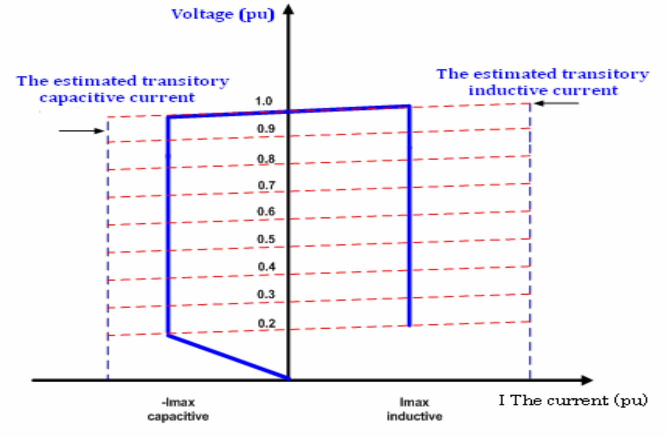

Figure (4): Static characteristic of STATCOM

4. Case Study

Generators, loads, transmission lines, and transformers are among the key components of the electrical network. All data for the generator, load, and transmission line parameters are defined per unit system and MVA base in this study. After the data has been collected, the Power System Analysis Toolbox (PSAT) program, which is based on MATLAB, is used. PSAT is a piece of educational software that is used to analyze and evaluate electrical power systems. In this paper, the simulated of 44-Bus 132 kV Kurdistan power system is used as the case study. The Kurdistan power system consists of 9 generating stations, 34 load stations, and 53 transmission lines. The simulation model is shown in figure 6.

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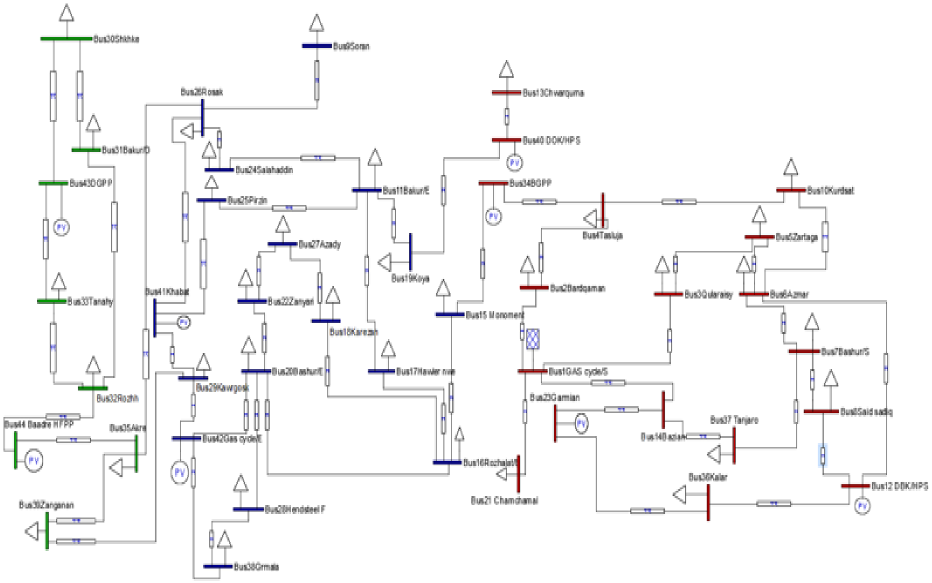

Figure (6): Line diagram of 44 buses of Kurdistan power system simulated with PSAT software

5. Methodology

5.1 Continuous Power Flow (CPF)

The continuation method is a mathematical path-following methodology used to solve systems of nonlinear equations. It may easily trace a solution branch around the turning point using the continuation approach (Ajjarapu, 2007). As a result, the continuation technique is attractive for estimating the critical point in a power system. At the voltage stability limit, the Jacobian matrix of power flow equations becomes singular. Continuation power flow overcomes this problem. According to a load situation, continuation power flow finds continuous load flow solutions (Keskin, 2007). CPF can solve the entire PV curve, and it is thought to be an effective and helpful technique for determining so-called P-V curves and maximum loading points as shown in figure 5. Voltage stability analysis is performed by starting from an initial stable operating point and then increasing the loads by the factor (λ) until a singular point of power flow linearization is reached. The loads are defined as: -

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$$PL = PL_o(1+\lambda) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

$$QL = QL_o(1+\lambda) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Where PL_O and QL_o are the active and reactive base loads, whereas *PL* and *QL* are active and reactive loads at bus L for the current operating point as defined by **λ.**

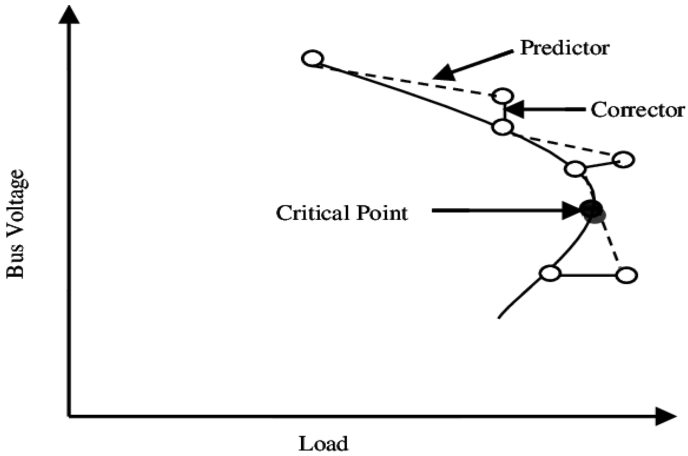

Figure (5): Principle of continuous Power Flow

5.2. Indexes-based Voltage Instability measure

The voltage sensitivity factor is represented by the absolute ratio of the per unit voltage change *dVi* to the total active power change *dP*total for the i^{th} bus in the power system of the study case, where it could be written as |*dVi/dPtotal*|. Knowing that the total active load change for any given bus is the same for all other buses in the same network, therefore the voltage stability factor can be considered as an index of the differential change of the voltage for the given i^{th} bus. The i^{th} bus that gives an index value (*dVi*) closest to 1, that i^{th} bus is considered a critical bus and may lead to instability in the system. As a result, the critical i^{th} bus is the weakest bus which is nominated to be the optimal location for placing the (SVC/STATCOM)(Amin, 2019).

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6. Simulation Results and Discussions

The bifurcation voltage curve or the voltage profile analysis is based on (the collapse curve or PV curve). The continuous power flow (CPF) program in the PSAT was used to determine the power flow, voltage profile, and voltage stability analysis. From the continuation power flow results which are shown in figure 7, it can be noted that bus Bus 9 (Soran), Bus 13 (Chwarqurna), Bus15 (Monoment), Bus 16(Rozhalat/E), Bus17(Hawlernew), Bus11(Bakur/E), Bus18(Karezan), Bus24(Salahaddin), Bus26(Rozak), Bus27(Azady), Bus20(Bashur/E), Bus22(Zanyari), Bus25(Pirzin), Bus28(HendsteelF) and Bus 40(Akre) are critical buses. Among these buses, buses (9,13,15) have the weakest voltage profile. Table (1) is explaining the voltage sensitivity factors, *|dVi/dPtotal|* for all buses in the network of the study case. Figures (7), (8) & (9) show the PV curves of Kurdistan power system for the buses (9, 13,15 ,16 ,17 ,11 ,18 ,24 ,26 ,27 ,20 ,22 ,25 ,28 and 40) without (SVC/STATCOM).

Table 1 Voltage Sensitivity Factors of buses Kurdistan power system.

No of Bus	Bus name	Voltage Sensitivity factor
1	Gas cycle/S	0
2	Bardqaman	0.000335788
3	Qularaisy	0.000411172
4	Tasluja	0.000440932
5	Zartaga	0.000781907
6	Azmar	0.001113511
7	Bashur/S	0.001917637
8	Said sadiq	0.002369054
9	Soran	0.015723046
10	Kurdsat	0.001031715
11	Bakur/E	0.013539097
12	DBK/HPS	0
13	Chwarqurna	0.016448623
14	Bazian	0.000444242
15	Monoment	0.020995964
16	Rozhalat/E	0.015693782
17	Hawlernew	0.015004439
18	Karezan	0.014488842
19	Koya	0.006348388
20	Bashur/E	0.01061131
21	Chamchmal	0.000301142

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22	Zanyari	0.013153293
23	Garmian	0
24	Salahaddin	0.012170546
25	Pirzin	0.011022868
26	Rosak	0.01002607
27	Azady	0.013364497
28	Hendsteel F	0.009826207
29	Kawrgosk	4.66578E-05
30	Shkhke	0.000498673
31	Bakur/D	0.000592984
32	Rozhhalat/D	0.000513179
33	Tanahy	0.000105366
34	BGPP	0
35	Akre	0.006189166
36	Kalar	0.000782426
37	Tanjaro	0.002253205
38	Grmala	0.003388043
39	Zanganan	0.005067727
40	DOK/HPS	0
41	Khabat	0
42	Gas cycle/E	0
43	DGPP	0
44	Baadre HFPP	0

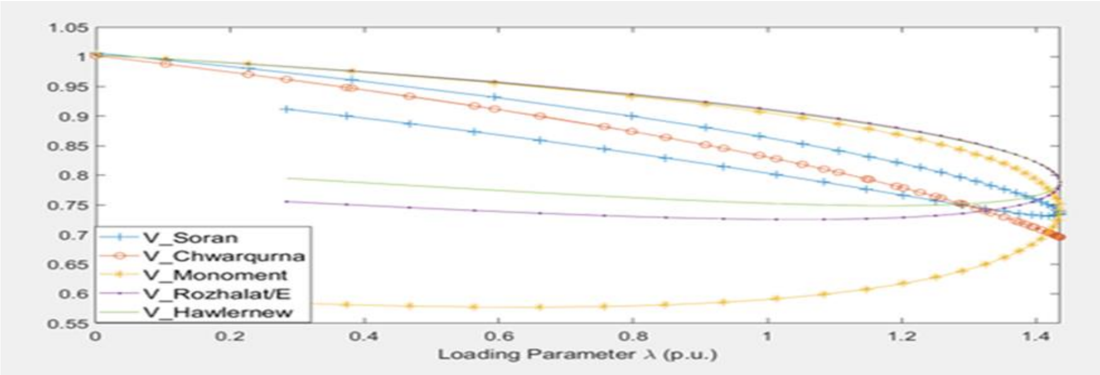

Figure (7): PV curves of the weakest buses No of 9,13,15,16,17

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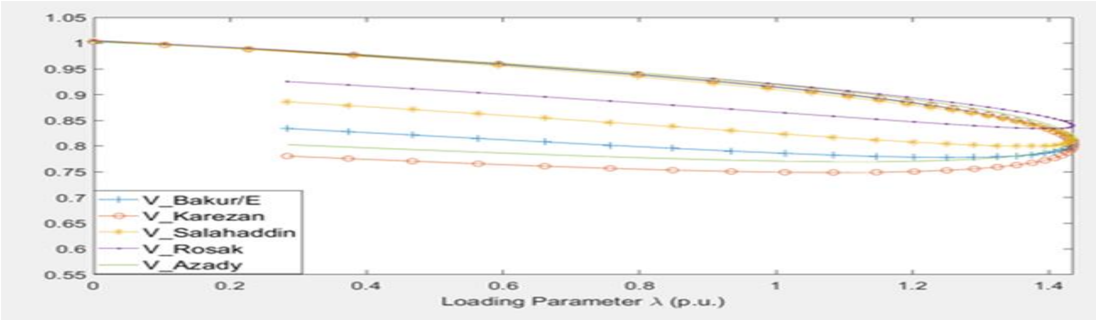

Figure (8): PV curves of the weakest buses No of 11,18,24,26,27

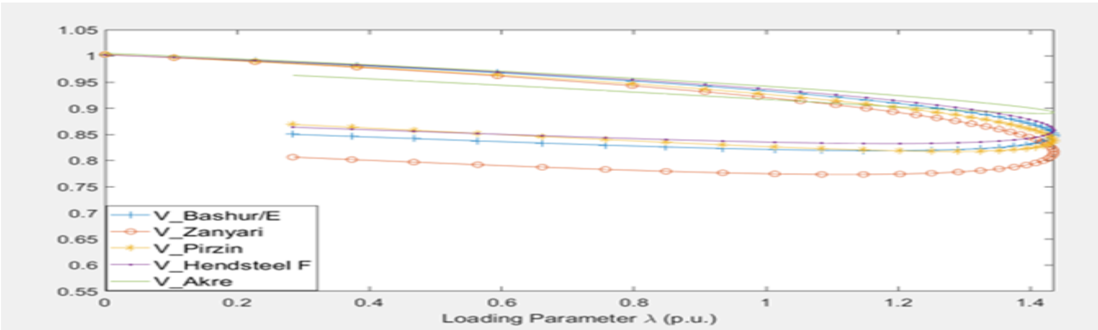

Figure (9): PV curves of the weakest buses No of 20,22,25,28,40

7. Effect of Insertion of SVC/STATCOM at bus 9(SORAN)

Based on the results obtained, the best place for (SVC/STATCOM) is bus 9 (SORAN) because it improves 15 buses (weak buses). This will reduce the total losses in the system as a whole. Figure 11 presents the voltage profile of 44 buses in three cases (without SVC/STATCOM, with SVC & with STATCOM), it noticed there are differences between the voltage of each bus. while when the SVC/STATCOM is placed in bus 9 (SORAN), the voltage of the majority of the buses is enhanced, and the per-unit voltage of the bus at SORAN has been raised from (0.73430 to 0.80666 *p.u.*) with SVC which represents 8.9% rise. While using STATCOM, the voltage is risen from (0.73430 to 0.86332*p.u.*), which is about a 12.9% rise. Table (2) and figures (11, 12, 13) show the Voltage profile of Bus-9 before and after insertion of SVC / STATCOM.

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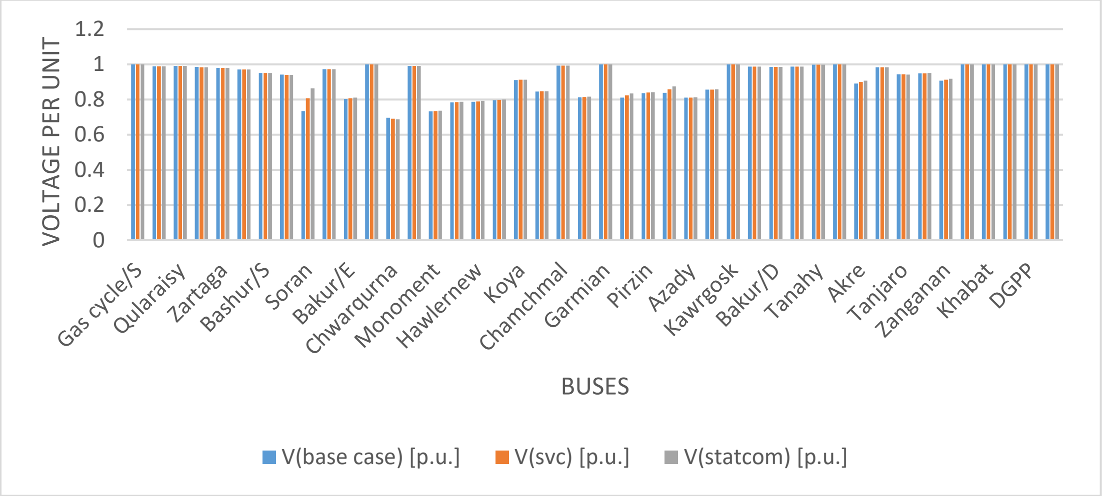

Figure (10): Bus voltage for 44-bus Kurdistan power system with/without (SVC/STATCOM) in bus-9

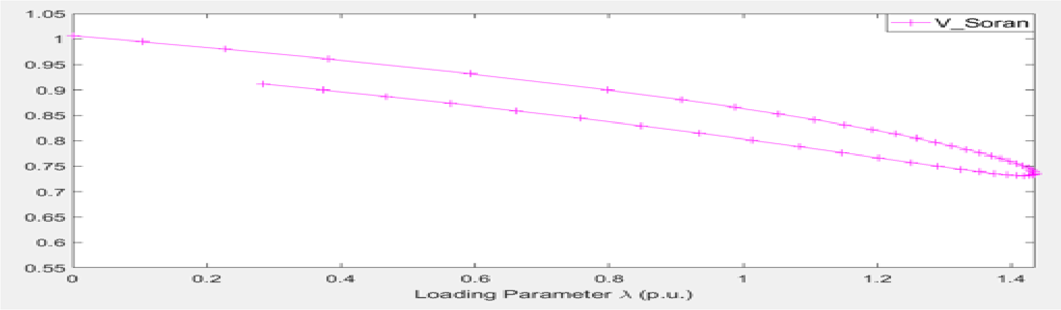

Figure (11): PV curve of Kurdistan power system without (SVC/STATCOM) in bus 9

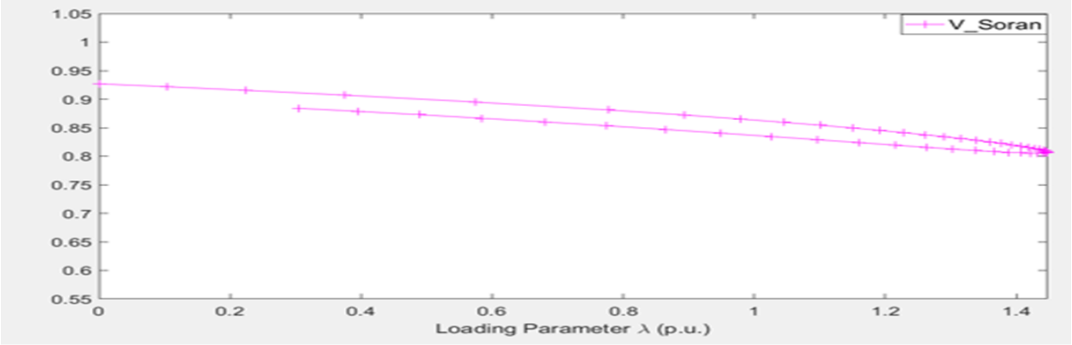

Figure (12): PV curve of Kurdistan power system with (SVC) in bus 9

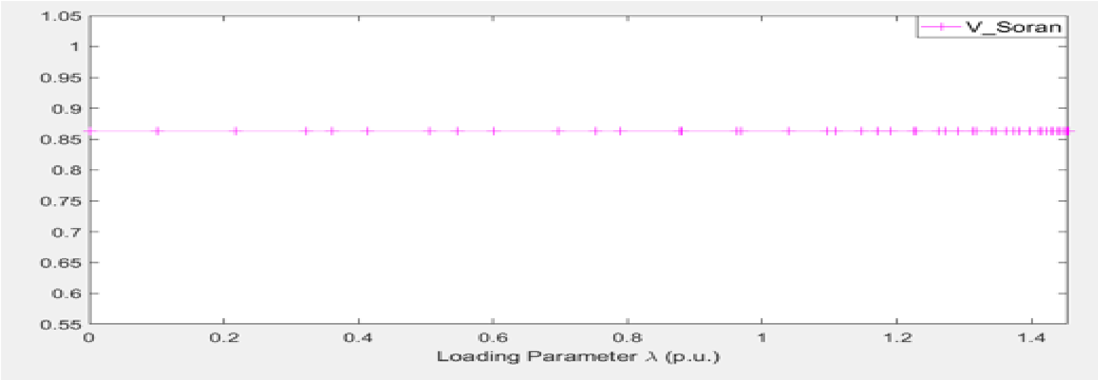

Figure (13): PV curve of Kurdistan power system with (STATCOM) in bus 9

Table (2): Voltage profile of Bus-9 before and after insertion of SVC/STATCOM

No	No of Bus	Bus Name	V (p.u) Base case	V (p.u) with SVC	V (p.u) with STATCOM
1	9	Soran	0.7343099	0.806664	0.863326
2	11	Bakur/E	0.8030821	0.806842	0.810443
3	15	Monoment	0.7331633	0.734643	0.736855
4	16	Rozhalat/E	0.7827762	0.784474	0.786609
5	17	Hawlernew	0.7867158	0.789436	0.792315
6	18	Karezan	0.7965667	0.797952	0.799792
7	19	Koya	0.9109475	0.912021	0.913233
8	20	Bashur/E	0.8459786	0.846661	0.847766
9	22	Zanyari	0.8126122	0.813699	0.815245
10	24	Salahaddin	0.809985	0.823769	0.834953
11	25	Pirzin	0.8361575	0.839027	0.841811
12	26	Rosak	0.8381281	0.858664	0.874933
13	27	Azady	0.8098948	0.811021	0.812606
14	28	Hendsteel F	0.8558684	0.856427	0.857394
15	35	Akre	0.8911758	0.900278	0.90757

Also, the total active and reactive power losses had been reduced. The total active reduction was from (3.20943 to 3.20390 *p.u.*) with SVC or it's around 0.38% of reduction but with STATCOM the reduction was from (3.20943 to3.19861 *p.u.*) or around 1.34 % of reduction. While the total reactive had been reduced from (15.13793 to 15.09542 *p.u.*) with SVC which is around 0.28 % while with STATCOM it

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is reduced from ((15.13793 to 15.04656 *p.u.)* which is around 0.60% reduction. The results of the examination are shown in figure 14.

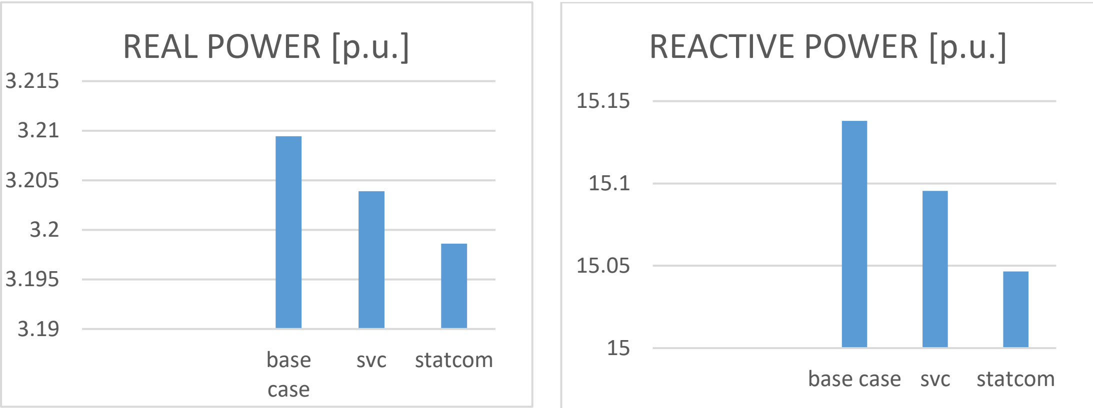

Figure 14: Total P, Q losses with/without (SVC/STATCOM) at bus 9(Soran)

8. Conclusion

The power demand is rising daily. As a result, maintaining power quality while the load rises have been a challenging challenge. Because system redesign is extremely expensive, it is important to maintain tight control over the power system's characteristics to achieve maximum efficiency. So (SVC/STATCOM) must be used most effectively and feasible and both improve the voltage profile and reduce the active and reactive power losses in the system. In this paper, suitable models for the SVC and STATCOM in steady-state studies are presented and in detail discussed. The best location of (SVC/STATCOM) is determined for the 44-bus Kurdistan power system based on PV curves that identify the weak bus. The results of simulations on the 44-Bus Kurdistan power system have intelligently shown how STATCOM/SVC devices increased the buses' voltage profile and decreased the total active(P) and reactive(Q) power. the results of simulations also show that with the insertion of STATCOM, improving the voltage profile is more than the case when the SVC is put in the system.

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Appendix(A): Continuation power flow results of Kurdistan power system

Table (A-1): Bus voltage magnitude and phase angle.

Bus	Bus Name	V[p.u.]	Phase [rad]
Bus 01	Gas cycle/S	1	0
Bus 02	Bardqaman	0.988008811	-0.002826537
Bus 03	Qularaisy	0.990070626	-0.006405179
Bus 04	Tasluja	0.984201531	0.003143277
Bus 05	Zartaga	0.980004846	-0.014244319
Bus 06	Azmar	0.971256155	-0.018497989
Bus 07	Bashur/S	0.951334575	-0.030658534
Bus 08	Said sadiq	0.9410518	-0.054122198
Bus 09	Soran	0.734309925	-1.578195809
Bus 10	Kurdsat	0.972221707	-0.016681632
Bus 11	Bakur/E	0.803082135	-1.251293306
Bus 12	DBK/HPS	1	0.01096176
Bus 13	Chwarqurna	0.695707316	-1.900608151
Bus 14	Bazian	0.990006642	0.005751244
Bus 15	Monoment	0.733163267	-1.022841429
Bus 16	Rozhalat/E	0.782776192	-1.088267647
Bus 17	Hawlernew	0.786715795	-1.179564377
Bus 18	Karezan	0.79656671	-1.063470974
Bus 19	Koya	0.910947519	-1.542281343
Bus 20	Bashur/E	0.845978575	-0.985362925
Bus 21	Chamchmal	0.992002489	-0.011121143
Bus 22	Zanyari	0.812612243	-1.036743936
Bus 23	Garmian	1	0.241609765
Bus 24	Salahaddin	0.809984955	-1.355660295
Bus 25	Pirzin	0.836157523	-1.265525304
Bus 26	Rosak	0.838128144	-1.390396124
Bus 27	Azady	0.809894813	-1.041264518
Bus 28	Hendsteel F	0.855868427	-0.970281067
Bus 29	Kawrgosk	0.999057567	-1.230271748
Bus 30	Shkhke	0.987322256	-1.452495926

Bus31	Bakur/D	0.984944089	-1.450493153
Bus32	Rozhhalat/D	0.987114526	-1.444243102
Bus33	Tanahy	0.997403929	-1.448582182
Bus34	BGPP	1	0.036026718
Bus35	Akre	0.891175837	-1.416051571
Bus36	Kalar	0.983242896	0.17810402
Bus37	Tanjaro	0.943089048	-0.025459896
Bus38	Grmala	0.949289105	-0.863839861
Bus39	Zanganan	0.907443837	-1.373062993
Bus40	DOK/HPS	1	-1.651883943
Bus41	Khabat	1	-1.230386102
Bus42	Gas cycle/E	1	-0.809319016
Bus43	DGPP	1	-1.44718629
Bus44	Baadr HFPP	1	-1.384595551

Table(A-2): indicates the global summary report.

TOTAL GENERATION	
REAL POWER [p.u.]	30.28503
REACTIVE POWER [p.u.]	28.77546
TOTAL LOAD	
REAL POWER [p.u.]	27.07559
REACTIVE POWER [p.u.]	13.63752
TOTAL LOSSES	
REAL POWER [p.u.]	3.209433
REACTIVE POWER [p.u.]	15.13793

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پوختە:

زیادبوونی خواست لەسەر کارەبا وایکردووە سیستەمی کارەبا لە ئاستێکی کارایی کەمتردا کاربکات. لەگەڵ ئەو کارە زۆرانەی کە بۆ باشترکردنی تۆڕی کارەبا ئەنجام دراون، ناهاوسەنگی ڤۆڵتیە و باری زۆری هێڵەکان بوونەتە کێشەیەکی چالاک بۆ چارەسەرکردن. دەتوانرێت کۆنترۆڵی ڤۆڵتیە لە بەرهەمهێنان و گواستنەوە و بەکارهێنانی کارەبادا دیاری بکرێت. کاتێک سیستەمی کارەبا لە ژێر فشاردایە، ناهاوسەنگی کارەبای کارلێککەر بەشدارییەکی بەرچاو دەکات لە ناسەقامگیری ڤۆڵتیە. بۆ ئەوەی زۆرترین کارایی سیستەمێکی کارەبا هەبێت، ئامێرەکانی سیستەمی سیستەمی گواستنەوەی نەرم (FACTS) دەبێت بە کاریگەرترین و جێبەجێکراوترین شێوە بەکاربهێنرێن. ئامێرەکانی FACTS وەکو قەرەبووکەرەوەی ئیستاتیک var (SVCs) و قەرەبووکەرەوەی هاوکاتی ئیستاتیک (STATCOMs) دەتوانن ناسەقامگیری لە هێڵە قورسەکاندا کەم بکەنەوە، کە لە ئەنجامدا زیانەکانی سیستەم کەمترە و متمانەپێکراوی تۆڕێکی نایابتر دەبێت.

لەم توێژینەوەیەدا کۆنترۆڵکەری FACTS وەک SVC و STATCOM لە تۆڕی سیستەمی کارەبای کوردستاندا جێگیرکراون بۆ باشترکردنی پرۆفایلی ڤۆڵتیە و کەمکردنەوەی زیانەکانی سیستەم و تێچووی سیستەمەکە کە بە بەکارهێنانی نەرمەکاڵای PSAT لەسەر بنەمای MATLAB هاوشێوە کراوە. جگە لە بەراوردکردنی گرافیکی ئەنجامەکان دەخرێنەڕوو بۆ لێکۆڵینەوە لە کاریگەریی شێوازە پێشنیار کراوەکان.

الملخص:

دفعت الزيادة في الطلب على الكهرباء نظام الطاقة للعمل بمستوى كفاءة أقل. مع العديد من الإجراءات المتخذة لتحسين الشبكة الكهربائية ، أصبح عدم توازن الجهد والحمل الزائد للخط من المشاكل الصعبة التي يجب معالجتها. يمكن تحديد التحكم في الجهد في توليد ونقل واستخدام الكهرباء. عندما يكون نظام الطاقة تحت الضغط ، فإن عدم توازن التيار التفاعلي يساهم بشكل كبير في عدم استقرار الجهد. لتعظيم كفاءة نظام الطاقة ، يجب استخدام أجهزة أنظمة النقل المرنة (FACTS) بشكل أكثر فاعلية وجدوى. يمكن لأجهزة FACTS مثل معوضات varالثابتة (SVCs) والمعوضات المتزامنة الثابتة (STATCOMs) أن تقلل من عدم الاستقرار في الخطوط المثقلة بالأعباء ، مما يؤدي إلى انخفاض خسائر النظام وزيادة موثوقية الشبكة الممتازة.

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في هذا البحث ، تم دمج وحدة تحكم FACTS مثل SVC و STATCOM في شبكة نظام الطاقة في كردستان لتحسين ملف تعريف الجهد وتقليل خسائر النظام وتكلفة النظام المحاكى باستخدام برنامج PSAT القائم على MATLAB. بالإضافة إلى المقارنات الرسومية للنتائج المقدمة للتحقيق في فعالية الأساليب المقترحة.