Title of the study	**Installation of switched capacitors on 11 KV feeders**
Site address	**Doddaballapur sub-division, Bangalore Electricity Supply Company Limited**
Period of study	**January 08 to October 08**
Rating	*** * ***

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1. Introduction

Most of the electrical equipments connected to a power supply not only require active power but also certain amount of reactive power. Magnetic fields in Motors and Transformers are maintained by reactive current. Also series inductance in transmission lines implies consumption of reactive power. Hence it is imperative that in an electrical system, the feeder lines cater considerable amount of reactive power in addition to the active power carried by them. Shunt capacitors are employed to compensate the reactive power generated in the system to alleviate the ill effects of reactive components and will benefit the system in:-

a) Improving the voltage profile

b) Reduction of line current resulting in reduction of system losses

c) Increased line efficiency resulting in optimum utilization of designed capacity

Doddaballapur sub-division of Bescom, the pilot site selected for implementation of DRUM initiative receives its power requirement through 56 nos 11KV feeders emanating from five 66/11 KV substations spread over entire Taluk of Doddaballapur. Even though about 60% load is consumed by industrial consumers the consumption from the agricultural loads amount to 25% of the total load. The feeders feeding to the irrigation pump sets (IP sets) work at a low PF due to the nature of load which are predominantly catering to agriculture loads.

2. Scheme Profile

To address this problem the DPR for DRUM initiative at D.B Pur envisaged installation of a total 63 nos of capacitors banks of 600 KVAR each on various 11KV feeders.

Switched capacitors were proposed as the power supply on the rural feeders are staggered as per the policy of the State

Government and the 3 phase power supply is given for a restricted period of 8 to 10 hours in a day. The agricultural pump sets which are the predominant loads on all rural feeders work only during this period during which reactive power compensation is required.

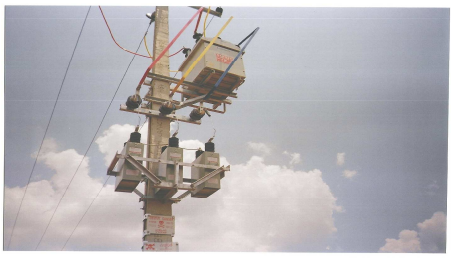
The equipment consists of a set of 3 capacitor units for each phase and an 11KV on-load switch for operating the capacitor bank.

A simple pole mounting design has been selected and the equipments are mounted on single 9 meter RCC poles.

3. Implementation

Single pole mounted Capacitor Bank at project site

Out of the existing 56 feeders 32 feeders were selected for installation of capacitors, 19 of which are rural feeders, one industrial feeder and one feeder catering to combined urban as well as rural loads.



Close up view of Capacitor Bank at project site

Work was carried out through turnkey contract at a total cost of 146.16 lakhs which is 6.32% below the DPR cost. The work was completed in 3 months time

4. Results

Three feeders were selected for conducting the sample study. The feeders are DF 2 and DF 6 of "D" Cross sub-station and KF 8 of KIADB sub-station. The data of the feeders for nine months was obtained. The period covers three months prior to the installation of capacitors and six month after commissioning of capacitors.

Feeder: DF 2
Feeder Length: 21.46 Kms
Distance of Location from "D" Cross SS: 6 Km
Conductor: Rabbit

Results of DF 2 feeder at Doddaballapur					
Month	**Morning Peak**		**Evening Peak**		**Avg.PF**
	Current	**MW**	**Current**	**MW**	
January 08	140.00	2.30	140.00	2.30	0.828
February 08	140.00	2.30	130.00	2.10	0.832
March 08	140.00	2.30	140.00	2.40	0.811
April 08	140.00	2.30	120.00	2.00	0.864
May 08	120.00	2.00	110.00	1.80	0.918
June 08	120.00	2.00	110.00	1.80	0.903
July 08	110.00	1.80	120.00	2.00	0.891
August 08	60.00	0.80	70.00	1.10	0.922
Average peak load from Jan.08 to April. 08 (before installation of capacitors)	140.00		132.50		
Average peak load from May.08 to July 08 (after installation of capacitors)	116.67		113.33		
Reduction in peak current	**17%**		**14%**		

Feeder: DF 6
Feeder Length: 6.48 Kms
Distance of Location from "D"Cross SS: 1.5 Km
Conductor: Rabbit

Results of DF6 feeder at Doddaballapur					
Month	**Morning Peak**		**Evening Peak**		**Avg.PF**
	Current	**MW**	**Current**	**MW**	
January 08	200	3.2	200	3.2	Previous data not available in the meter. Present Average PF-0.96
February 08	190	3.1	200	3.2	
March 08	190	3.1	200	3.2	
April 08	180	3.0	190	3.1	
May 08	170	2.9	180	3.0	
June 08	160	2.7	180	3.0	
July 08	180	3.0	190	3.1	
August 08	160	2.8	160	2.8	
Average peak load from Jan.08 to April. 08 (before installation of capacitors)	190	3.1	198	3.2	
Average peak load from May.08 to July 08 (after installation of capacitors)	167	2.85	178	2.9	
Reduction in peak current	**12.1**		**10.1**		

Feeder: KF 8
Feeder Length 8.28Kms
Distance of Location from KIADB SS 2.5&3.8 Km
Conductor: Rabbit

Results of KF 8 feeder at Doddaballapur					
Month	**Morning Peak**		**Evening Peak**		**Avg.PF**
	Current	**MW**	**Current**	**MW**	
January 08	110	1.9	110	1.9*	Previous data not available in the meter. Present Average PF-0.90
February 08	130	2.10	140	2.10	
March 08	110	1.9	110	1.9	
April 08	90	1.5	110	2.00	
May 08	100	1.8	110.00	.1.90	
June 08	70	1.2	80	1.3	
July 08	90	1.50	90	1.50	
August 08	70	1.2	80	1.30	
Average peak load from Jan.08 to April. 08 (before installation of capacitors)	110	2.0	118	2.0	
Average peak load from May.08 to July 08 (after installation of capacitors)	83	1.43	90	1.5	
Reduction in peak current	**24%**		**23%**		

A sample study was also conducted on the above three feeders by taking the instantaneous readings. The individual readings were taken with the capacitors ON & OFF the circuit. These instantaneous readings are considered for calculation of cost benefits as they reflect the correct savings of energy, whereas average values provided above will have many other factors viz.,

seasonal fluctuations, temporary change over of loads etc, influencing the results.

Sl. No	Particulars	Feeder DF2	Feeder DF6	Feeder KF8
1	Line current (in amps) without capacitor bank	129	135	176
2	Line current (in amps) with capacitor bank	114	118	154
3	Difference in current (in amps)	15	17	22
4	Percentage savings	12%	13%	13%

Reduction in line current is of order of 12-13 percent and so is the reduction in demand. This has also resulted in improvement of tail end voltages by 2 to 3%

5. Cost benefit analysis

The benefit from installation of capacitors will be in the form of reduction in loading of transmission and distribution network. This in turn results in reduction in energy losses. The pay back period has been worked out by considering the savings in terms power purchase cost to Bescom, which works out to 8.5 months. The benefits available from the transmission system are not considered as the same are in the KPTCL perview. Detailed calculations are furnished below:-

Installation of Capacitor Bank to 11KV Feeders at D.B Pur

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1	Line current (in amps) without capacitor bank	129	135	176
2	Line current (in amps) with capacitor bank	114	118	154
3	Difference in current (in amps)	15	17	22
4	Power Factor without capacitor bank	0.65	0.73	0.84
5	Power Factor with capacitor bank	0.87	0.96	0.90

6	Demand (in KVA) without capacitor bank 1.732*11KV *amps.	2458	2572	3353
7	Demand (in KVA) with capacitor bank	2171	2248	2934
8	Reduction in demand in KVA	287	324	419
9	% Reduction in Demand	11.7%	12.6%	12.5%
10	Feeder loss reduction* on 11KV side in kwh per day	133.59	290.32	490.02
11	Savings per day taking average purchase rate of Rs 2.75	Rs,367	Rs.798	Rs.1348
12	Total Savings/ month from all the three feeders	Rs.75,390		
13	Total Cost of 3 Capacitors Banks	5X 2,12,998 = 10,64,990		
14	Pay back period	14Months		

*For the calculation of feeders losses

- resistance of rabit conductor is considered
- line length of 4.5 KMs is considered
- Capacitor bank is assumed to work our 5 hours in a day.

6. Conclusion

Encouraged by the results, Bescom would consider installation of switched capacitors in place of fixed capacitors which are in use currently.

7. Guidelines for repeatability in other distribution areas

a. **Benefits: -** Since this is a simple devise and does not require any special skill or effort for execution and requires only a minimum shutdown of lines, the discoms can reap considerable benefit by executing such projects. By installing 63 capacitors banks on 31 feeders, the sub-division is benefited in terms of reduction losses and improved quality of power supply.

b. **Challenges: -** There are no major challenges in execution of the project. But continuous monitoring of functioning of the capacitors banks is required, which could pose some challenges to the field staff.

c. **Key pitfalls/precautions: -** It is desirable that a data logging facility is incorporated in the 11 KV monitoring switch to log the switching operations. It is essential that the operations are monitored regularly as any mis-operations of the capacitors not coming to the circuit at the pre set load results in non compensation of line losses and defeates very purpose of the scheme.