1934.5 kVAr. The voltage constraints are assumed to be 0.95 p.u and 1.00 p.u.

The results from the base case load flow are as follows:

The maximum voltage was obtained at the 1st bus which is also the slack bus. The voltage magnitude at the slack bus was found to be 1.000 p.u. The minimum voltage was obtained at the 27th bus. The voltage magnitude at this bus was found to be 0.8894 p.u. The total real power injected at the slack bus is 4821.61 kW and the total reactive power injected at the slack bus is 2927.26 kVAr. The total real power loss was found to be 221 kW. The annual cost for real power loss per kW is $ 168. So the annual cost for a real power loss of 221 kW was found to be $ 37128.

Fig 2 shows the plot between bus numbers in x-axis and their corresponding voltage magnitudes in the y-axis. The voltage at the slack bus is 1.000 p.u. The voltage magnitudes show a steady decrease from the first bus until the 12th bus. The decrease in the voltage at the buses and the power losses are due to the deficient amount of reactive power. However there is a steep rise in the plot between bus 12 and bus 13. This is due to the fact that bus 13 is connected directly to bus 3 rather than bus 12. Same way there is a rise in the plot between bus 27 and bus 28. This is due to the fact that bus 28 is connected directly to bus 7 rather than bus 27.

The total real power load connected at bus 34 is 57 kW. The total real power load connected at bus 33 is 114 kW. The total real power injected at bus 34 is 57 kW. The total real power injected at bus 33 is 114.003 kW. The difference between total real power load and the total real power injected at bus 33 is 0.003 kW. This is the transmission loss which is occurring between bus 33 and bus 34.

After Capacitor Placement

The load flow results after capacitor placement is discussed below:

The maximum voltage was obtained at the 1st bus which is also the slack bus. The voltage magnitude at the slack bus was found to be 1.000 p.u. The minimum voltage was obtained at the 32nd bus. The voltage magnitude at this bus was found to be 0.9555 p.u. Thus by capacitor placement the voltage profile at buses has significantly improved. The total real power injected at the slack bus is 3856.631 kW and the total reactive power injected at the slack bus is 2406.144 kVAr. The total real power loss after capacitor placement was found to be 162.4 kW. The annual cost for real power loss per kW is $ 168. So the annual cost for a real power loss of 162 kW was found to be $ 27216. The decrease in the real power loss after capacitor placement is 59 kW. The decrease in the cost of the real power loss occurred is $ 9912. Thus by capacitor placement the real power losses was reduced considerably.

Table 1 shows the different locations at which capacitor banks have been placed. The candidate locations chosen for capacitor placement after sensitivity analysis are buses 4, 5, 6, 28 and 29. The cost of capacitor banks at these locations are $ 350, $ 800, $ 600, $ 900 and $ 1050 respectively.

ORDER	BUS NO.	SIZING
1	4	350
2	5	800
3	6	600
4	28	900
5	29	1050

Table 1: Capacitor Locations and Sizing

Fig 2 shows the comparison between voltage magnitudes before and after capacitor placement. Though the maximum voltage magnitude remains at 1.000 p.u, there was a significant improvement in the voltage magnitudes at every other bus. Fig 3 shows the comparison between real power loss before and after capacitor placement. There is a significant loss reduction after placement of capacitors.

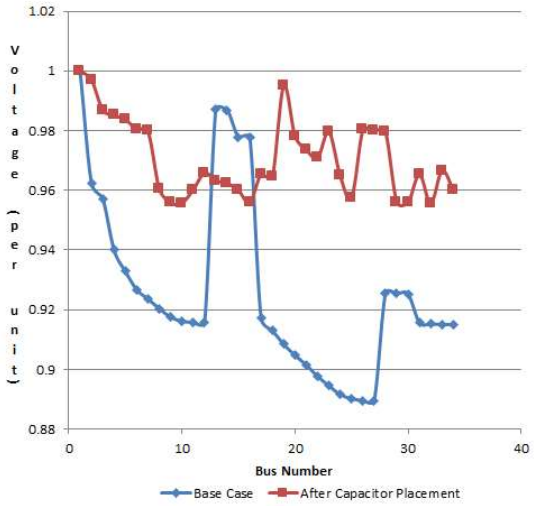

Figure 2: Comparison of voltage before and after Capacitor Placement

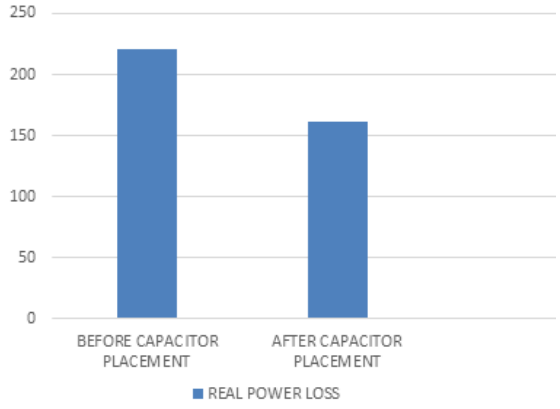

Figure 3: Comparison of Real Power Loss before and after Capacitor Placement

Table 2: Comparison with other methods

Items	*Un-Compensated*	*Compensated*			
		Su CT, Tsal CCA "fuzzy reasoning approach" IEE Proceedings 1996	Prakash, Sydulum, "PSO Approach" IEEE Proceedings 2007	R.Srinivasa Rao "PSGA method" ELSEIVER 2011	Proposed
Total Losses(kW)	221	168.47	168.8	161.7	162
Loss Reduction	-	23.999	24.85	27, 377	26.696
Total kVAr = ∑A		2700	2063	2039	3700
Total Annual Cost($)	37128	33182	29936	28484	28095
Net Savings($/year) = Annual Cost	-	4089	7306	8756	9912
% Savings	-	10.89	19.61	23.51	26.61

7. Conclusion

Overall kVA demand was reduced at each bus due to capacitor placement. The overall real power loss was reduced by optimal placement of capacitor and sizing in the 34 bus radial distribution network using Genetic Algorithm with Binary and Real Encoding. The effectiveness and superiority of our method was compared with methods used by other authors. Compared to the Fuzzy GA method [26] or PSO method [16] the losses occurred in our method is very less and almost the same as that to PGSA method [11]. The annual cost per year is the least compared to the other methods and the net savings is the highest compared to other methods. The comparison results confirmed the effectiveness and the superiority of our proposed method over other techniques. Thus our objective was achieved in this project.

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