Energy Audit: A Case Study Of Electrical Machines Lab

Rishikesh.G, Harish Kumar.M.N, Gokulakrishnan.G, Praveenkumar.M

Abstract: The increase in machines lab all over Indian Engineering college's energy consumption has been more apparent than such increases in the industrial and transportation sectors. The main objective of this project is to analysis the energy consumption of the machine's lab in VIT. On an periodical monitoring of these energy meter daily at a particular time for one month we can able to find the power factor, active, reactive and apparent powers of that particular lab.Thus, we can able to give solutions on what basis the load can be decreased. What amount of capacitor should be placed in order to maintain the power factor and reactive power. Thus, by plotting the graph and comparing all the outputs of the above-mentioned monitoring process the total amount is calculated according to TNEB norms can also be calculated. And after placing the capacitor the amount in reduction of cost can also be calculated.

1. INTRODUCTION

Vitality is one of the significant contributions for the monetary advancement of any nation. On account of the creating nations, the vitality division expect a basic significance in perspective on the regularly expanding vitality needs requiring colossal ventures to meet them. For lessening cost and expanding productivity, at that point use vitality preservation, the executives and review. The target of Energy Management is to accomplish and keep up ideal vitality obtainment what's more, usage, all through the association as to limit vitality costs/squander without influencing creation and quality. To limit natural impacts. Vitality Audit is the way to a precise methodology for basic leadership in the territory of vitality the executives. It endeavors to adjust the all outvitality contributions with its utilization, and serves to recognize all the vitality streams in an office.

2. PRINCIPLE

At the point when the object of study is an involved structure at that point decreasing vitality utilization while keeping up or improving human solace, wellbeing and security are of essential concern. Past essentially distinguishing the wellsprings of vitality use, a vitality review looks to organize the vitality utilizes as indicated by the best to least savvy open doors for vitality investment funds.

3. METHODOLOGY

The readings had been taken manually will the machines in the lab is running (Fig1). We have taken the readings from the control panel of that particular lab which is shown in Fig2. We have calculated the reactive power of the total lab on a daily basis.Based on that the Capacitance required of a individual day is calculated.

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For a set of five days we have calculated the mean Capacitance KVAR that needs to be implemented in the lab so has to reduce the reactive power for a certain extent. Has the reactive power of the lab is reduced so that the electricity bill of our institute with respect to that of a particular lab has been reduced. The maximum demand of the lab has also been calculated from the electrical blueprint of the lab. The readings taken on different days has been shown in Table 1, Table 2, Table 3, Table 4 and Table 5.

Fig1. VIT Machines Lab

Fig.2 ControlPannel

4. TYPES OF ENERGY AUDIT

The term vitality review is usually used to portray an expansive range of vitality ponders running from a speedy stroll through of an office to recognize serious issue territories to a far reaching examination of the ramifications of elective vitality effectiveness estimates adequate to fulfill the money related criteria of modern financial specialists. Various review

methodology have been produced for non-private (tertiary) structures Audit is required to recognize the most proficient and financially savvy Energy Conservation Opportunities (ECOs) or Measures (ECMs). Vitality protection openings (or measures) can comprise in increasingly proficient use or of incomplete or worldwide substitution of the current establishment. When looking to the current review techniques created in IEA, by ASHRAE and by Krarti (2000), it gives the idea that the fundamental issues of a review procedure are:

- The examination of structure and utility information, including investigation of the introduced hardware and investigation of vitality bills;
- The review of the genuine working conditions;
- The comprehension of the structure conduct and of the connections with climate, inhabitance and working timetables;
- The choice and the assessment of vitality protection measures;
- The estimation of vitality sparing potential;
- The distinguishing proof of client concerns and needs.

Regular sorts/dimensions of vitality reviews are recognized underneath, despite the fact that the genuine assignments performed and dimension of exertion may change with the expert giving administrations under these expansive headings. The best way to guarantee that a proposed review will meet your particular needs is to explain those necessities in a point by point extent of work. Setting aside the effort to set up a formal sale will likewise guarantee the structure proprietor of getting focused and equivalent proposition. For the most part, four dimensions of examination can be plot (ASHRAE):

- Level 0 – Benchmarking: This first examination comprises in a starter Whole Building Energy Use (WBEU) investigation dependent on the investigation of the memorable utility use and costs and the correlation of the exhibitions of the structures to those of comparable structures. This benchmarking of the contemplated establishment permits deciding whether further examination is required;
- Level I – Walk-through review: Preliminary examination made to survey building vitality productivity to recognize straightforward and minimal effort upgrades as well as a rundown of vitality preservation measures (ECMs, or vitality protection openings, ECOs) to situate the future point by point review. This investigation depends on visual checks, investigation of introduced gear and working information and point by point examination of recorded vitality utilization gathered amid the benchmarking stage;
- Level II – Detailed/General vitality review: Based on the aftereffects of the pre-review, this sort of vitality review comprises in vitality use overview so as to give an extensive examination of the contemplated establishment, a progressively nitty gritty investigation of the office, a breakdown of the vitality use and a first quantitative assessment of the ECOs/ECMs chose to address the imperfections or improve the current establishment. This dimension of examination can include progressed nearby estimations and refined PC based reproduction devices to assess exactly the chose vitality retrofits;
- Level III – Investment-Grade review: Detailed Analysis of Capital-Intensive Modifications concentrating on potential expensive ECOs requiring thorough building study.

5. BENCHMARKING

The inconceivability of portraying every single imaginable circumstance that may be experienced amid a review implies that it is important to discover a method for depicting what comprises great, normal and terrible vitality execution over a scope of circumstances. The point of benchmarking is to respond to this inquiry. Benchmarking essentially comprises in contrasting the deliberate utilization and reference utilization of other comparative structures or produced by reenactment devices to recognize extreme or unsuitable running expenses. As referenced previously, benchmarking is additionally important to recognize structures exhibiting intriguing vitality sparing potential. A critical issue in benchmarking is the utilization of execution files to describe the structure. These lists can be:

- Comfort lists, contrasting the real solace conditions with the solace necessities;
- Energy records, comprising in vitality requests isolated by warmed/molded region, permitting examination with reference estimations of the files originating from guideline or comparable structures;
- Energy requests, legitimately contrasted with "reference" vitality requests produced by methods for recreation devices.

Commonly, benchmarks are set up dependent on the vitality outlets (loads) inside the structure and are then additionally parsed into "base loads" and "climate touchy burdens". These are built up through a straightforward relapse investigation of vitality utilization and request (whenever metered) corresponded to climate (temperature and degree - day) information amid the period for which utility information is accessible. Total base burdens will speak to as the capture of this relapse and the slant will commonly speak to the mix of structure envelope conduction and invasion misfortunes less misfortunes or additions from the base burdens themselves. For instance, while lighting is normally a base burden, the warmth produced from that lighting must be subtracted from the climate touchy cooling load got from the slant to pick up a precise image of the genuine commitment of the structure envelope on cooling vitality use and request.

6. WALK-THROUGH (OR) PRELIMINARY AUDIT

The primer review (on the other hand called a basic review, screening review or stroll through review) is the least complex and fastest kind of review. It includes negligible meetings with site-working faculty, a short survey of office service bills and other working information, and a stroll through of the office to get comfortable with the structure activity and to distinguish

any glaring zones of vitality waste or wastefulness. Normally, just serious issue regions will be secured amid this kind of review. Remedial measures are quickly portrayed, and speedy appraisals of usage cost, potential working cost reserve funds, and basic compensation periods are given. A rundown of vitality protection measures (ECMs, or vitality preservation openings, ECOs) requiring further thought is likewise given. This dimension of detail, while not adequate for achieving an official conclusion on actualizing proposed measure, is satisfactory to organize vitality effectiveness ventures and to decide the requirement for a progressively point by point review.

7. GENERAL AUDIT

The general review (on the other hand called a smaller than expected review, site vitality review or point by point vitality review or complete site vitality review) develops the starter review depicted above by gathering increasingly nitty gritty data about office activity and by playing out a progressively itemized assessment of vitality preservation measures. Service bills are gathered for a 12-to three-year time frame to enable the reviewer to assess the office's vitality request rate structures and vitality use profiles. In the event that interim meter information is accessible, the nitty gritty vitality profiles that such information influences conceivable will to ordinarily be dissected for indications of vitality squander. Extra metering of explicit vitality devouring frameworks is frequently performed to enhance utility information. Top to bottom meetings with office working faculty are led to give a superior comprehension of real vitality devouring frameworks and to pick up knowledge into short-and longer-term vitality utilization designs. This sort of review will almost certainly distinguish all vitality preservation estimates proper for the office, given its working parameters. A point by point money related examination is performed for each measure dependent on nitty gritty execution cost gauges, site-explicit working cost funds, and the client's venture criteria. Adequate detail is given to legitimize venture execution. The development of cloud-based vitality reviewing programming stages is empowering the directors of business structures to work together with general and forte exchanges contractual workers in performing general and vitality framework explicit reviews. The advantage of programming empowered joint effort is the capacity to distinguish the full scope of vitality effectiveness choices that might be pertinent to the particular structure under examination with "live time" cost and advantage gauges provided by neighborhood temporary workers.

8. INVESTMENT-GRADE AUDIT

In most corporate settings, moves up to an office's vitality framework must vie for capital financing with non-vitality related speculations. Both vitality and non-vitality ventures are evaluated on a solitary arrangement of money related criteria that for the most part stress the normal degree of profitability (ROI). The anticipated working investment funds from the execution of vitality ventures must be grown with the end goal that they give an abnormal state of certainty. Truth be told, financial specialists frequently request ensured funds. The speculation grade review develops the nitty gritty review depicted above and depends on a total designing investigation so as to detail specialized and financial issues important to legitimize the venture identified with the changes.

9. SIMULATION-BASED ENERGY AUDIT PROCEDURE FOR NON-RESIDENTIAL BUILDINGS

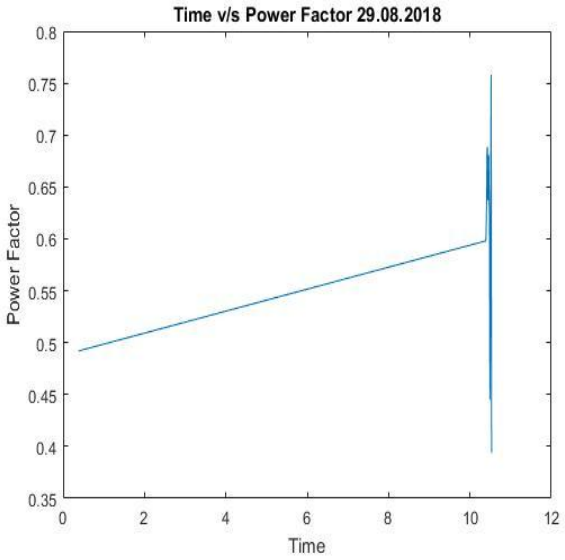
A total review method, fundamentally the same as the ones proposed by ASHRAE and Krarti (2000), has been proposed in the edge of the AUDITAC and HARMONAC ventures to help in the execution of the EPB ("Energy Performance of Buildings") order in Europe and to fit to the present European market. The accompanying system proposes to make a concentrated utilization of current BES apparatuses at each progression of the review procedure, from benchmarking to definite review and monetary investigation:

- Benchmarking stage: While standardization is required to permit examination between information recorded on the contemplated establishment and reference esteems found from contextual analyses or insights. The utilization of reenactment models, to play out a code-agreeable recreation of the establishment under examination, permits to survey straightforwardly the considered establishment, with no standardization required. To be sure, applying a recreation-based benchmarking instrument permits an individual standardization and permits maintaining a strategic distance from size and atmosphere standardization.
- Preliminary review organizes: Global month to month utilizations are commonly lacking to permit an exact comprehension of the structure's conduct. Regardless of whether the investigation of the vitality bills does not permit relating to exactness the diverse vitality customers present in the office, the utilization records can be utilized to align building and framework reproduction models. To survey the current framework and to recreate effectively the structure's warm conduct, the reenactment show must be aligned on the contemplated establishment. The emphases expected to play out the alignment of the model can likewise be completely coordinated in the review procedure and help in distinguishing required estimations and basic issues.
- Detailed review arranges: At this stage, nearby estimations, sub-metering and observing information are utilized to refine the adjustment of the BES device. Broad consideration is given to comprehension not just the working qualities of all vitality devouring frameworks, yet additionally circumstances that reason load profile minor departure from short-and longer-term bases (for example every day, week after week, month to month, yearly). At the point when the alignment criteria is fulfilled, the reserve funds identified with the chose ECOs/ECMs can be measured.
- Investment-grade review arrange: At this stage, the outcomes given by the adjusted BES apparatus can be utilized to evaluate the chose ECOs/ECMs and situate the point by point building study.

TABLE1 READINGS TAKEN ON 29.08.2018

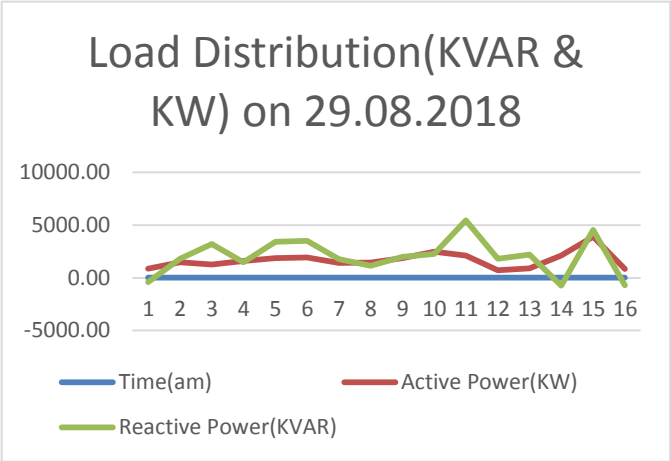
Time(am)	Voltage(V)	Current(A)	Power Factor	ϕ	sinϕ	Active Power(KW)	Reactive Power(KVAR)
10.38	407.4	4.208	0.492	60.52787925	-0.743051672	843.4548864	-1273.842608
10.39	407.5	6.056	0.598	53.27320792	0.133467727	1475.75636	329.3743265
10.40	406	4.986	0.614	52.12070561	0.959822648	1242.930024	1942.984344
10.41	405.9	6.163	0.64	50.2081805	-0.057270604	1600.999488	-143.2659483
10.42	405.1	6.716	0.688	46.52800069	0.561244852	1871.808301	1526.951706
10.43	407.7	6.836	0.688	46.52800069	0.561244852	1917.481594	1564.210282
10.44	406.5	5.381	0.637	50.43152093	0.165276615	1393.358831	361.5221842
10.45	405.3	5.477	0.641	50.13357254	-0.131527705	1422.909812	-291.9688965
10.46	404.3	6.716	0.681	47.07816392	0.045709949	1849.104863	124.1152542
10.47	404.5	9.562	0.64	50.2081805	-0.057270604	2475.41056	-221.5129011
10.48	403.4	8.363	0.62	51.68386553	0.988407566	2091.653204	3334.525569
10.49	403.7	3.997	0.445	63.57666123	0.67783078	718.0470605	1093.740223
10.50	404	4.188	0.518	58.80180918	0.776096006	876.431136	1313.11719
10.51	402.9	7.839	0.666	48.24091153	-0.898798871	2103.449845	-2838.706225
10.52	402.4	12.73	0.758	40.71180186	0.128545959	3882.894416	658.4833574
10.53	402.8	5.172	0.394	66.79637879	-0.733143682	820.8129504	-1527.344743
		Mean Power Factor	0.6075				
Energy Meter Readings: 144 to 145.1Wh							
		Time	0.25 hours				
		Kw	4.4				
		Angle	52.591				
		Kvar	5.7531				
		Improved Angle(PF=0.9)	25.8419				
		Improved Kvar	2.131				
		Capacitor Ratings Should be	3.6221				

GRAPH 1



GRAPH 1 shows the relation between the time and the power factor which is taken on a mentioned date of 29.08.2018

GRAPH 2

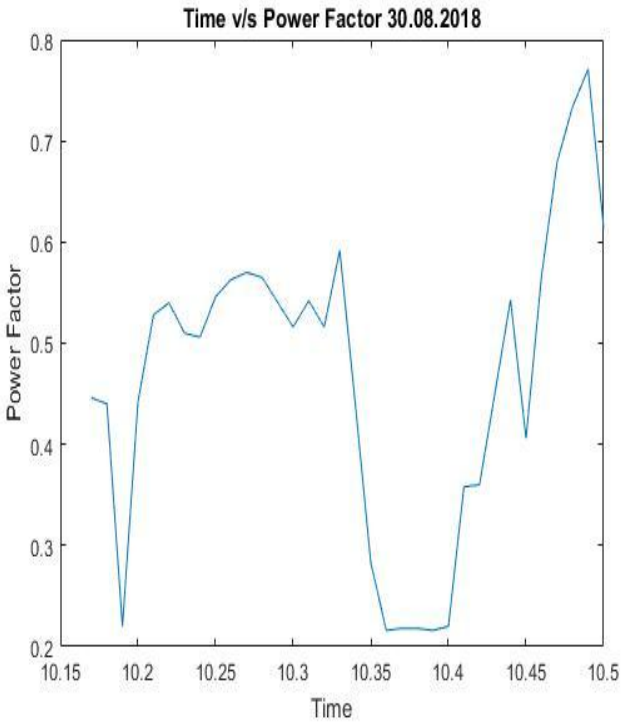


GRAPH 2 shows the relation between the Load Distribution in KW and KVAR which is taken on a mentioned date of 29.08.2018

TABLE 2 READINGS TAKEN ON 30.08.2018

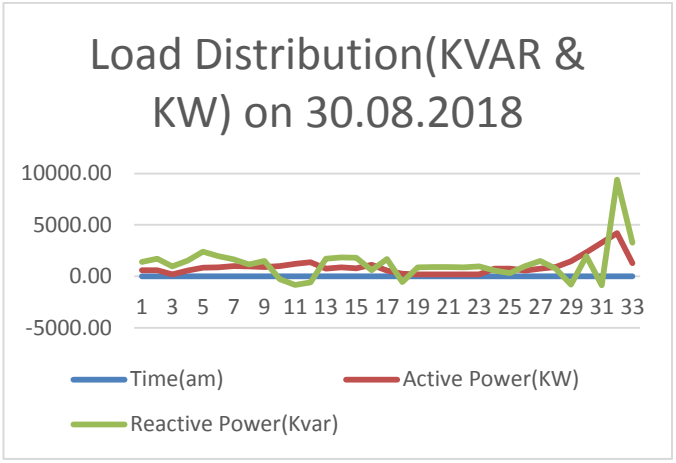
Time(am)	Voltage(V)	Current(A)	Power Factor	ϕ	sinϕ	Active Power(KW)	Reactive Power(Kvar)
10.17	413.50	3.133	0.446	63.51266376	0.629423185	577.790993	815.4149033
10.18	412.80	3.133	0.44	63.89611886	0.874432965	569.053056	1130.906252
10.19	413.30	1.987	0.22	77.29096701	0.948621161	180.669962	779.0334046
10.20	412.50	2.969	0.442	63.76844121	0.805541129	541.322925	986.5562899
10.21	412.30	3.77	0.528	58.12957778	0.999948857	820.707888	1554.291505
10.22	412.00	3.821	0.54	57.31636115	0.694477448	850.09608	1093.282511
10.23	411.00	4.662	0.51	59.33617026	0.346737114	977.20182	664.3767424
10.24	411.60	4.634	0.506	59.60224289	0.08790393	965.1213264	167.6639479
10.25	412.70	4	0.546	56.90697335	0.350687929	901.3368	578.9156334
10.26	412.10	4.22	0.563	55.73647731	-0.725795751	979.091906	-1262.203811
10.27	410.40	5.178	0.57	55.24977425	-0.963261613	1211.279184	-2046.980247
10.28	410.20	5.841	0.565	55.59770869	-0.813973008	1353.727683	-1950.261582
10.30	410.70	3.483	0.516	58.93568017	0.684982914	738.1215396	979.8462072
10.31	410.20	3.907	0.542	57.18010843	0.590308243	868.6370588	946.0583317
10.32	410.50	3.65	0.516	58.93568017	0.684982914	773.1357	1026.327024
10.33	411.30	4.624	0.592	53.70093691	-0.289650632	1125.89591	-550.8724023
10.34	412.60	3.078	0.44	63.89611886	0.874432965	558.792432	1110.514825
10.35	412.40	2.079	0.283	73.56066402	-0.964629165	242.6384268	-827.0533675
10.36	411.10	1.965	0.216	77.52579829	0.848962046	174.487284	685.8013039
10.37	410.20	1.945	0.218	77.40840952	0.905011527	173.928902	722.0534917
10.38	409.70	1.931	0.218	77.40840952	0.905011527	172.4664926	715.9824029
10.39	412.70	1.984	0.216	77.52579829	0.848962046	176.8601088	695.1274066
10.40	412.90	1.99	0.22	77.29096701	0.948621161	180.76762	779.4544976
10.41	412.70	5.03	0.358	69.02258012	-0.092326581	743.165398	-191.6589946
10.42	411.00	4.97	0.36	68.89980398	-0.213576429	735.3612	-436.2661636
10.43	411.20	3.006	0.451	63.19213897	0.352541789	557.4663072	435.7653422
10.44	410.60	3.374	0.543	57.11190369	0.533925066	752.2528692	739.6807789
10.45	411.30	5.314	0.406	66.04619252	-0.072682651	887.3731692	-158.8587063
10.46	410.50	6.231	0.567	55.45870954	-0.886607592	1450.287059	-2267.787509
10.47	409.50	8.389	0.679	47.23445115	-0.110336235	2332.565645	-379.0375702
10.48	408.10	10.9	0.734	42.77721518	-0.933868534	3265.04486	-4154.118061
10.49	405.80	13.37	0.771	39.5562269	0.959290046	4183.095966	5204.672273
10.50	407.70	5.098	0.614	52.12070561	0.959822648	1276.171124	1994.947799
		Mean Power Factor	0.464727273				
Energy Meter Readings: 147.8 to 148.8Wh							
	Time	0.55 hours					
	Kw	1.8182					
	Angle	62.3079					
	Kvar	3.4643					
	Improved Angle(PF=0.9)	25.8419					
	Improved Kvar	0.8806					
	Capacitor Ratings Should be	2.5837					

GRAPH 3



GRAPH 3 shows the relation between the time and the power factor which is taken on a mentioned date of 30.08.2018

GRAPH 4

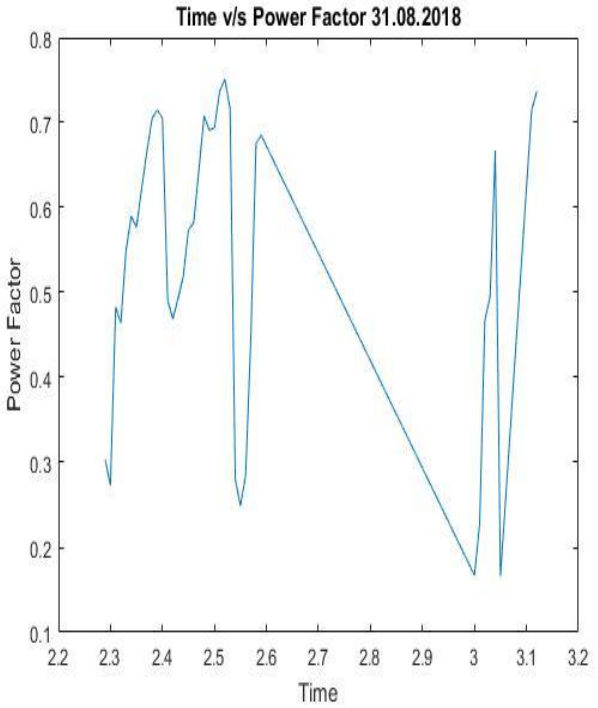


GRAPH 4 shows the relation between the Load Distribution in KW and KVAR which is taken on a mentioned date of 30.08.2018

TABLE 3 READINGS TAKEN ON 31.08.2018

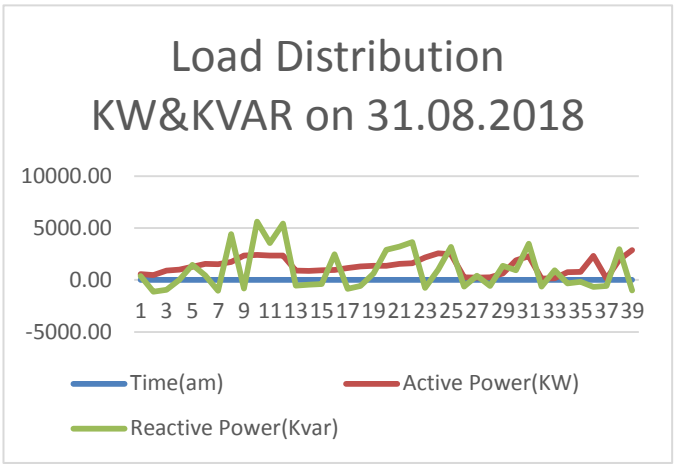
Time(am)	Voltage(V)	Current(A)	Power Factor	ϕ	sinϕ	Active Power(KW)	Reactive Power(Kvar)
2.29	405.6	4.577	0.303	72.3621205	-0.105293924	562.4986536	-195.4709263
2.30	405.2	4.178	0.273	74.15713739	-0.946136267	462.1686888	-1601.738307
2.31	406.1	4.581	0.483	61.11847925	-0.989853036	898.5462003	-1841.467255
2.32	405.1	5.356	0.464	62.35447705	-0.459450131	1006.748038	-996.8761171
2.33	406.3	5.701	0.55	56.63298703	0.084219387	1273.973965	195.0787389
2.34	404.9	6.514	0.59	53.8429918	-0.422241541	1556.135974	-1113.669918
2.35	406.4	6.415	0.577	54.76018593	-0.976399926	1504.271312	-2545.529285
2.36	406.1	6.886	0.622	51.53766738	0.955745927	1739.363661	2672.652307
2.37	405.8	8.674	0.666	48.24091153	-0.898798871	2344.259527	-3163.690416
2.38	406.7	8.454	0.705	45.17045595	0.927683094	2423.960469	3189.59879
2.39	405.5	8.117	0.715	44.35680084	0.365810662	2353.382103	1204.045125
2.40	409.1	8.153	0.705	45.17045595	0.927683094	2351.451572	3094.187048
2.41	412.5	4.416	0.491	60.59367011	-0.785441853	894.4056	-1430.76088
2.42	416.3	4.469	0.469	62.03059607	-0.718231288	872.5485643	-1336.229593
2.43	419.3	4.53	0.493	60.46204567	-0.697415781	936.418497	-1324.69176
2.44	415.4	4.438	0.519	58.73480265	0.816578067	956.7999588	1505.398575
2.45	415.2	4.875	0.574	54.97036838	-0.999971852	1161.8334	-2024.043026
2.46	415.4	5.345	0.582	54.40866472	-0.84232879	1292.222166	-1870.233563
2.47	413.1	5.15	0.644	49.90925975	-0.348736572	1370.08746	-741.9248504
2.48	410.5	4.67	0.708	44.92757806	0.810661441	1357.26078	1554.066356
2.49	410.2	5.476	0.691	46.29068025	0.740093616	1552.162343	1662.439134
2.50	411.3	5.643	0.694	46.05241639	0.877906971	1610.750335	2037.592144
2.51	412	7.121	0.737	42.52351525	-0.993732941	2162.248924	-2915.465377
2.52	411.1	8.299	0.751	41.32292462	-0.463747277	2562.200894	-1582.175351
2.53	411.9	8.343	0.717	44.1926529	0.20880782	2463.957379	717.5642537
2.54	415	2.194	0.28	73.73979529	-0.996162767	254.9428	-907.0161609
2.55	413.9	2.221	0.249	75.58165476	0.182404157	228.8987031	167.6790157
2.56	415.7	2.205	0.285	73.44115141	-0.926318485	261.2362725	-849.0806605
2.57	415.8	3.347	0.448	63.38456174	0.524994519	623.4738048	730.6257366
2.58	416	6.71	0.676	47.46814583	-0.337496448	1886.95936	-942.0740859
2.59	416.4	8.065	0.685	46.76439285	0.351803388	2300.41221	1181.449358
3.00	418.8	1.952	0.167	80.38656171	-0.962167054	136.5220992	-786.5692576
3.01	418.4	1.859	0.228	76.82064807	0.989013062	177.3396768	769.2598977
3.02	418.2	3.767	0.468	62.09544966	-0.671627587	737.2681992	-1058.054832
3.03	418.2	3.797	0.495	60.33024966	-0.597186814	786.013173	-948.2761672
3.04	417.2	8.358	0.667	48.16405653	-0.862488613	2325.800719	-3007.461224
3.05	418.1	1.821	0.166	80.44466858	-0.944720275	126.3857766	-719.2723232
3.11	415.3	6.58	0.715	44.35680084	0.365810662	1953.86191	999.6412847
3.12	414.1	9.369	0.737	42.52351525	-0.993732941	2859.341037	-3855.388574
		Mean Power Factor	0.538179487				
	Energy Meter Reading: 151.7 to 153.3						
	Time	0.7169 hours					
	Kw	2.2318					
	Angle	57.4388					
	Kvar	3.495					
	Improved Angle(PF=0.9)	25.8419					
	Improved Kvar	1.0809					
	Capacitor Ratings Should be	2.4141					

GRAPH 5



GRAPH 5 shows the relation between the time and the power factor which is taken on a mentioned date of 31.08.2018

GRAPH 6

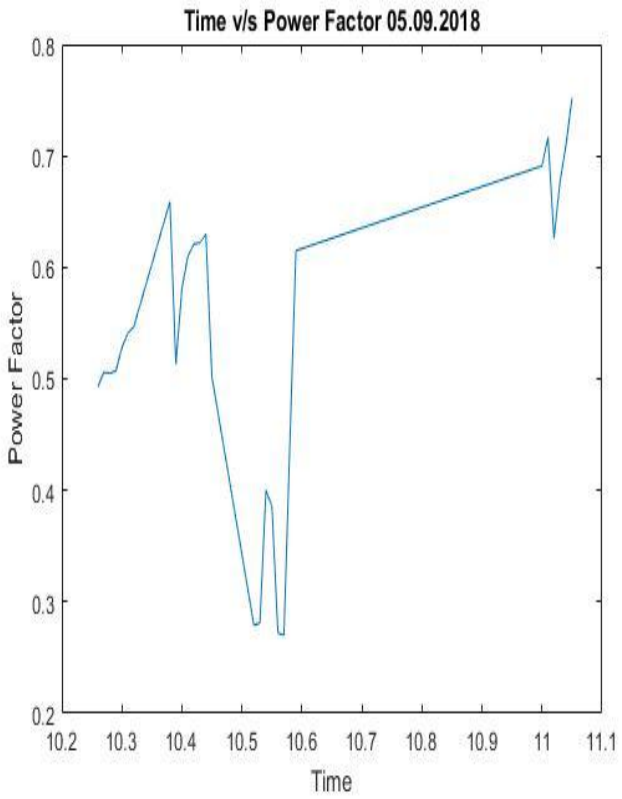


GRAPH 6 shows the relation between the Load Distribution in KW and KVAR which is taken on a mentioned date of 31.08.2018

TABLE 4 READINGS TAKEN ON 05.09.2018

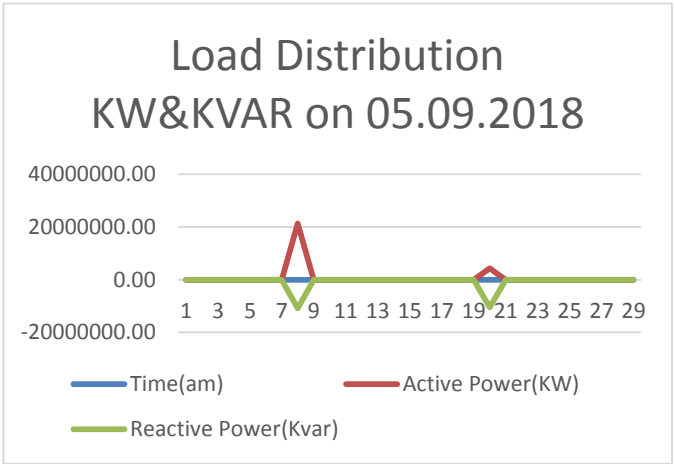
Time(am)	Voltage(V)	Current(A)	Power Factor	ϕ	sinϕ	Active Power(KW)	Reactive Power(Kvar)
10.26	403.1	3.017	0.493	60.46204567	-0.697415781	599.5632811	-848.1640852
10.27	401.8	3.115	0.506	59.60224289	0.08790393	633.313142	110.0211743
10.28	401.9	3.108	0.505	59.66864764	0.021611099	630.798126	26.99453604
10.29	401.2	3.098	0.507	59.53579295	0.153853926	630.1592232	191.2277519
10.30	401.1	3.272	0.528	58.12957778	0.999948857	692.9467776	1312.33208
10.31	400.7	3.31	0.541	57.24826085	0.643906405	717.537497	854.0240109
10.32	400.9	3.284	0.547	56.83855713	0.285846205	720.1559132	376.3324223
10.38	400.6	80527	0.659	48.77634837	-0.996667492	21258757.58	-32151612.44
10.39	401.2	3.184	0.513	59.13613434	0.526200352	655.3168704	672.1792751
10.40	400.4	4.034	0.581	54.47909191	-0.878167034	938.4391016	-1418.427337
10.41	399.6	4.101	0.61	52.41049704	0.839617188	999.643356	1375.930728
10.42	399.5	4.255	0.621	51.6108034	0.974687936	1055.620823	1656.845218
10.43	399.2	4.356	0.622	51.53766738	0.955745927	1081.605254	1661.96112
10.44	398.3	4.492	0.63	50.94987746	0.632204377	1127.173068	1131.117059
10.45	399.8	4.105	0.502	59.86759262	-0.17640424	823.871858	-289.5109338
10.52	402	4.076	0.279	73.79946934	-0.9996092	457.156008	-1637.911654
10.53	102.9	4.114	0.281	73.68010311	-0.989167397	118.9558986	-418.7448276
10.54	401	5.144	0.4	66.42182152	-0.433502452	825.0976	-894.204581
10.55	400.4	5.077	0.386	67.29416448	-0.968893226	784.6726888	-1969.595992
10.56	399.7	40198	0.272	74.21668677	-0.925190369	4370262.243	-14865163.75
10.57	399.2	4.04	0.27	74.33573315	-0.87357033	435.44736	-1408.866274
10.58	398.7	4.204	0.444	63.64062321	0.723438639	744.2038512	1212.580678
10.59	399.9	6.14	0.615	52.04807971	0.977653908	1510.06239	2400.517718
11.00	399.3	7.128	0.691	46.29068025	0.740093616	1966.731386	2106.462148
11.01	398.4	7.465	0.717	44.1926529	0.20880782	2132.398152	621.0061511
11.02	397.3	8.791	0.626	51.24437751	0.829881382	2186.407852	2898.497078
11.03	398.2	5.503	0.677	47.39034507	-0.263313459	1483.506444	-576.9973602
11.04	397.7	6.597	0.71	44.76508467	0.705258371	1862.775099	1850.334833
11.05	397	8.674	0.752	41.23607767	-0.385152604	2589.570656	-1326.303033
		Mean Power Factor	0.533965517				
Energy Meter Reading: 167.5 to 168.7 Wh							
	Time	0.65 hours					
	Kw	1.8462					
	Angle	57.7239					
	Kvar	2.9231					
	Improved Angle(PF=0.9)	25.8419					
	Improved Kvar	0.8942					
	Capacitor Ratings Should be	2.0289					

GRAPH 7



GRAPH 7 shows the relation between the time and the power factor which is taken on a mentioned date of 05.09.2018

GRAPH 8

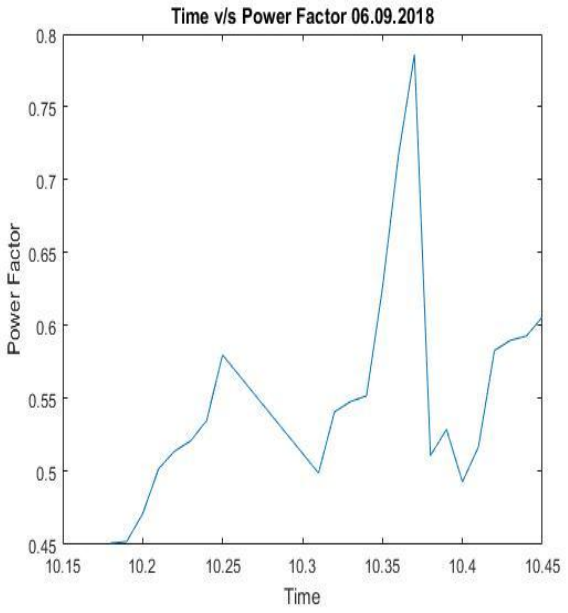


GRAPH 8 shows the relation between the Load Distribution in KW and KVAR which is taken on a mentioned date of 05.09.2018

TABLE 5 READINGS TAKEN ON 06.09.2018

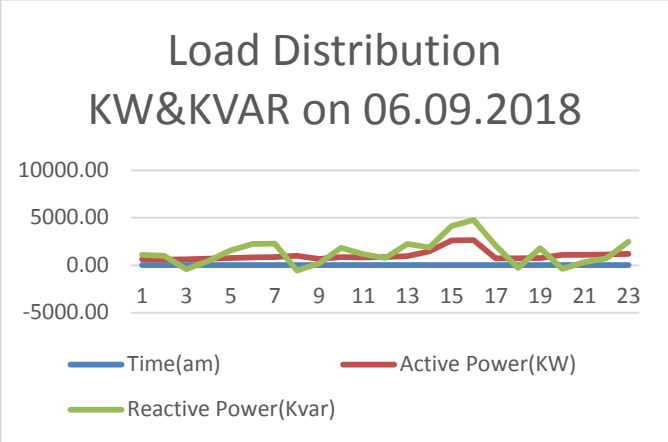
Time(am)	Voltage(V)	Current(A)	Power Factor	ϕ	sinϕ	Active Power(KW)	Reactive Power(Kvar)
10.18	407.4	3.296	0.451	63.19213897	0.352541789	605.5984704	473.38973
10.19	407.5	3.23	0.452	63.12792554	0.291765826	594.9337	384.0294745
10.20	406	3.31	0.471	61.9007717	-0.80226595	632.95806	-1078.13312
10.21	405.9	3.423	0.502	59.86759262	-0.17640424	697.4766414	-245.0952922
10.22	405.1	3.547	0.514	59.06936301	0.58176531	738.5613058	835.9325821
10.23	407.7	3.877	0.521	58.60064655	0.886448269	823.5201609	1401.167027
10.24	406.5	3.89	0.535	57.65608859	0.894548847	845.987475	1414.536673
10.25	405.3	4.205	0.58	54.54945736	-0.909625731	988.48617	-1550.262854
10.31	404.3	3.298	0.499	60.06613744	-0.367088467	665.3573186	-489.468934
10.32	404.5	3.819	0.541	57.24826085	0.643906405	835.7289555	994.6972773
10.33	403.4	3.767	0.548	56.77008748	0.219614902	832.7450744	333.7285178
10.34	403.7	3.761	0.552	56.49567019	-0.052972767	838.1102664	-80.42938416
10.35	404	3.784	0.626	51.24437751	0.829881382	956.988736	1268.669545
10.36	402.9	5.035	0.717	44.1926529	0.20880782	1454.507276	423.5878577
10.37	402.4	8.197	0.786	38.18673915	0.468531057	2592.599621	1545.436948
10.38	402.8	12.82	0.511	59.26953778	0.408420181	2638.750856	2109.039337
10.39	404	3.369	0.529	58.06208627	0.998354345	720.009204	1358.836138
10.40	408	3.489	0.493	60.46204567	-0.697415781	701.791416	-992.7797334
10.41	408	3.52	0.517	58.86876829	0.732162976	742.49472	1051.50318
10.42	408.3	4.557	0.583	54.33817552	-0.802277315	1084.743267	-1492.735704
10.43	406.7	4.548	0.59	53.8429918	-0.422241541	1091.306244	-781.0081868
10.44	406.4	4.717	0.593	53.62981242	-0.220900136	1136.774358	-423.4630871
10.45	405.8	4.837	0.606	52.6991645	0.650247838	1189.489888	1276.34196
		Mean Power Factor	0.552913043				
Energy Meter Reading: 171.1 to 171.8Wh							
	Time	0.45 hours					
	Kw	1.5556					
	Angle	56.4338					
	Kvar	2.3444					
	Improved Angle(PF=0.9)	25.8419					
	Improved Kvar	0.7534					
	Capacitor Ratings Should be	1.591					

GRAPH 9



GRAPH 9 shows the relation between the time and the power factor which is taken on a mentioned date of 06.09.2018

GRAPH 10



GRAPH 10 shows the relation between the Load Distribution in KW and KVAR which is taken on a mentioned date of 06.09.2018

10. RESULTS AND DISCUSSION

	Capacitance Required
	3.6221
	2.5837
	2.4141
	2.0289
	1.591
Mean	2.44796

Thus, we have calculated the amount of Capacitor bank that has to be implemented in the lab so has to decrease the reactive power generated. This will in turn reduce the electricity bill for our Institution. We have also plotted various graphs for understanding purpose. Graph 1, Graph 3, Graph 5, Graph 7 and Graph 9 shows the relation between the time and the power factor for five different days. Graph 2, Graph 4, Graph 6, Graph 8 and Graph 10 shows the relation between the Load Distribution in KW and KVAR for five different days.

ELECTRICAL BLUE PRINT

Machines	V(V)	I(A)	P(KW)	Quantity
DC Motor	220	6.5	1.1	12
3ϕ Induction Motor	415	2.2	1	6
AC Generator	415	2.8	1.2	6
1ϕ InductionMotor	230	7.6	1.1	5
3ϕ Induction Motor	415	3.15	1.1	5
DC Motor	220	6.5	1.1	10
DC Series Motor	220	6.8	1.5	1
DC Shunt Motor	220	27.5	5.2	1
AC Generator	415	7	4	1
3ϕ Synchronous Motor	415	8.5	3.7	1
DC Generator	220	15	3.5	1
Induction Generator	415	7.5	3.7	1
DC Motor	220	10	2.2	1
DC Generator	220	10	2.2	1
DC Motor	220	18.5	3.5	1
DC Motor	220	19.6	3.7	1
DC Generator	220	16.8	3.7	1
AC Generator	415	8.5	3.7	1
3ϕ Synchronous Motor	220	17	3.7	1
DC Shunt Motor	220	27.5	5.2	1
3ϕ Alternator	415	7	5	1
3ϕ Induction Motor	415	5.2	2.2	1

The Maximum power Demand of the lab is 69. 5855KW.The load on an installation is 2.232KW, 0·5 lagging p.f. which works for 1 hour per day. The energy consumed is 1. 6KWH.It has a reactive power of 3.495 KVAR. If we connect a capacitor of capacitance of 2.45KVAR is added. The Tariff of Tamil Nadu Government is given below

	For Handlooms in residence, 0 to 200 units bimonthly is free. (Above 200 units bi-monthly, the corresponding slab in the domestic tariff is applicable)				
*I-B	Huts in village panchayats,TAHDCO:- Till installation of meters (Fully subsidised by the Govt.)		0	290/service	0	0
	On installation of meters (Fully subsided by the Govt.)		4.95	0	0	0
I-C	L.T. Bulk supply to residential Colonies of Railway, Defence , Police quarters etc.		4.60	120/service	4.60	120/service
II-A	Public lighting by Govt./Local bodies, Public water supply, Sewerage etc.,		6.35	120/kW	6.35	120/kW
II-B(1)	Govt and Govt. aided Educational Institutions, Govt. Hospitals and Research labs, etc		5.75	120/kW	5.75	120/kW
II-B(2)	Private Educational Institutions & Hostels		7.50	120/kW	7.50	120/kW
#II-C	Actual Places of Public worship(Bi-monthly)	0-120 units	5.75	120/kW	2.85	120/kW
		Above 120 units	5.75	120/kW	5.75	120/kW
III-A(1)	Cottage and Tiny Industries, Agricultural and allied activities, Sericulture, Floriculture, Horticulture and Fish/Prawn culture etc. (contracted load shall not exceed 12 kW) (Bi-monthly)					

Calculation
Before adding the capacitor Maximum Apparent Power Demand= 69.5855/0.5=139.171KVA Apparent Power=SQRT (Active power^2+Reactive Power^2) Apparent Power = 4.15 KVA Total Cost =(5.75*139.171) +(1.6*120) =Rs.992.23/day **After adding the capacitor** Reactive Power=1.045 KVAR Active Power = SQRT (Apparent Power^2-Reactive Power^2) Active Power= 4.106KW Energy Consumed=4.106 KWH Φ=14.7439 Improved Power factor=0.967 Maximum Apparent Power Demand= 69.5855/0.967=71.9601 KVA Total Cost = (5.75*71.9601) + (4.106*120) =Rs.906.49/day Saving Percentage =8.64%

11. CONCLUSION

The electrical power required to drive a motor has three components: reactive power (P_r, kVAR), active power (P_a, kW), and apparent power (P_{ap}, kVA). The active power is the actual amount of work done by the motor and measured for billing purposes. The reactive power is the power required to magnetize the motor winding or to create magnetic flux, and is not recordable. The apparent power is the vector sum of kilowatts and KVAR and is the total amount of energy furnished by the utility company.Capacitor should not be selected as a means of correcting poor power factors that are the result of oversized motors or unbalanced pumping units. Choosing a capacitor for this purpose might cause overcorrection, which can result in a leading power factor. A leading power factor, in turn, might cause over voltages that would cause control-component failure or power-cable failure. This potential problem generally is avoided by connecting the capacitors downstream of the motor contactors and switching them on and off, along with the motor contactors. From our studies and analysis in machines lab using the energy auditing techniques we are recommending the capacitor of **2.44796 KVAR** for the machine's lab.The Maximum power Demand of the lab is 69.5855KW. The cost which is spent before adding the capacitor is Rs.992.23/day. The cost which is spent after adding the capacitor is Rs.906.49/day. Thus, the percentage of Savings is 8.64%. We have also plotted the load curve for each individual day.

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