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Presentation on Detailed Energy Audit findings – S 16 Block

Syngene International Limited, Bommasandra, Bengaluru

Thursday, 5 September 2019

Project Code.
2019IB16

Facility energy consumption summary

Source	Year 2018-19	
	kWh/year	Lakh Rs./year
Electricity from Grid	**9349128**	**752.60**
Electricity from Diesel Generator	419599	62.98

- Cost of Electrical Energy considered: 8.5 Rs. / kWh

Areas Covered

- Electrical Systems
- Electrical Drives
- HVAC
- Compressed Air
- Blowers, Fans and Vacuum Pumps
- Steam Utilization and distribution.

Methodology - Instrumented study

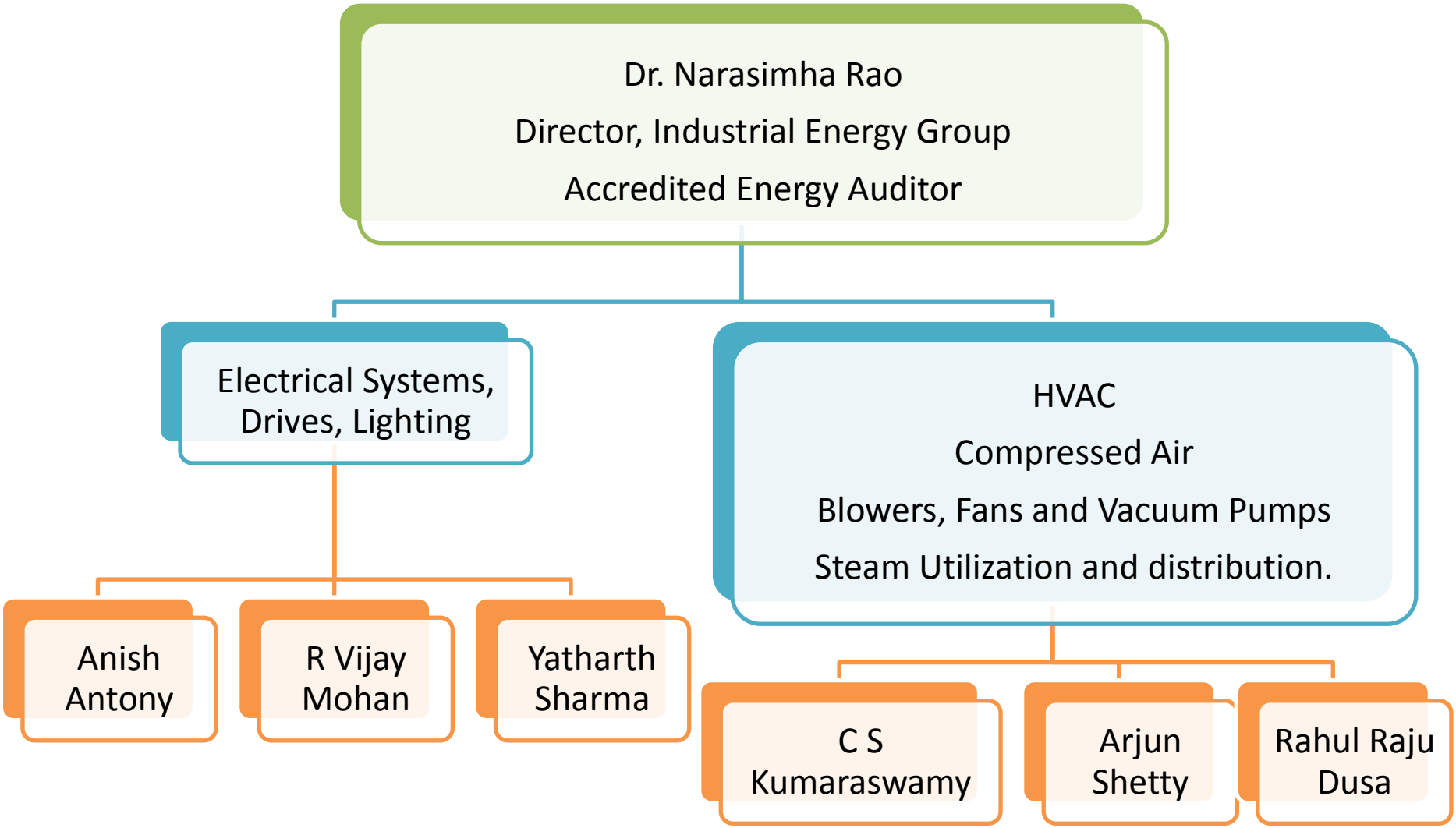




- Power analyzers (Krykard ALM 32, ALM 10, Fluke 41B)
- Anemometer
- Multi-fuction kit
- Ultrasonic water flow meter
- Infra-red thermohunter
- Thermograph
- Lux meter

Energy Audit Team

Team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HVAC
Compressed Air
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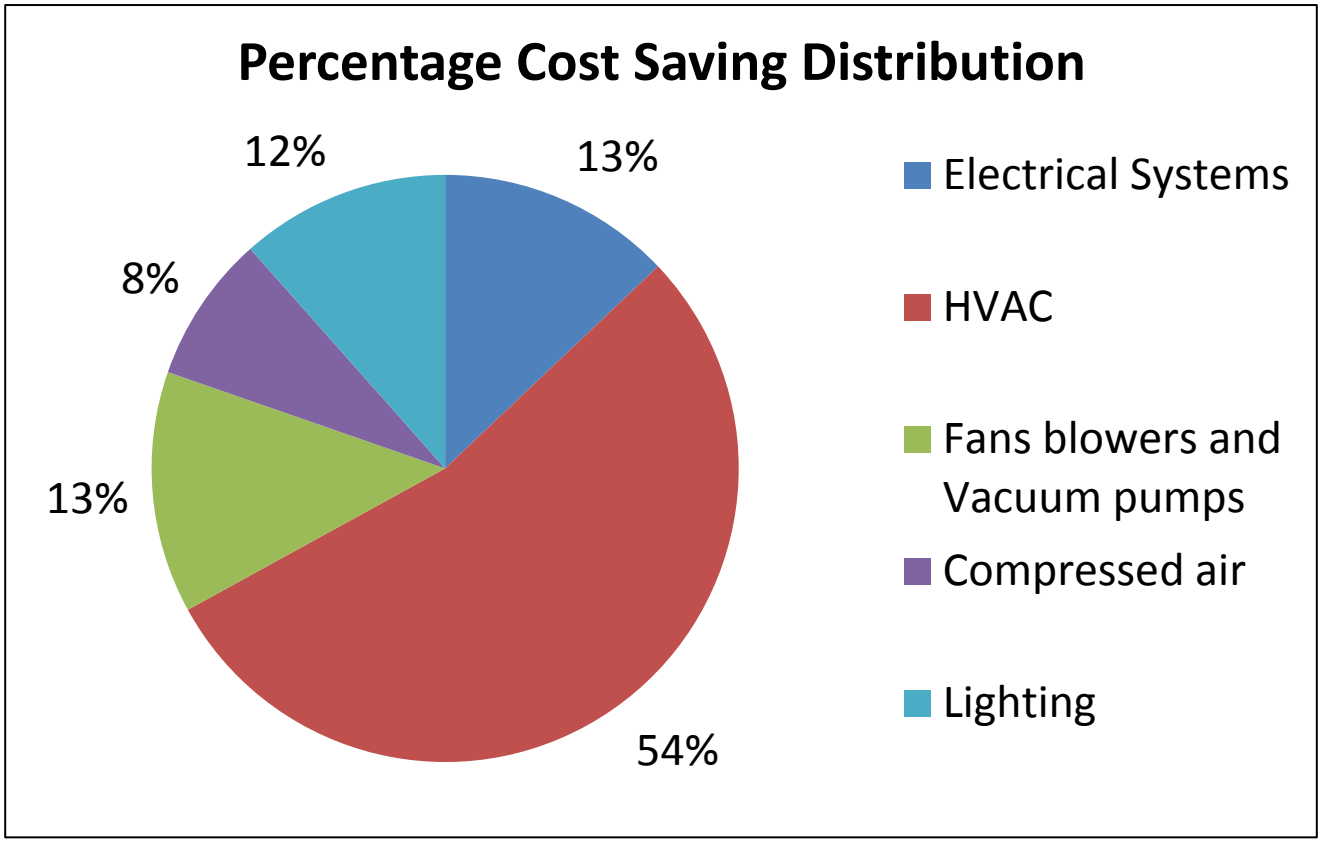
Energy Saving Recommendations

Summary

Type of Recommendations	No. of Recommendations	Annual energy saving potential	Annual Saving Potential,	Cost of Implementation,	Payback Period, Years
		Lakh kWh	Rs. Lakh	Rs. Lakh	
Short term investment, payback less than I Year	10	2.36	20.12	4.98	0.2
Medium investment, payback between 1- 3 years	3	1.02	8.63	19.20	2.2
Long investment, payback more than 3 years	2	1.36	11.57	61.62	5.3
Total	**15**	**4.74**	**40.32**	**85.80**	**2.1**

Summary



- Energy savings : 4.86% of total energy consumption
- Cost savings : 4.93% of total energy cost

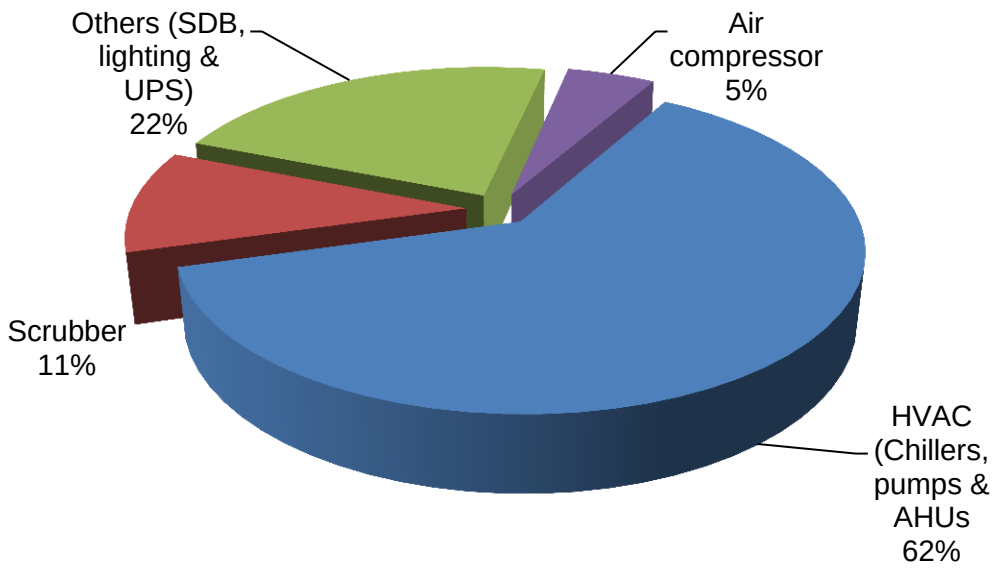
Electrical Systems

Introduction

- Source of power to S-16 block is from Syngene central utility at 11kV. Stepping down to 433V at S16 substation by two 3.15MVA transformers.
- S-16 block has and exclusive 11 kV substation.
- The maximum demand of the S16 Block during day time is around **2.5 MVA** and during night time it is around **1.1 MVA** (including S-11 feeder).
- Only one feeder i.e, S-11 feeder goes to S-11 block which has a load of around **200 kW**.
- Power factor maintained at **0.97 lag** at both transformers.
- Average Unit cost of the facility is Rs. **8.5/kWh** based on previous month electricity bills data.

Load breakup of S16 Block

Description	HVAC (Chillers, pumps & AHUs	Scrubber	Others (SDB, lighting & UPS)	Air compressor	Total
Ground floor	77.4	0	27.6		105.0
First floor	235.7	0	268.4		504.0
Second floor	238.8	118.5	110.9		468.2
Third floor	299.6	100.1	60.3		460.0
Utility	453.9			105	558.9
Total	1305.5	218.6	467.2	105.0	2096.3
Load breakup %	**62.3**	**10.4**	**22.3**	**5.0**	**100.0**



Description	Day time	Night time
First floor	30.8	28.3
2nd floor ELDB	2.6	2.5
2nd floor LDB-1 SARC-II	5.4	5.2
3rd floor south LDB-1	2.4	2.4
3rd floor south LDB-2	3.9	3.9
3rd floor south LDB-3	1.4	1.2
3rd floor south LDB-4	3.1	2.6
Total load, kW	**49.8**	**46.1**

Summary of Potential savings – (Electrical systems, Drives and Lighting section)

S.No	Energy Conservation Measures	Annual Energy Savings Potential	Annual energy cost Savings,	Investment, Cost	Simple payback period
		Electricity, Lakh kWh	Value, Rs Lakh	Rs Lakh	Years
SHORT TERM MEASURES					
Electrical Systems					
1	Parallel operation of Transformer-1 & 2	0.11	0.96	Nil	Immediate
2	Install capacitor banks near chillers	0.04	0.34	Nil	Immediate
Lighting					
3	Replace the existing 2 x 36 W T8 FTLs lamps with energy efficient 2 x 16 W T8 LED tube lights	0.11	0.93	0.48	0.5
MEDIUM TERM MEASURES					
Electrical Systems					
4	Provide additional run of cable to Air compressor-2 and Chiller secondary pumps panel board	0.06	0.48	1	2.1
Lighting					
5	Practice Energy efficient lighting operations by installing dimming sensors and motion sensors	0.44	3.73	5	1.3
LONG TERM MEASURES					
Electrical Systems					
6	Install Active filter at different load centres	0.4	3.43	24	7
	Sub total	**1.16**	**9.87**	**30.48**	**3.09**

Transformer Load Management

Parameter Description		Trafo-1		Trafo-2	
		Day time	Night time	Day time	Night time
Voltage (P - P)	R	416.8	420.8	415.5	420.2
	Y	414.5	418.4	416.8	422.3
	B	415.7	420.3	418.2	423.6
% VTHD		4.5	2.5	4.7	1.8
Current	R	2223.0	1077.4	691.2	211.9
	Y	2242.5	1038.7	688.7	203.4
	B	2246.1	1060.7	730.5	218.2
	N-E	150.6	82.1	46.5	20.1
%ITHD		11.1	10.1	23.4	18.9
kW	Min	1135.0	664.7	281.2	126.5
	Avg.	1570.4	757.2	491.8	15.3
	Max	1803.2	849.6	621.0	212.0
kVA	Min	1155.6	672.5	291.4	128.6
	Avg.	1616.1	769.6	508.0	154.4
	Max	1854.4	865.5	641.3	216.2
kVAr	Min	215.5	20.1	53.5	-26.6
	Avg.	372.9	134.5	126.8	11.0
	Max	453.2	188.2	162.2	36.9
PF		0.97	0.98	0.97	0.98
%Iunb		2.1	3.3	2.5	3.4
Energy consumption, kWh/day		17929	9196	5579	1905
		27125		7484	
		34609			

Transformer Load Management

Description	Parameter	Day time	Night time
Trafo-1	% loading	59.0	27.5
	%Vthd	4.5	2.5
	%Ithd	11.1	10.1
Trafo-2	% loading	20.4	6.9
	%Vthd	4.7	1.8
	%Ithd	23.4	18.9

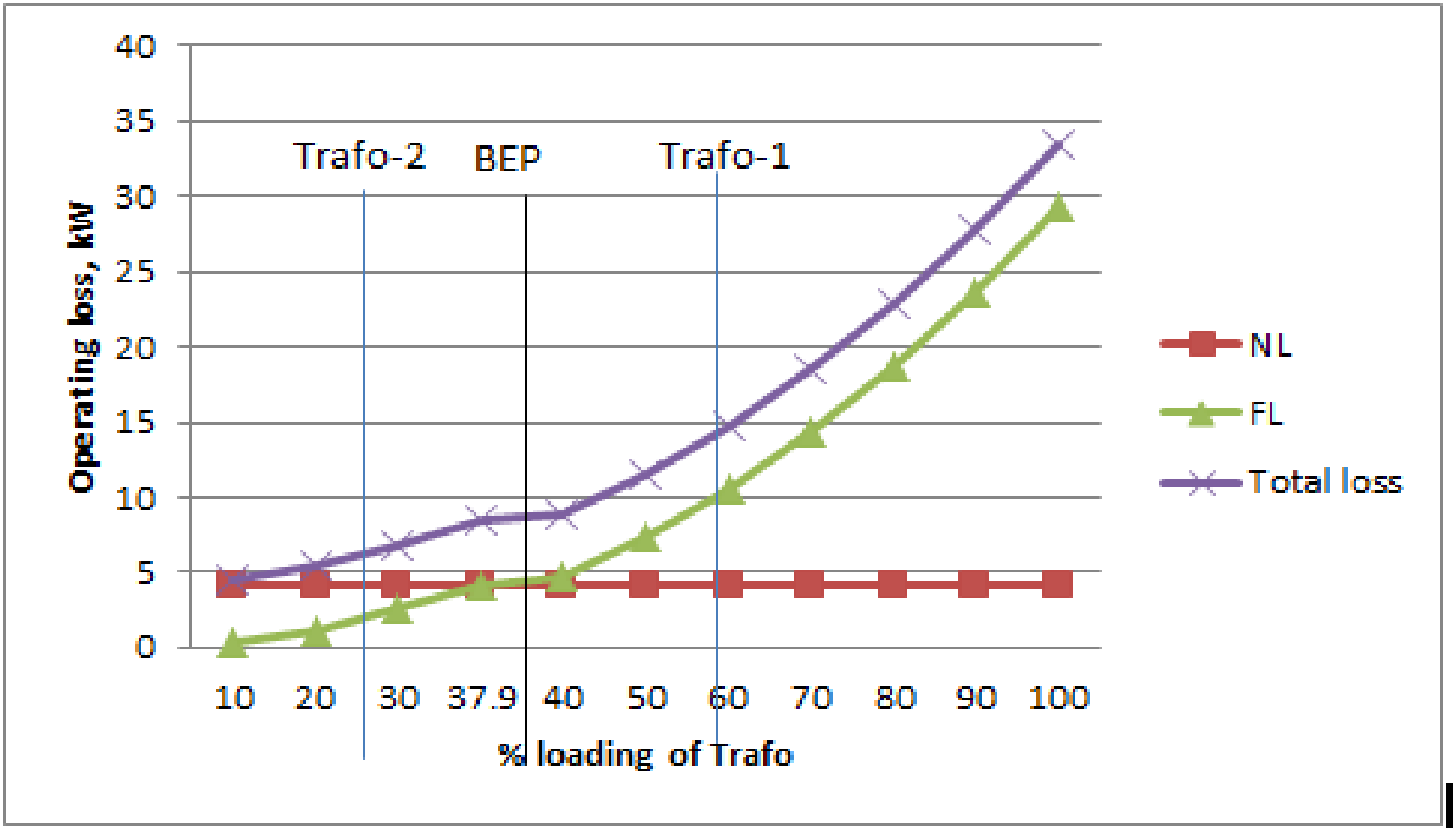
Description	I	%Ithd	PF
Utility MCC-4	293	34.5	0.91
SARC-II	166	22	0.97
PMCC-2 (SRC FF)	680	18.5	0.977
PMCC-1 (SRC GF)	196	24	0.932
SARC-I (SRC SF)	295	28.3	0.973
S-11 feeder	310	56	0.866
SRC TF	760	27	0.96
VRF unit (SRC SF)	214	33.2	0.94

- Trafo-1 is loaded above the best efficiency point(BEP) and Trafo-2 is loaded less than BEP.
- Plant has maintain good power factor at PCC and Sub PCC level. At present, 900 kVAr capacitor banks along with 7% detuned harmonics filter was installed for Trafo-1. And 600 kVAr Capacitor bank is yet to be commissioned for Trafo-2.
- Harmonics level at the transformer feeders found to be above the permissible IEEE limits (Athd= 8%) at transformer secondary side.

Isc/ IL : 65kA/2500 = 44

Electrical System- Recommendation

Parallel operation of Transformer-1 & 2



Electrical System- Recommendation

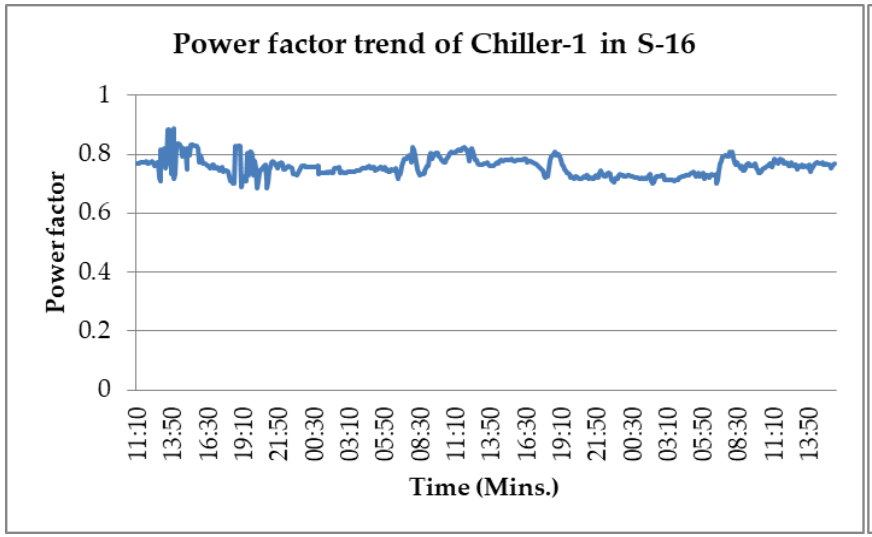
Parallel operation of Transformer-1 & 2

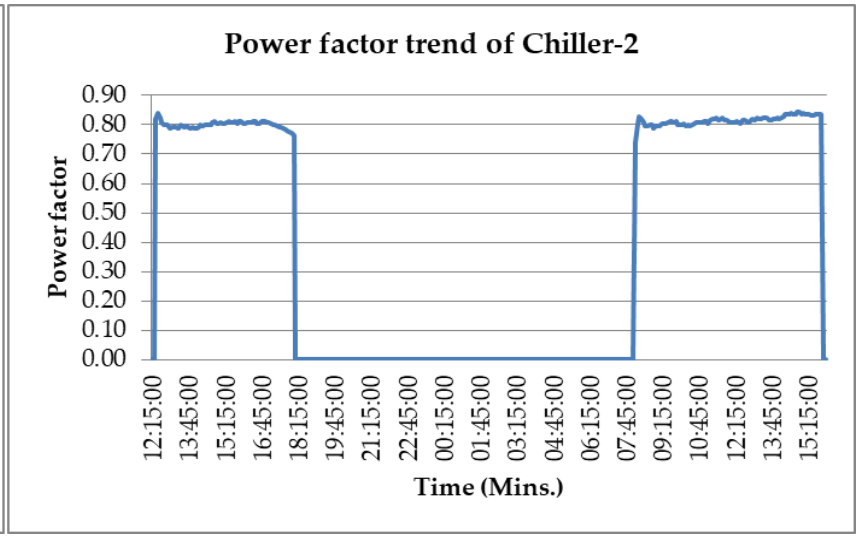
Parameter Description	Unit	Existing scenario				Proposed scenario			
		Trafo-1		Trafo-2		Trafo-1		Trafo-2	
		Day time	Night time	Day time	Night time	Day time	Night time	Day time	Night time
Rated capacity	kVA	3150	3150	3150	3150	3150	3150	3150	3150
No load losses	kW	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
Load losses	kW	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2
BEP	%	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9
Avg load	kVA	1616	770	508	154	1062	462	1062	462
Peak load	kVA	1854	866	641	216	1248	541	1248	541
% Loading of trafo	%	58.9	27.5	20.4	6.9	39.6	17.2	39.6	17.2
No load losses	kW	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
Daily Load losses	kW	8.8	2.0	1.0	0.1	3.9	0.7	3.9	0.7
Total losses	kWh	156	74	62	52	97	59	97	59
Total losses	kWh/day	230		113		156		156	
Total losses	kWh/day	344				313			
Loss reduction	**kWh/year**	**11,315**							

Annual energy savings : 11,315 kWh
Annual Energy cost saving : Rs. 95,178
Investment cost : Nil
Simple Payback period : Immediate

Electrical System- Recommendation

Install capacitor banks near chillers





Annual Energy savings	: 3962 kWh
Annual energy cost savings	: Rs. 33,677
Investment cost	: Nil
Simple payback period	: Immediate

(*Note: The existing capacitor banks in the APFC can be removed and 75 kVAR of fixed capacitor bank can be installed at each chiller*)

Electrical System- Recommendation

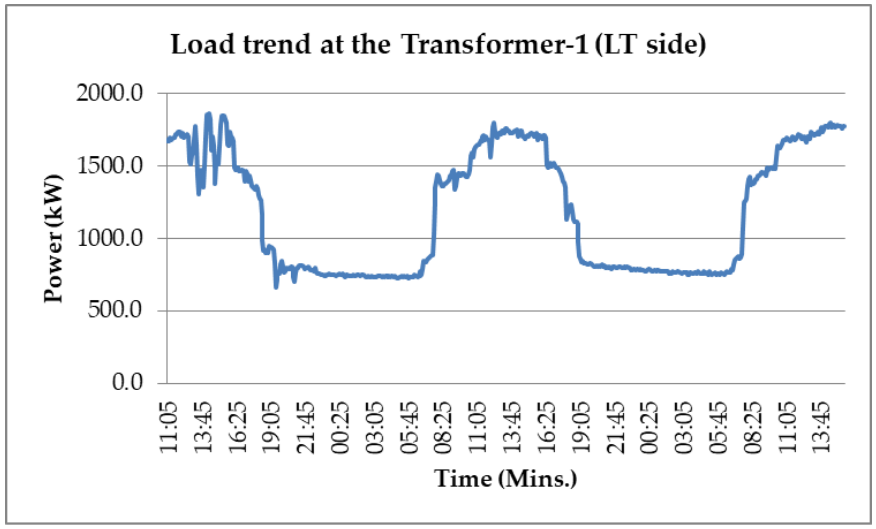
- Provide additional run of cables for the identified feeders.

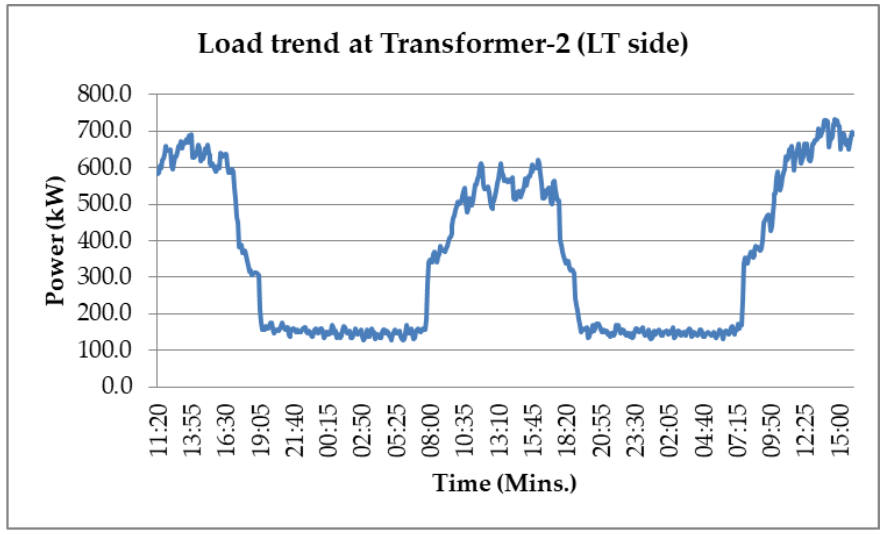
- At present single run of cable is laid to Air compressor-2 and Chiller secondary pump panel.
- The load on the cable is more than 70% of the its full rated capacity.
- Hence in order to ensure reliability and minimise cable losses, it is suggested to provide additional cable.

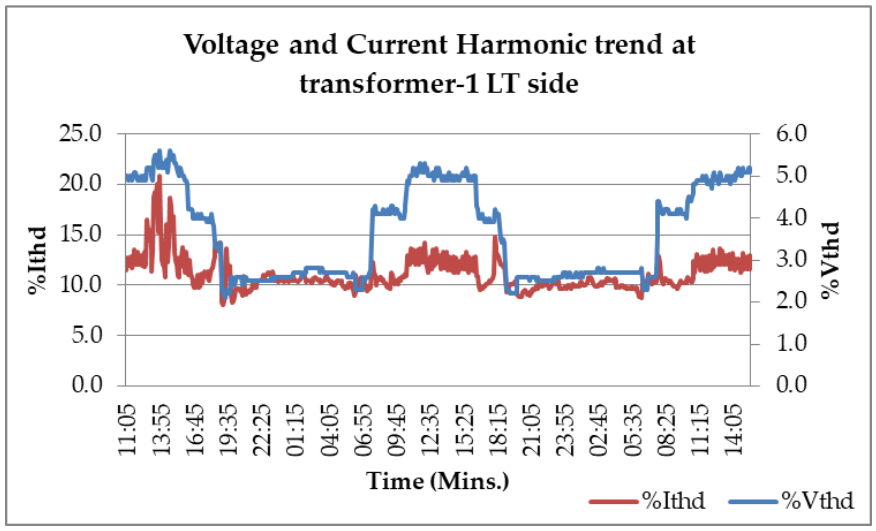
Sl. No.	Feeder/ Equipment	Cable details				Operating parameters		Proposed runs of cable	Distribution loss reduction (kWh/Year)
		Size	Runs	Length (km)	Ω	Amps	PF		
1	Air compressor-2	120	1	40	0.0088	180	0.87	2	3755
2	CHW Secondary pumps panel	50	1	85	0.0451	57	0.96	2	1919
Total									5674

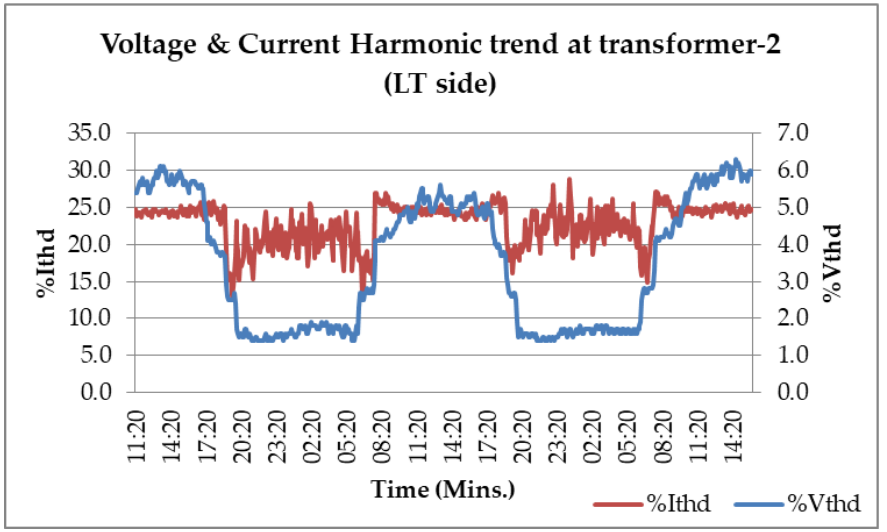
Annual energy savings : 5674 kWh
Annual energy cost savings : Rs. 48,229
Investment cost : Rs. 1,00,000
Simple payback period : 2.1 years

Load variation and Harmoics variation at transformer level









Harmonics Analysis at Feeder level

Description	I	%Ithd	PF
S-16 Trafo-1			
Utility MCC-4	293	34.5	0.91
SARC-II	166	22	0.97
HVAC panel	59.8	35.2	0.79
Scrubber panel	35.5	38.2	0.77
PMCC-2 (SRC FF)	680	18.5	0.977
MCC-2	51	38.5	0.91
MCC-3	310	36.1	0.92
PMCC-1 (SRC GF)	196	24	0.932
MCC-1	120	45.7	0.9
SARC-I (SRC SF)	295	28.3	0.973
MCC-1 HVAC panel-1	35.3	37.2	0.93
MCC-2 Scrubber panel	147.7	30.3	0.95
MCC-3 HVAC panel-2	55	34.4	0.93
S-11 feeder	310	56	0.87
S-16 Trafo-2			
SRC TF	760	27	0.96
HVAC panel North	217	40	0.91
HVAC panel-1 South	81	47.7	0.89
HVAC panel-2 South	73	38	0.92
Main Exhaust panel North	61	36	0.91
Main Exhaust panel South	91	36	0.92
TS &Biology lab south	85	25.6	0.96
VRF unit (SRC SF)	214	33.2	0.94

Bus Voltage at PCC	Individual voltage distortion	Total voltage distortion
	THD (%)	THD (%)
69KV and below	3	5
69.001KV through 161KV	1.5	2.5
161KV and above	1	1.5

Maximum Harmonic current distortion (% of I_L)						
Individual harmonic order (odd harmonics)						
I_{sc}/I_l	<11	11≤h<17	17≤h<23	23≤h<35	35≤h	THD
<20*	4	2	1.5	0.6	0.3	5
20<50	7	3.5	2.5	1	0.5	8
50<100	10	4.5	4	1.5	0.7	12
100<1000	12	5.5	5	2	1	15
>1000	15	7	6	2.5	1.4	20

Install Active Harmonic filters at all PCCs in load centres of each floor. This will help in mitigating the harmonics at source itself.

Electrical System- Recommendation

Install Active filter at different load centers

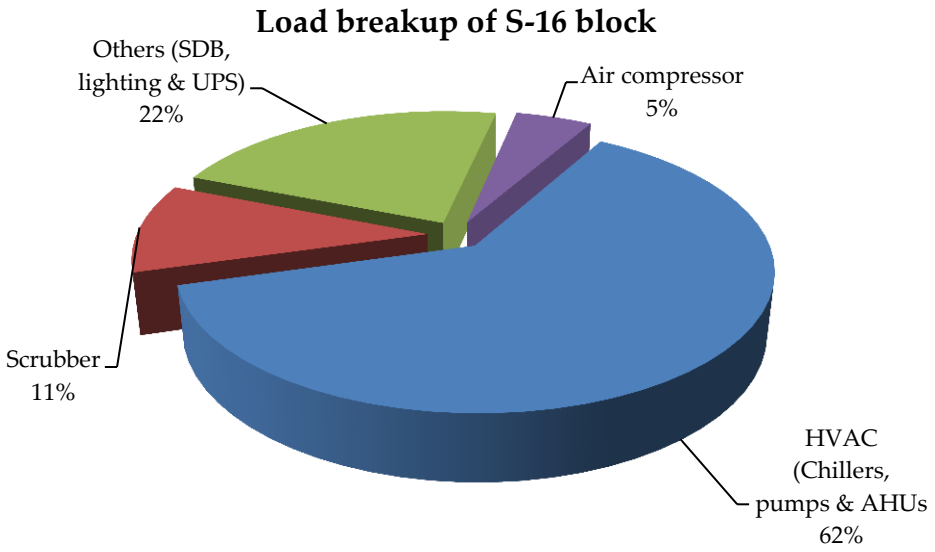
Description	%Vthd	I	%Ithd	kW	PF	DPF	Fundamental current	Filter current rating, If	Investment, Rs. Lakhs
Utility MCC-4	5.3	302.8	28.3	203.6	0.940	0.975	290.6	100	3.0
SARC-II	5.1	218.4	14.9	153.5	0.980	0.993	211.2	50	1.5
PMCC-2 (SRC FF)	5.1	728.3	17.3	507.7	0.977	0.988	717.5	150	4.5
PMCC-1 (SRC GF)	5.1	263.5	16.8	179.1	0.956	0.975	260.0	50	1.5
SARC-I (SRC SF)	4.9	306.7	22.2	211.8	0.973	0.988	299.4	75	2.3
S-11 feeder	4.8	310.0	56.0	193.9	0.866	0.980	303.8	75	2.3
SRC TF	6.1	770.8	25.6	533.2	0.960	0.992	746.8	200	6.0
VRF unit (SRC SF)	6.1	243.6	32.8	166.7	0.950	0.999	229.7	100	3.0
Total									24.0

Annual Energy savings : 40,324 kWh
Annual energy cost savings : Rs. 3,42,754
Investment cost : Rs. 24.0 lakhs
Simple payback period : 7.0 years

Electrical Drives

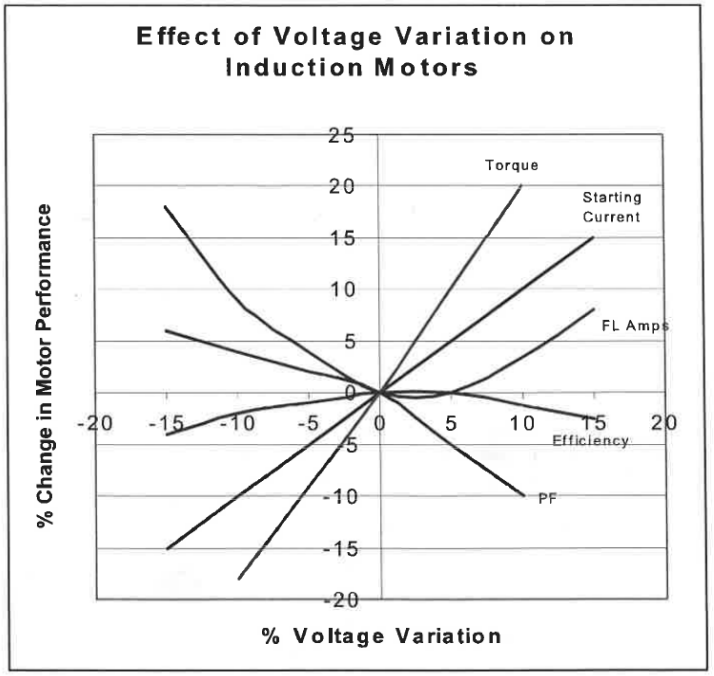
Electrical Drives- Load Breakup

Description	HVAC (Chillers, pumps & AHUs	Scrubber	Others (SDB, lighting & UPS)	Air compressor	Total
Ground floor	77.4	0	27.6		105.0
First floor	235.7	0	268.4		504.0
Second floor	238.8	118.5	110.9		468.2
Third floor	299.6	100.1	60.3		460.0
Utility	453.9			105	558.9
Total	1305.5	218.6	467.2	105.0	2096.3
Load breakup %	**62.3**	**10.4**	**22.3**	**5.0**	



Suggestion

Voltage Variation	110%	90%
Starting & Max. torque	Increase by 21%	Decrease by 21%
Synchronous speed	No change	No change
% slip	Decrease by 17%	Increase by 23%
Full load speed	Increase by 1%	Decrease by 1%
Full load efficiency	Increase by 0-1 point	Decrease by 1-3 points
Full load PF	Decrease by 2-8 points	Increase by 1-3 points
Full load current	Decrease by 0-7%	Increase by 10-12%
Locked rotor current	Increase by 10-14%	Decrease by 10-12%
Temp. rise @ full load	Decrease by 4-6°C	Increase by 4-8°C
Max. Overload capacity	Increase by 21%	Decrease by 19%
Magnetic noise (No load)	Increase slightly	Decrease slightly



Lighting System

Lighting - Observation

- Lighting fixtures survey is carried out to observe and collect details of the lamps installed in the Plant.
- Measurement of Lighting load is carried out LDB/MLDB.
- Measurement of illumination carried out at Process areas of the plant using lux meter.
- Plant has maintaining good lux level at all lab areas and work stations.
- LED lamps are being used predominantly in all major work and electrical panel area.

Description	Day time	Night time
First floor	30.8	28.3
2nd floor ELDB	2.6	2.5
2nd floor LDB-1 SARC-II	5.4	5.2
3rd floor south LDB-1	2.4	2.4
3rd floor south LDB-2	3.9	3.9
3rd floor south LDB-3	1.4	1.2
3rd floor south LDB-4	3.1	2.6
Total load, kW	**49.8**	**46.1**

Lighting - Observation

- Replace the existing 2 x 36 W T8 FTLs lamps with energy efficient 2 x 16 W T8 LED tube lights.

Particulars	Unit	Existing	Proposed
Type and wattage of lamps		2 x 36W FTL	2 x 16W LED
Number of Lamps	Nos.	40	40
Present Wattage	W	72	32
Operating Wattage	W	80	38
Annual Energy Savings (Assuming 6500 hrs year)	kWh/year	10,920	
Annual Cost Savings (@Rs. 8.5/kWh)	Rs./ year	92,820	
Investment per 2 x 16W LED tube light (Rs. 1200 per 2x 16 W lamp & fitting)	Rs.	48,000	
Simple payback period	Years	0.52	

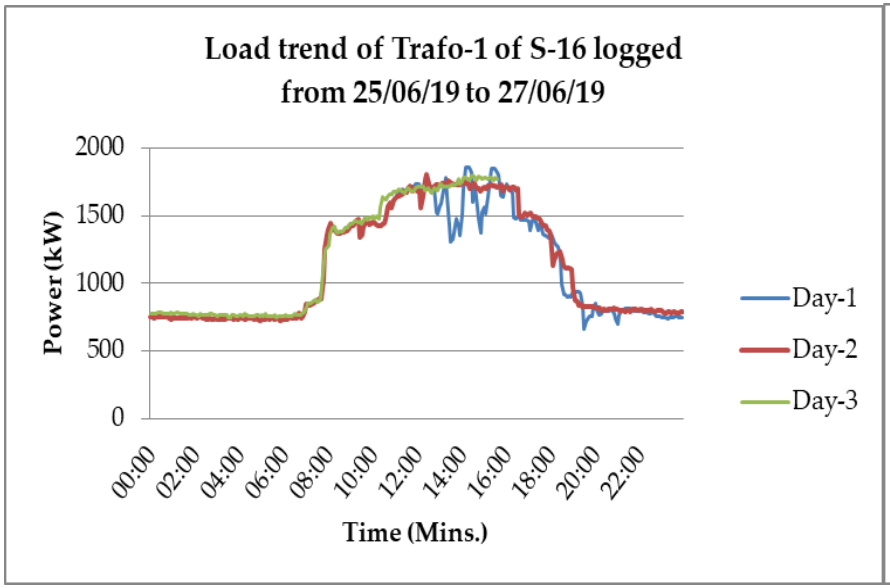
Practice Energy efficient lighting operations by installing dimming sensors and motion sensors

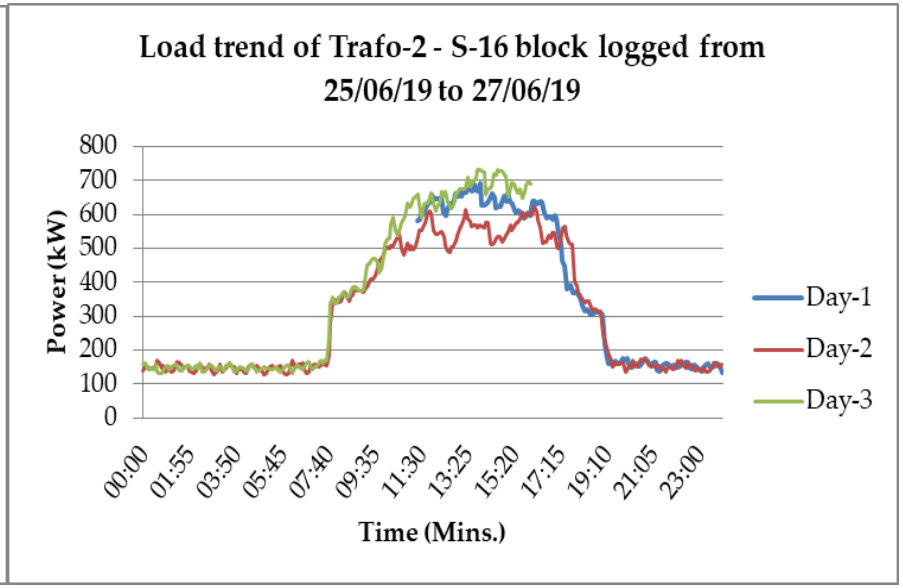
- Considering 15% of reduction if energy efficient operations is practiced
- Present energy consumption : 45 kW
- Annual energy savings : 3,875 kWh
- Annual Cost savings (@Rs. 8.5/kWh) : Rs. 3,72,938
- Investment cost
- (Cost of Sensor = RS. 5000/piece and 100 nos): Rs. 5,00,000
- Payback period : 1.34 years

Case Study:
Energy data analysis from EMS

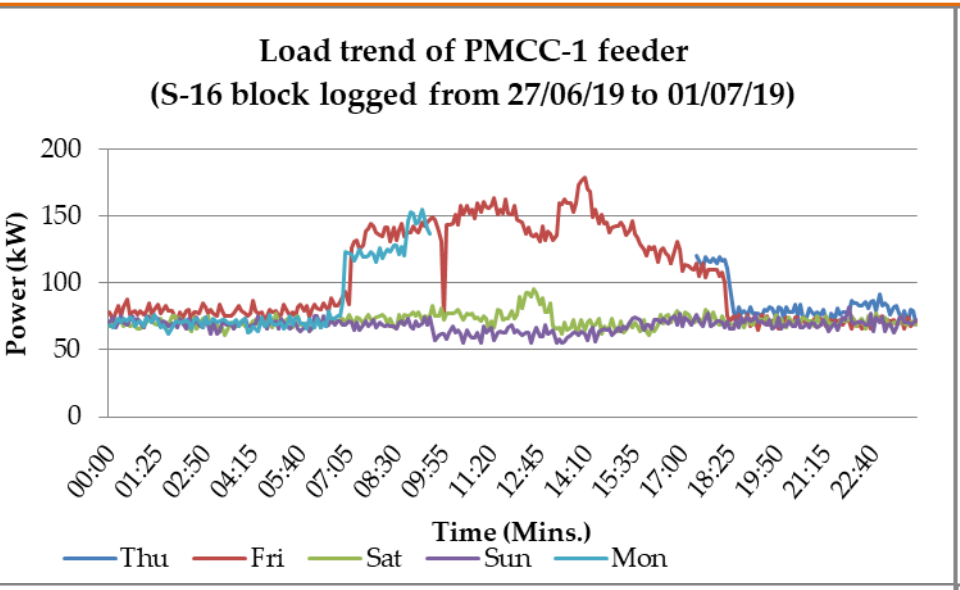
Suggestion: Energy data analysis

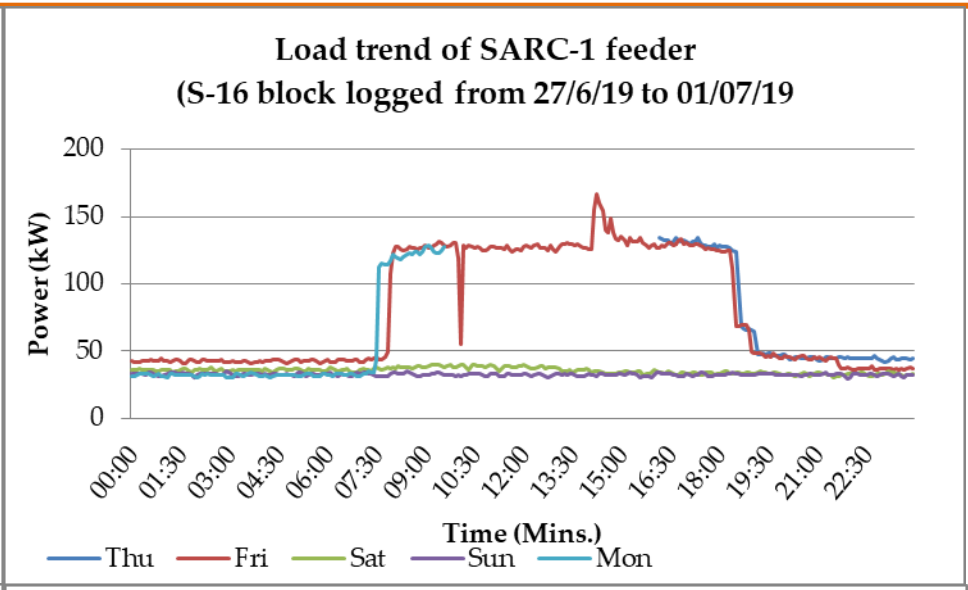
- The facility has energy management system.
- It is suggested to analyse the energy consumption data of each feeder to identify idle loads.
- This will help in further energy conservation with out any investment.

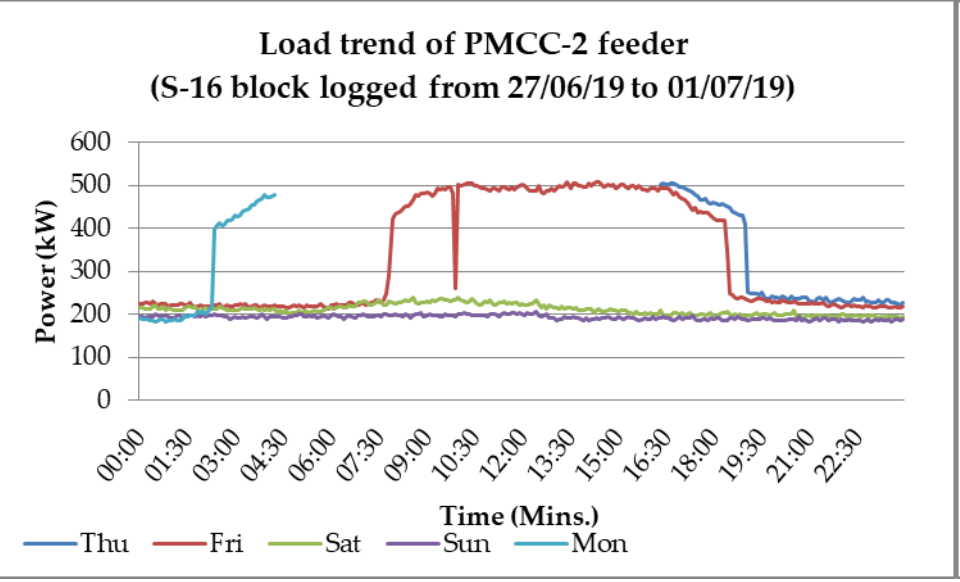


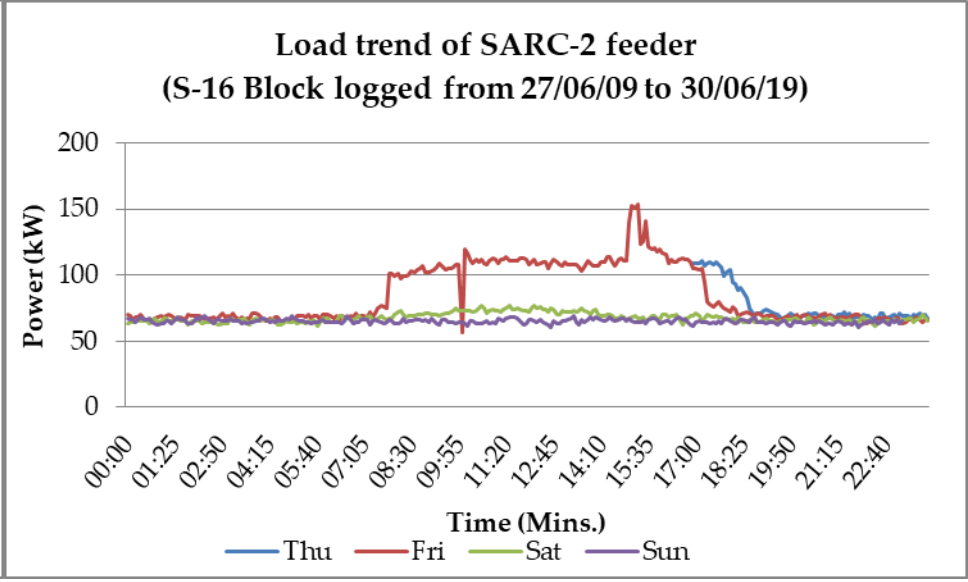


Energy data analysis

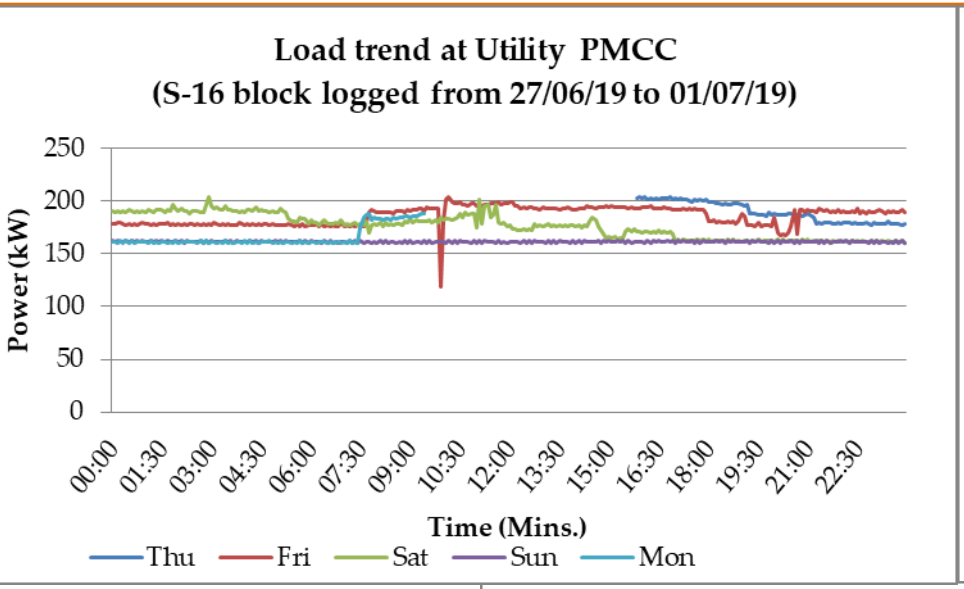


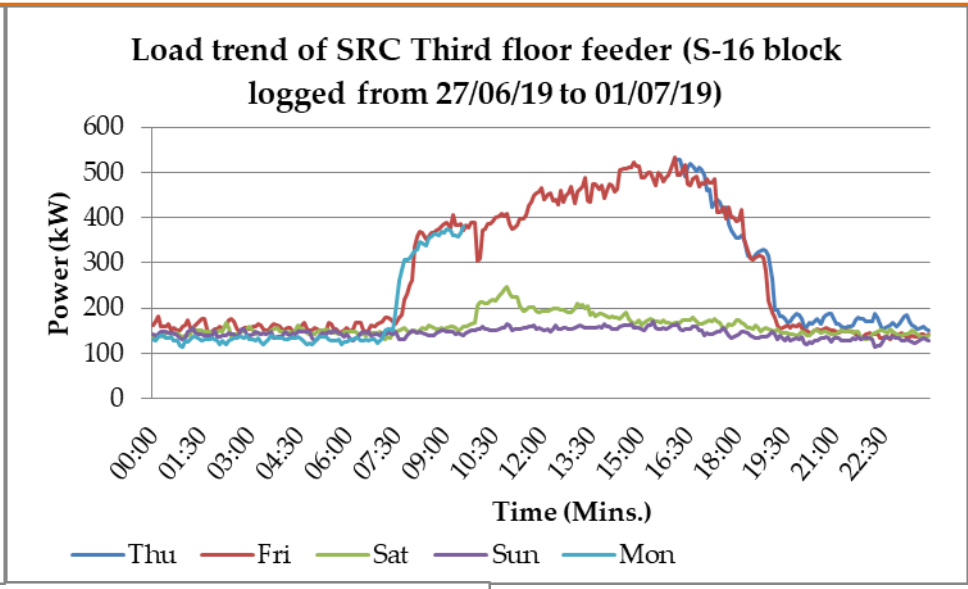


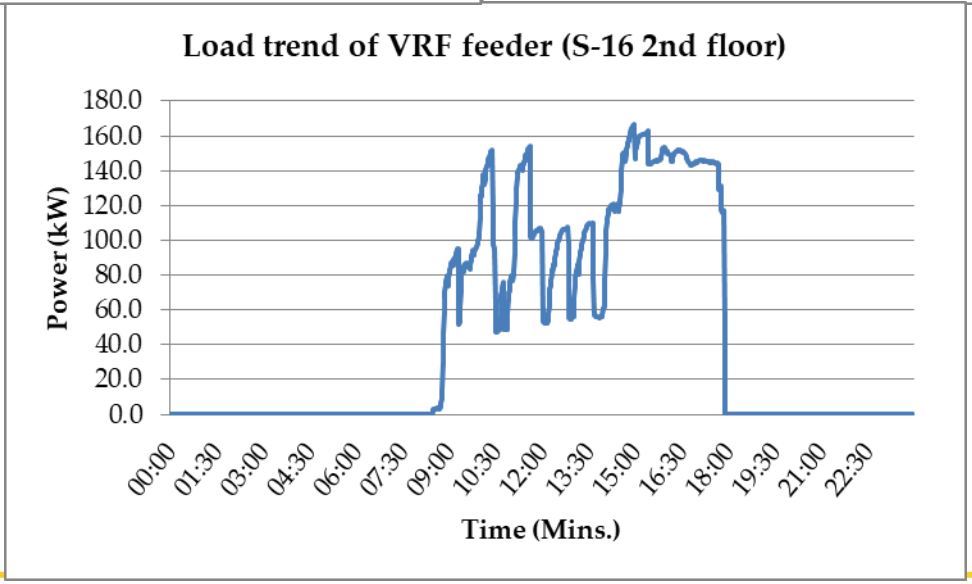




Energy data analysis



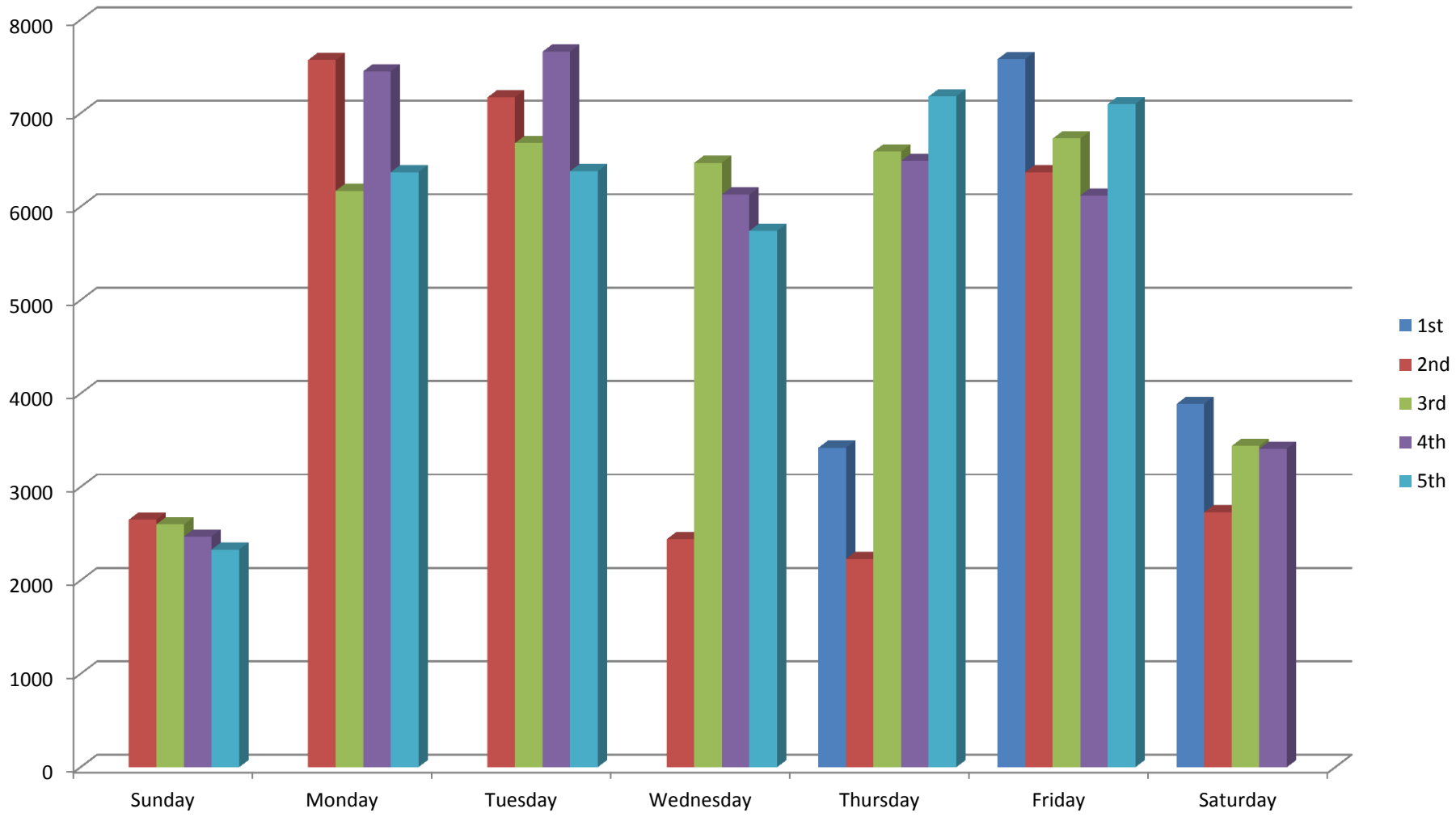




Feeders considered for analysis

- F 01: EM Incomer
- F 05: Admin MCC room
- F 09: ENV lab, RTF, Security and Canteen
- F 14: Store
- F 15: Power electronics lab
- F 16: STP
- F 17: Air Compressor
- F 20: Optronic lab
- F 21: IT server

F 01: Main Incomer



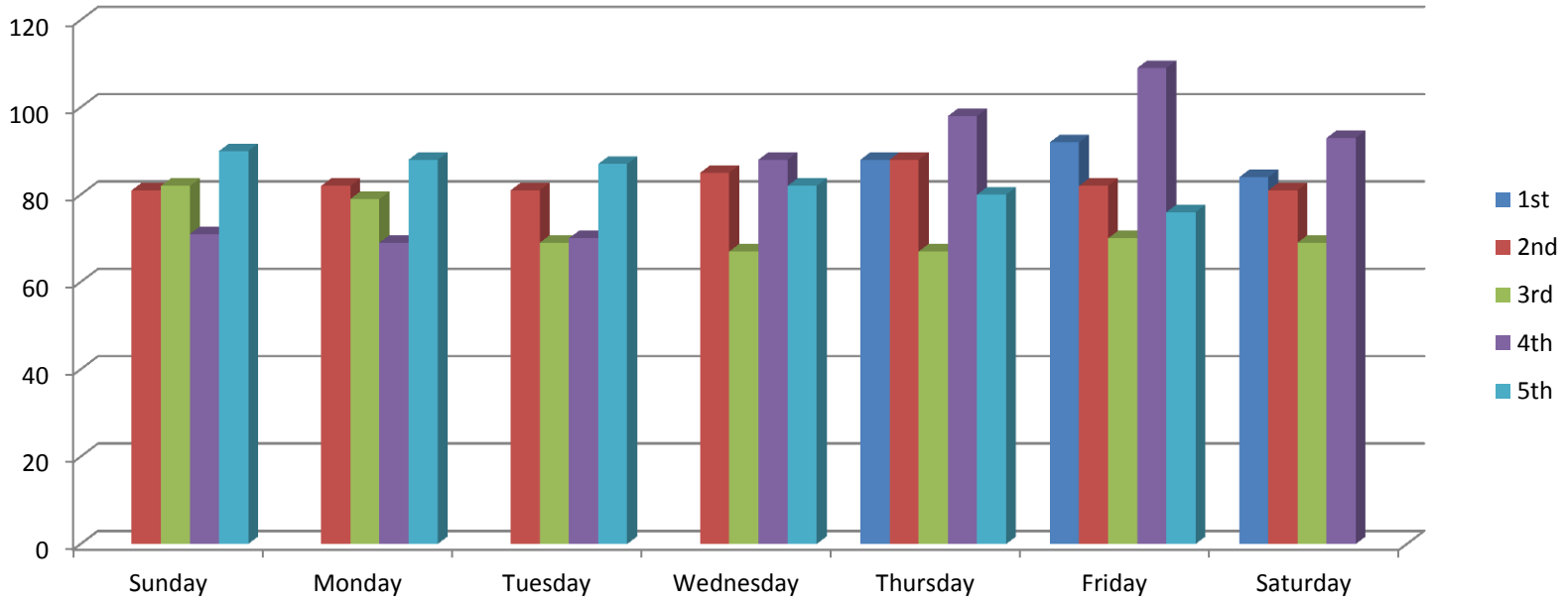
Consumption on Weekday v/s Weekend

Feeder Description	Feeder details	Date: 05/11/2018 (Monday)							Date: 11/11/2018 (Sunday)						
		Daily load	8AM to 5 PM		5PM to 10PM		10PM to 8AM		Daily load	8AM to 5 PM		5PM to 10PM		10PM to 8AM	
EM incomer	F1	7570	5500	340 to 640	1030	140 to 250	910	100 to 130	2600	960	80 to 110	580	110 to 120	1060	110 to 120
DG incomer	F2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Akash-1	F3	52	34	1 to 5	11	1 to 5	6	0 to 1	20	9	0 to 2	4	0 to 1	7	0 to 1
FLM MCC room	F4	1263	1135	66 to 154	56	7 to 17	64	5 to 16	214	109	8 to 14	40	7 to 9	65	6 to 9
Admin MCC room	F5	384	290	23 to 33	48	5 to 48	42	4 to 13	100	41	3 to 5	22	4 to 5	37	3 to 5
Proto shop	F6	16	10	0 to 2	5	1	1	0 to 1	0	0	0	0	0	0	0
Akash-3	F7	183	157	4 to 24	12	1 to 5	14	1 to 3	205	188	0 to 28	5	1	11	0 to 5
Assembly old panel	F8	66	57	2 to 9	5	1 to 2	4	0 to 1	17	7	1 to 2	5	1 to 2	5	0 to 1
ENV lab, RTF, Security and Canteen	F9	1502	1008	52 to 150	234	40 to 56	224	22 to 44	408	154	12 to 22	74	14 to 16	180	16 to 22
Paint shop	F11	256	255	0 to 44	0	0	1	0 to 1	1	1	0 to1	0	0	0	0
Akash -2	F12	17	11	1 to 2	4	0 to 2	2	0 to 1	4	2	0 to 1	1	0 to 1	1	0 to 1
Servo stabilizer	F13	267	222	13 to 28	24	3 to 7	22	2 to 3	59	25	2 to 3	13	3	21	2 to 3
Store	F14	335	280	10 to 35	27	4 to 8	28	3 to 4	72	31	3 to 4	15	3	26	2 to 3
Power electronics lab	F15	82	29	2 to 4	15	3	38	3 to 5	82	31	2 to 4	15	3	36	3 to 5
STP plant	F16	76	31	1 to 5	15	2 to 4	27	3 to 4	66	27	1 to 4	14	2 to 3	25	2 to 3
Air compressor	F17	430	399	39 to 41	31	0 to 31	0	0	0	0	0	0	0	0	0
Optronic lab	F20	2100	1500	70 to 190	380	30 to 140	220	20 to 30	980	420	40 to 50	190	30 to 40	370	40 to 50
IT server	F21	774	353	10 to 33	166	33 to 34	256	2 to 33	790	335	33 to 35	163	32 to 33	292	32 to 33
Lift	F22	11	9	1 to 2	1	0 to 1	1	0 to 1	4	2	0 to 1	1	0 to 1	1	0 to 1
	F23	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Feeders with same consumption

- F 15: Power electronics lab

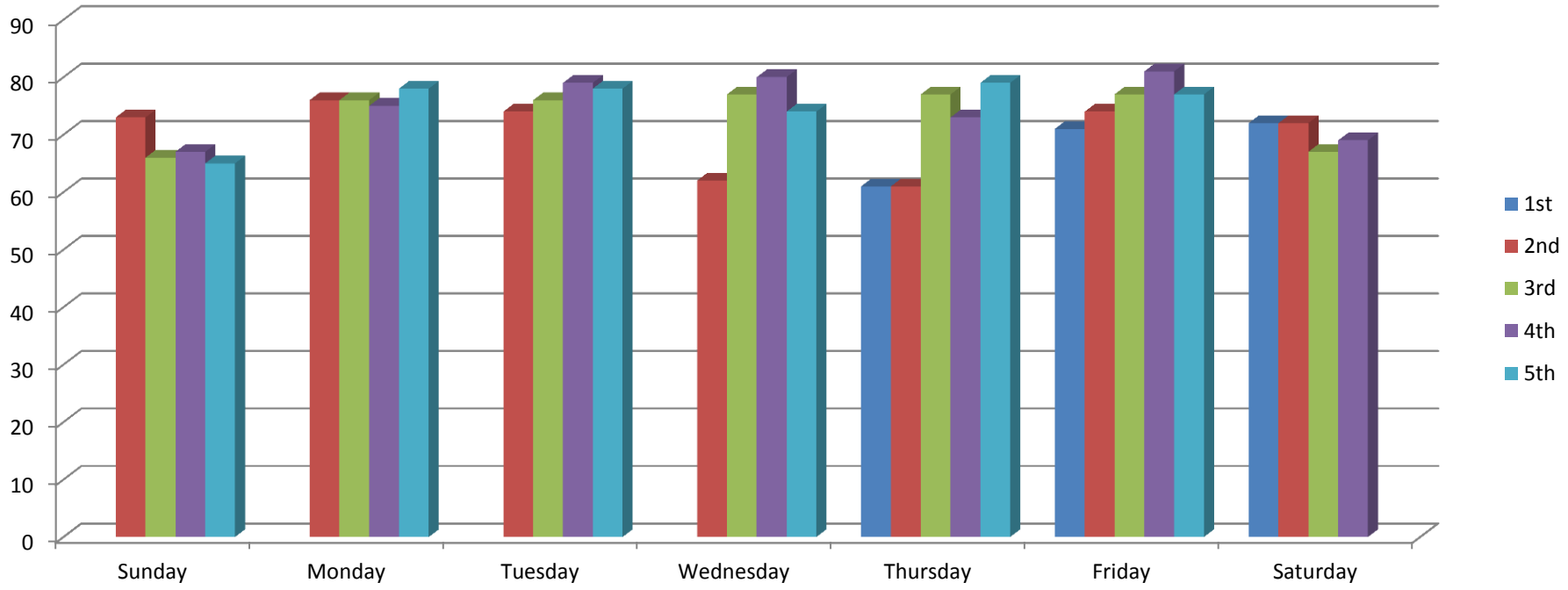
Week	1st	2nd	3rd	4th	5th
Sunday		81	82	71	90
Monday		82	79	69	88
Tuesday		81	69	70	87
Wednesday		85	67	88	82
Thursday	88	88	67	98	80
Friday	92	82	70	109	76
Saturday	84	81	69	93	



Feeders with same consumption

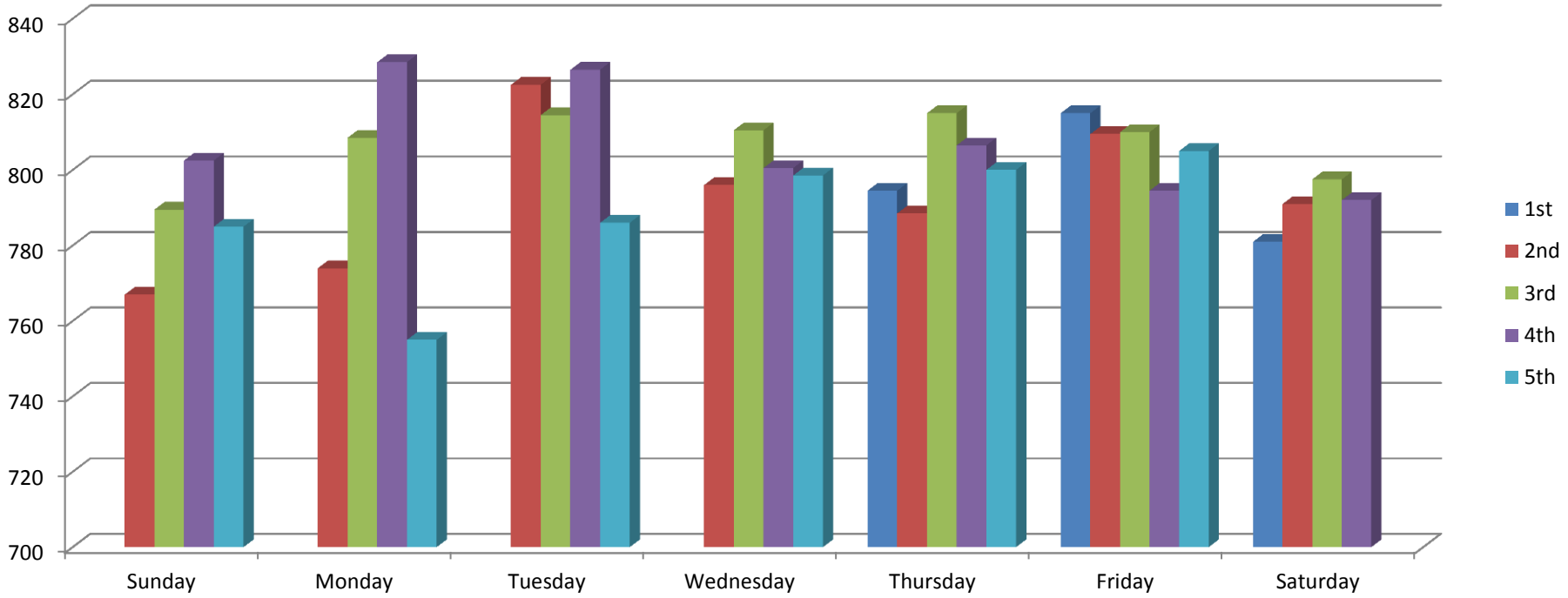
- F 16: STP plant

Week	1st	2nd	3rd	4th	5th
Sunday		73	66	67	65
Monday		76	76	75	78
Tuesday		74	76	79	78
Wednesday		62	77	80	74
Thursday	61	61	77	73	79
Friday	71	74	77	81	77
Saturday	72	72	67	69	



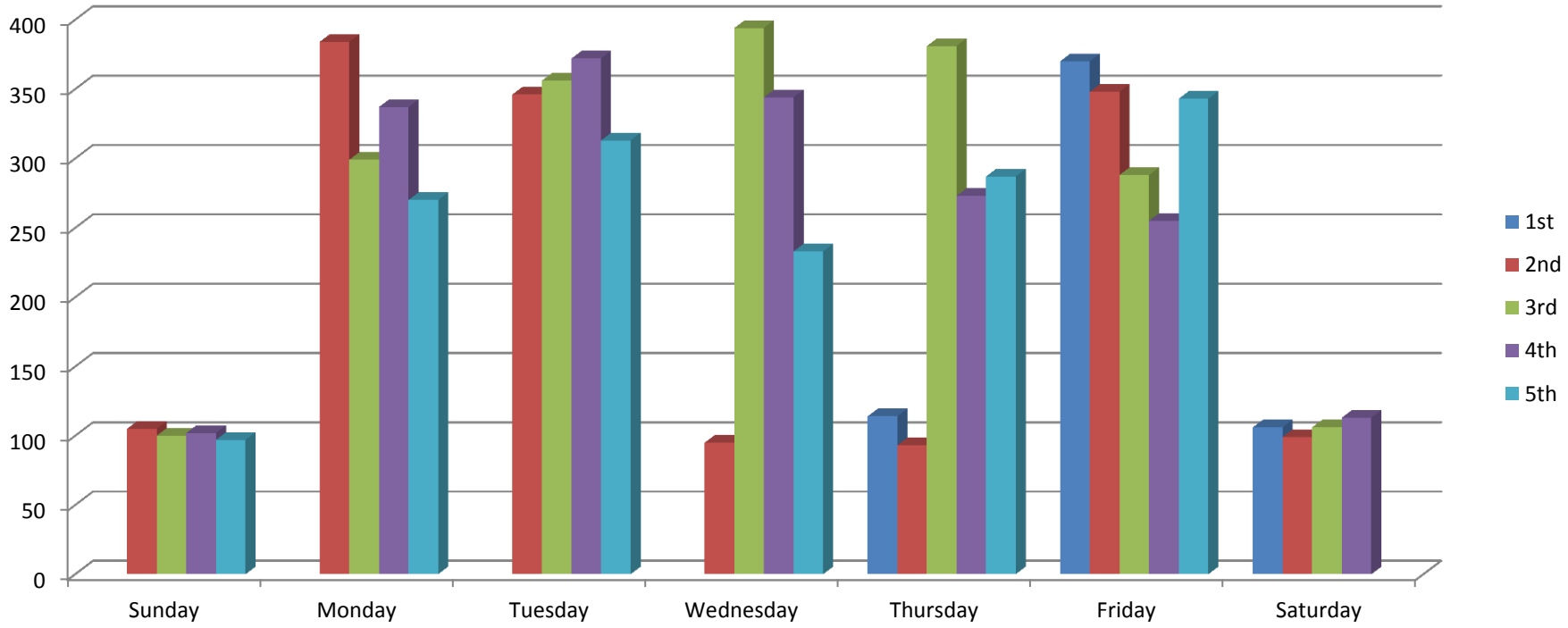
- F 21: IT server

Week	1st	2nd	3rd	4th	5th
Sunday		767	789	803	785
Monday		774	809	829	755
Tuesday		823	815	827	786
Wednesday		796	811	801	799
Thursday	795	789	815	807	800
Friday	815	810	810	795	805
Saturday	781	791	798	792	



F 05: Admin MCC room

Week	1st	2nd	3rd	4th	5th
Sunday		105	100	102	97
Monday		384	299	337	270
Tuesday		346	356	372	313
Wednesday		95	394	344	233
Thursday	114	93	381	273	287
Friday	370	348	288	255	343
Saturday	106	99	106	113	

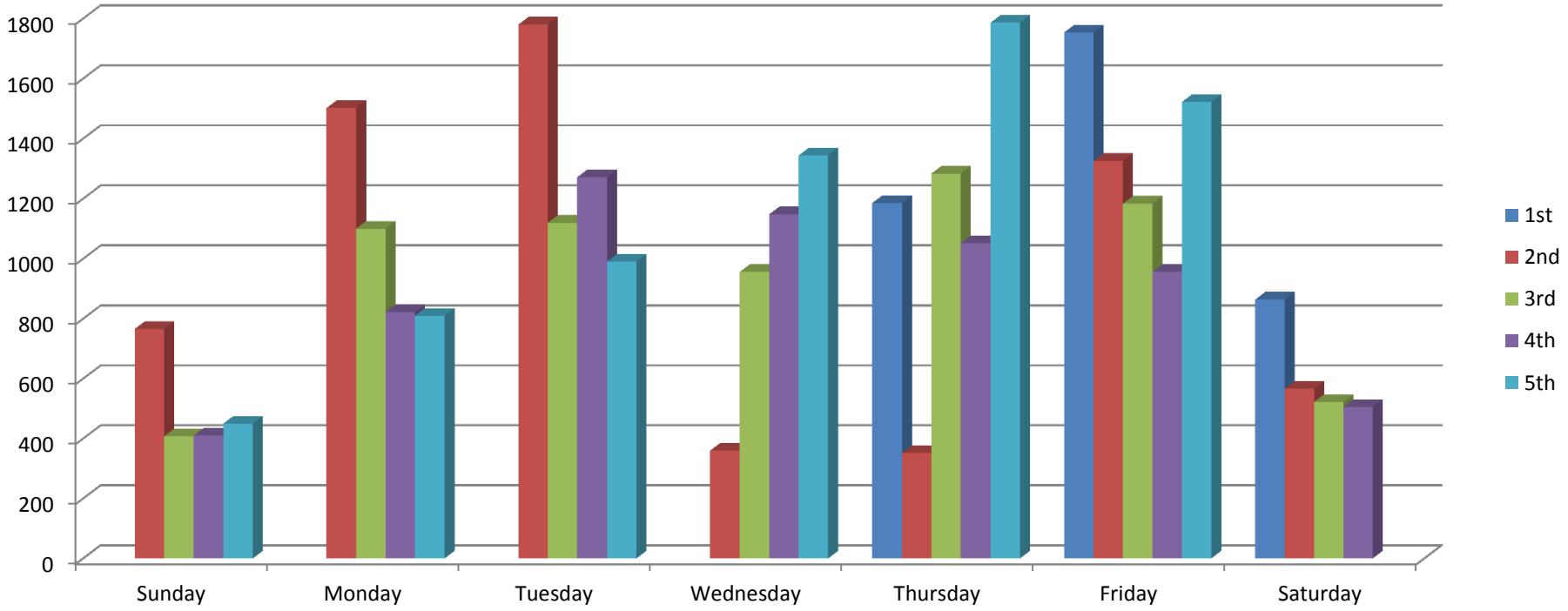


F 05: Admin MCC room

Weekday	Parameter	1st	2nd	3rd	4th	5th
	kWh/day		***105***	***100***	***102***	***97***
	8AM to 5PM		43	41	43	38
	5PM to 10PM		21	21	21	21
Sunday	10PM to 8AM		*41*	*38*	*38*	*38*
	kWh/day		***384***	***299***	***337***	***270***
	8AM to 5PM		277	222	248	183
	5PM to 10PM		69	39	50	47
Monday	10PM to 8AM		38	38	39	40
	kWh/day	***106***	***99***	***106***	***113***	
	8AM to 5PM	46	42	48	48	
	5PM to 10PM	22	20	21	24	
Saturday	10PM to 8AM	38	99	37	41	

F 09: ENV lab, RTF, Security and Canteen

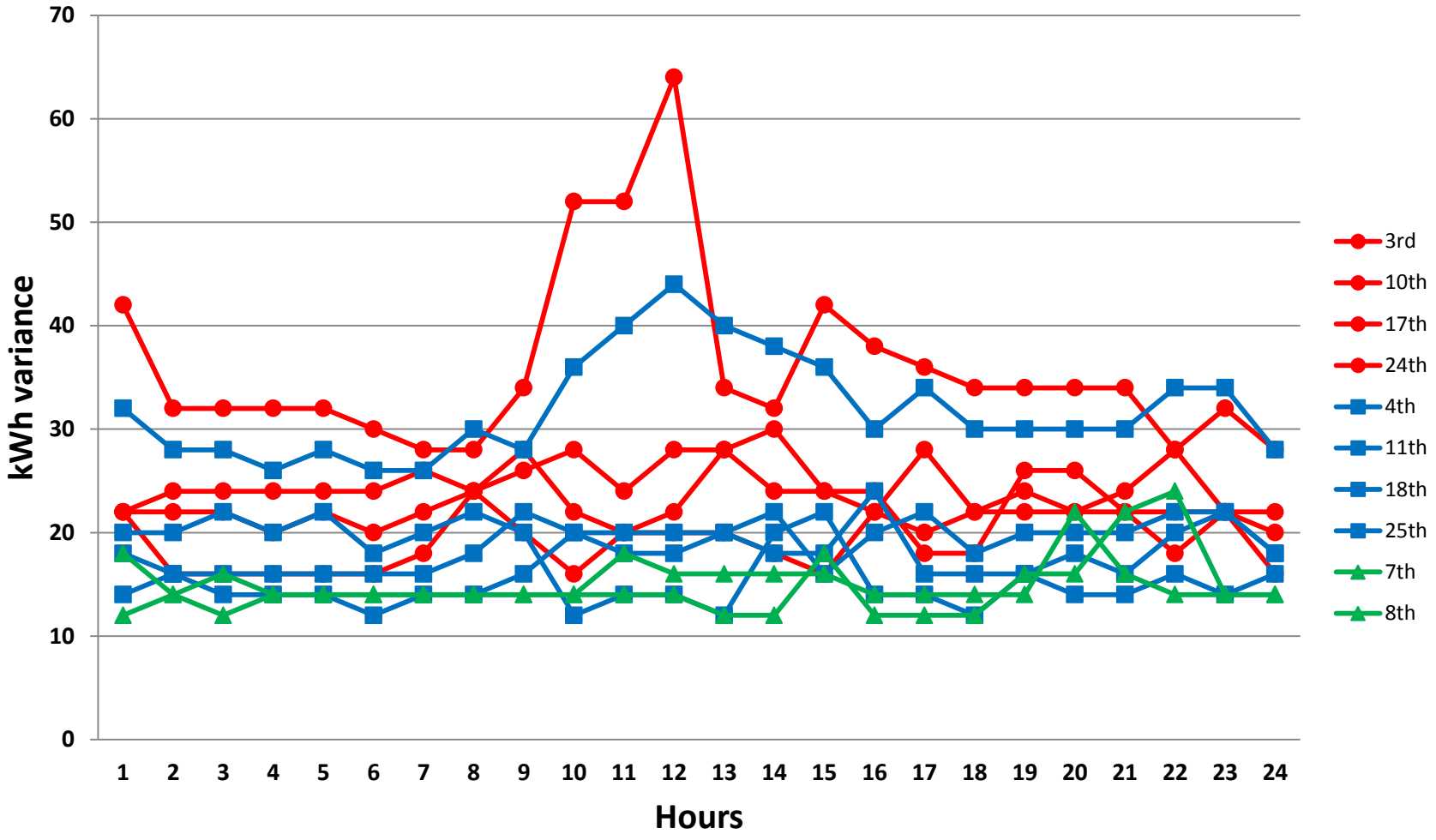
Week	1st	2nd	3rd	4th	5th
Sunday		766	408	410	450
Monday		1502	1100	822	810
Tuesday		1780	1120	1272	990
Wednesday		360	956	1148	1344
Thursday	1186	352	1284	1052	1786
Friday	1754	1326	1184	956	1522
Saturday	864	566	522	506	



F 09: ENV lab, RTF, Security and Canteen

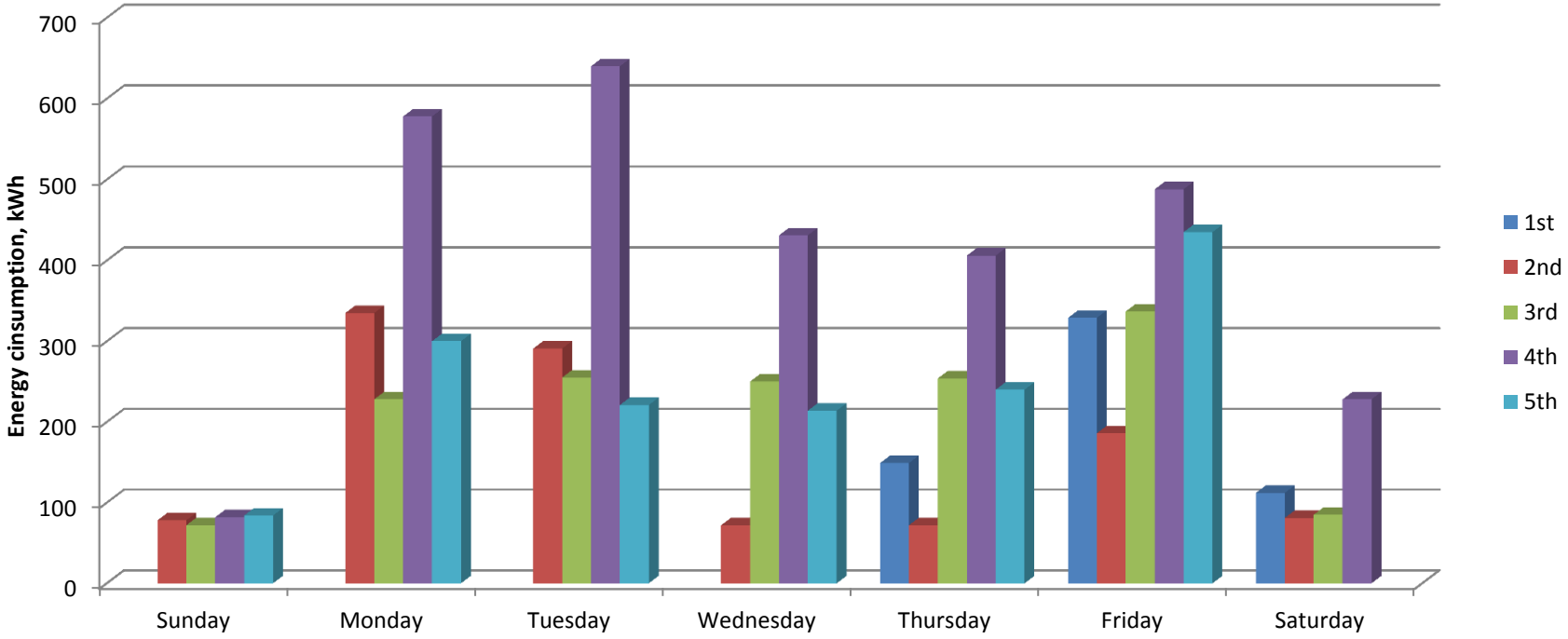
Weekday		1st	2nd	3rd	4th	5th
	kWh/day		***766***	***408***	***410***	***450***
	8AM to 5PM		356	164	186	196
	5PM to 10PM		154	72	86	100
Sunday	10PM to 8AM		*256*	*172*	*138*	*154*
	kWh/day		***1502***	***1100***	***822***	***810***
	8AM to 5PM		994	698	458	524
	5PM to 10PM		252	246	194	130
Monday	10PM to 8AM		256	156	170	156
	kWh/day	***864***	***566***	***522***	***506***	
	8AM to 5PM	412	254	204	234	
	5PM to 10PM	164	118	112	110	
Saturday	10PM to 8AM	288	566	206	162	

F 09: ENV lab, RTF, Security and Canteen



F 14: Store

Week	1st	2nd	3rd	4th	5th
Sunday		78	72	82	84
Monday		335	228	578	300
Tuesday		291	255	640	221
Wednesday		72	250	431	214
Thursday	149	72	254	406	240
Friday	329	186	337	488	435
Saturday	112	81	85	228	

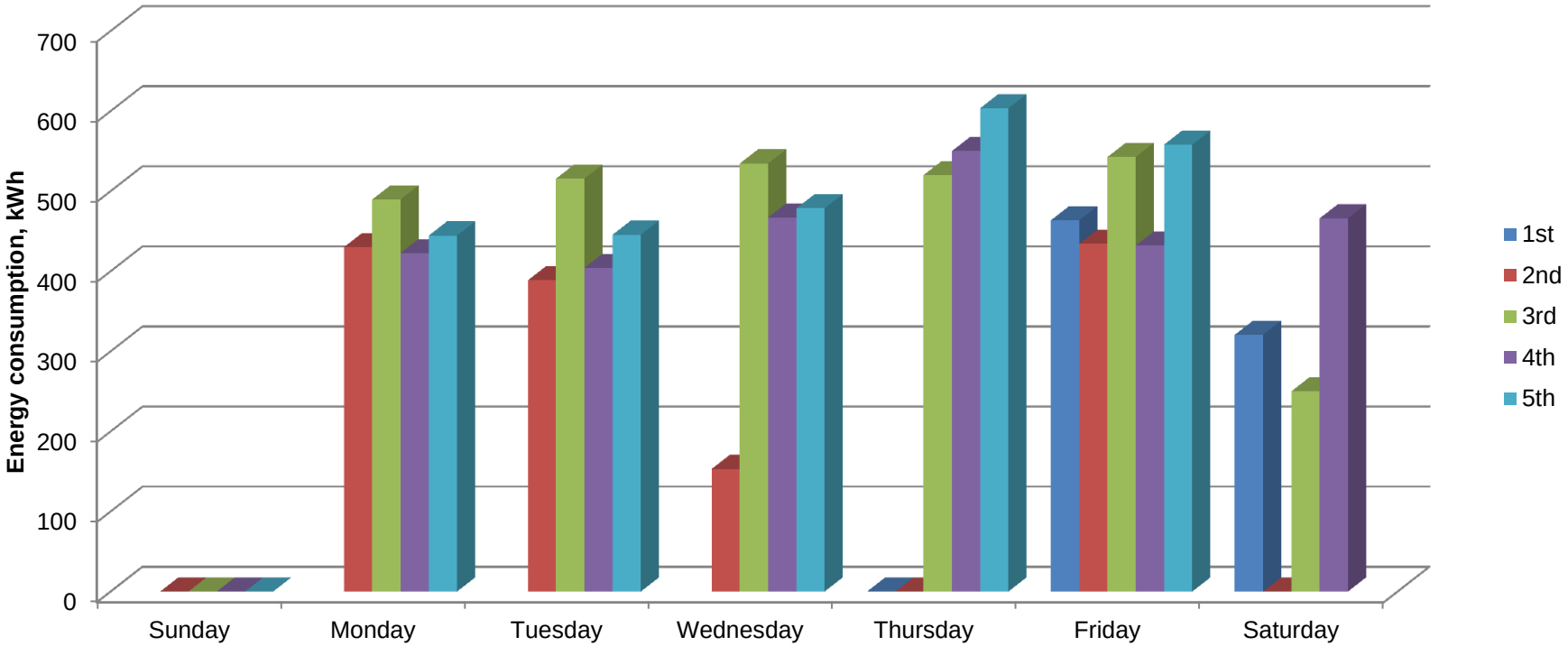


F 14: Store

Weekday		1st	2nd	3rd	4th	5th
	kWh/day		***78***	***72***	***82***	***84***
	8AM to 5PM		32	30	35	37
	5PM to 10PM		17	15	17	17
Sunday	10PM to 8AM		*29*	*27*	*30*	*30*
	kWh/day		***335***	***228***	***578***	***300***
	8AM to 5PM		261	173	402	204
	5PM to 10PM		46	27	145	64
Monday	10PM to 8AM		28	28	31	32
	kWh/day	***112***	***81***	***85***	***228***	
	8AM to 5PM	65	35	38	92	
	5PM to 10PM	19	18	17	23	
Saturday	10PM to 8AM	28	81	30	113	

F 17: Air Compressor

	1st	2nd	3rd	4th	5th
Sunday		0	0	0	0
Monday		430	490	423	445
Tuesday		389	516	404	446
Wednesday		153	535	467	479
Thursday	0	0	520	550	604
Friday	464	434	543	432	558
Saturday	321	0	250	466	

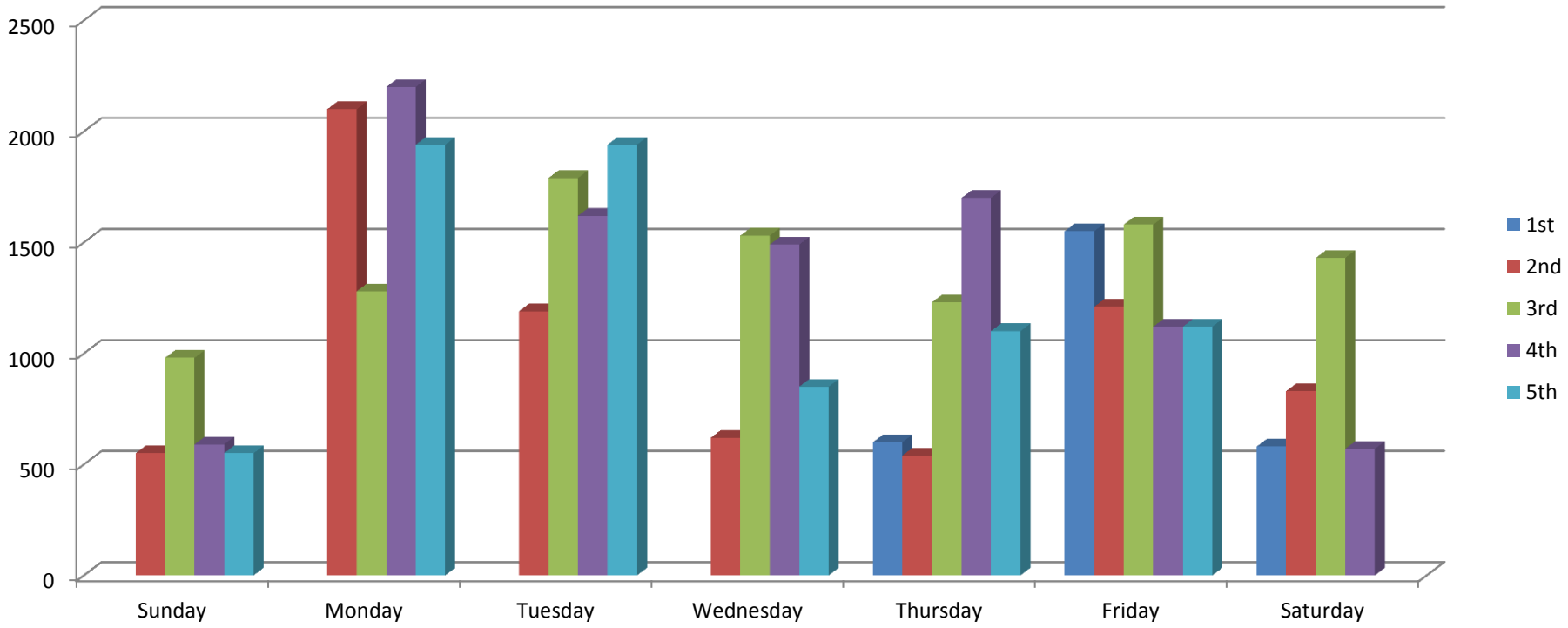


F 17: Air Compressor

Weekday		1st	2nd	3rd	4th	5th
Sunday	***kWh/day***		***0***	***0***	***0***	***0***
Monday	***kWh/day***		***430***	***490***	***423***	***445***
	8AM to 5PM		360	338	354	306
	5PM to 10PM		71	152	69	139
	10PM to 8AM		0	0	0	0
Saturday	***kWh/day***	***321***	***0***	***250***	***466***	
	8AM to 5PM	290	0	194	346	
	5PM to 10PM	31	0	36	87	
	10PM to 8AM	0	0	21	34	

F 20: Optronic lab

Week	1st	2nd	3rd	4th	5th
Sunday		550	980	590	550
Monday		2100	1280	2200	1940
Tuesday		1190	1790	1620	1940
Wednesday		620	1530	1490	850
Thursday	600	540	1230	1700	1100
Friday	1550	1210	1580	1120	1120
Saturday	580	830	1430	570	



Compressed air

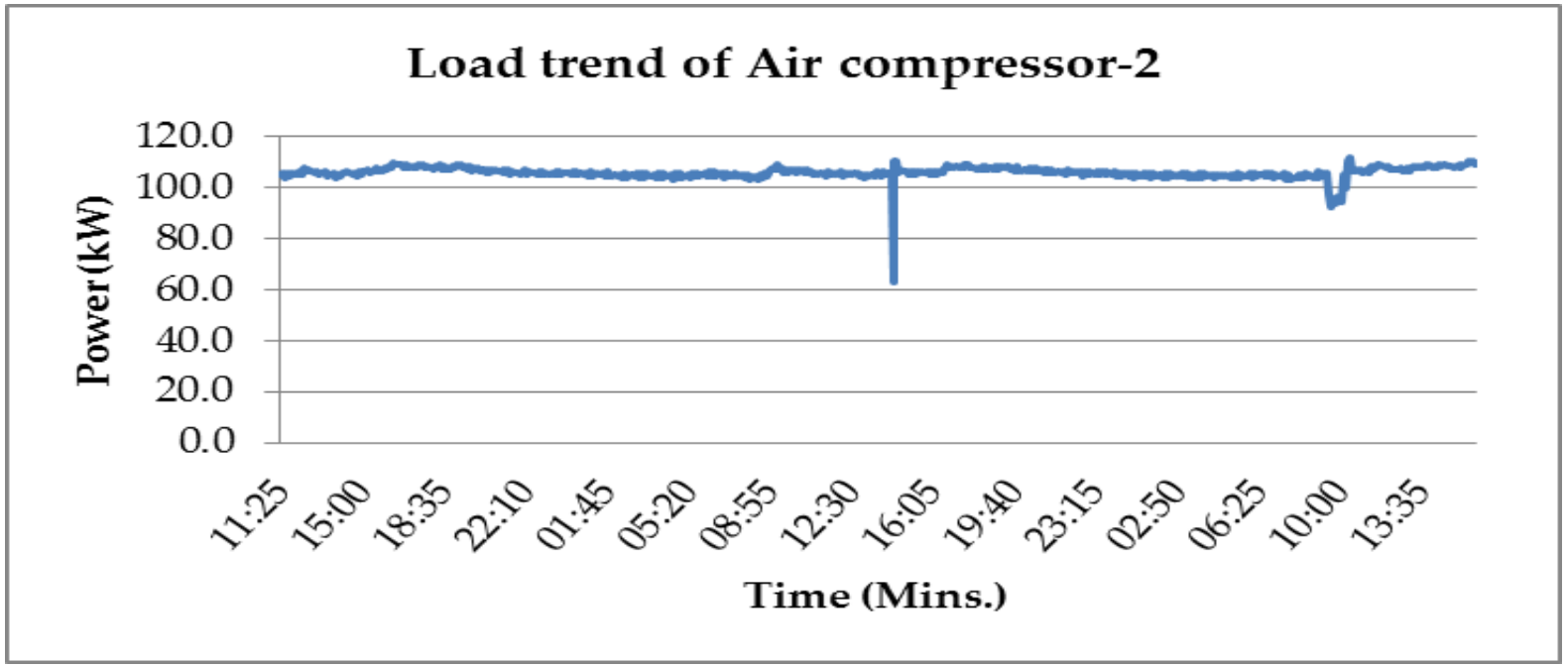
Compressed Air system

S.No	Energy Conservation Measures	Annual Energy Savings Potential	Annual energy cost Savings,	Investment, Cost	Simple payback period
		Electricity, Lakh kWh	Value, Rs Lakh	Rs Lakh	Years
SHORT TERM MEASURES					
1	Replace S 16 air compressor with S 14 air compressor	0.39	3.28	3	0.9
	Total	**0.39**	**3.28**	**3**	**0.9**

Compressed Air system

Description	Unit	Air compressor
Make		Atlas copco
Model		ZT -90- FF VSD
Type		Air cooled, Screw type, Oil free
Free Air Delivery	cfm	492
Pressure	kg/cm^2	9.0
Motor	kW	90
Installed numbers	Nos.	2

Energy Consumption trend - Air compressor - 2



Compressor	Load power, kW	Actual FAD, CFM	Sp. Power Consumption, (kW/ CFM)
Air Compressor -1	90	510	0.194
Air Compressor - 2	107	512	0.189

Energy Conservation Measures - Air compressors

1. Replace S16 Water cooled air compressor with S14 Air cooled air compressor.

Background :S16 Air compressor is water cooled type (No cooling water at present chilled water used). S14 air compressor is air cooled and cooling water is available).

Description	Unit	Value
Power consumption towards condenser cooling with chilled water	kW	6.0
Power consumption for normal water cooling	kW	1.49
Reduce in energy by replacing S14 Air compressor with S16 Air compressor	kW	4.46
Total energy savings	kW	4.46
Annual operating hours (360daysX24)	hours	8640
Annual Energy Savings	kWh	38551
Annual cost savings (Rs.8.50/kWh)	Rs. Lakhs	3.28
Investment (Replacement)/ provide cooling tower	Rs. Lakh	3
Payback period	Years	0.9

2. Plug compressed air leakages

Background :

During the study period it was observed that air leakages mainly found in hose pipe joints, air regulators and pipe joints. Hence it is to carryout compressed air leak test on every 4 months once

Recommendation : Plug compressed air leaks, Wherever possible use welding for plugging, as it is a good practice and should be preferred over threaded connection

HVAC

HVAC

S.No	Energy Conservation Measures	Annual Energy Savings Potential	Annual energy cost Savings,	Investment, Cost	Simple payback period
		Electricity, Lakh kWh	Value, Rs Lakh	Rs Lakh	Years
SHORT TERM MEASURES					
1	Switch of primary chilled water pump	1.10	9.34	Nil	Immediate
2	Replace process chilled water pump with optimum sized pump	0.17	1.43	1.5	1.05
3	Bypass VFDs of AHUVFM01, AHU 521, AHUVFM6, AHUVFM5, AHU516, AHU511, CSU01	0.02	0.20	Nil	Immediate
4	Avoid leakage of cold supply air via parallel connected stand-by systems for S16/TF/VAU 15A ,B and S16/TF/VAU13A,B	0.32	2.70	Minimal	Immediate
	Sub-Total	**1.61**	**13.67**	**1.5**	**0.1**

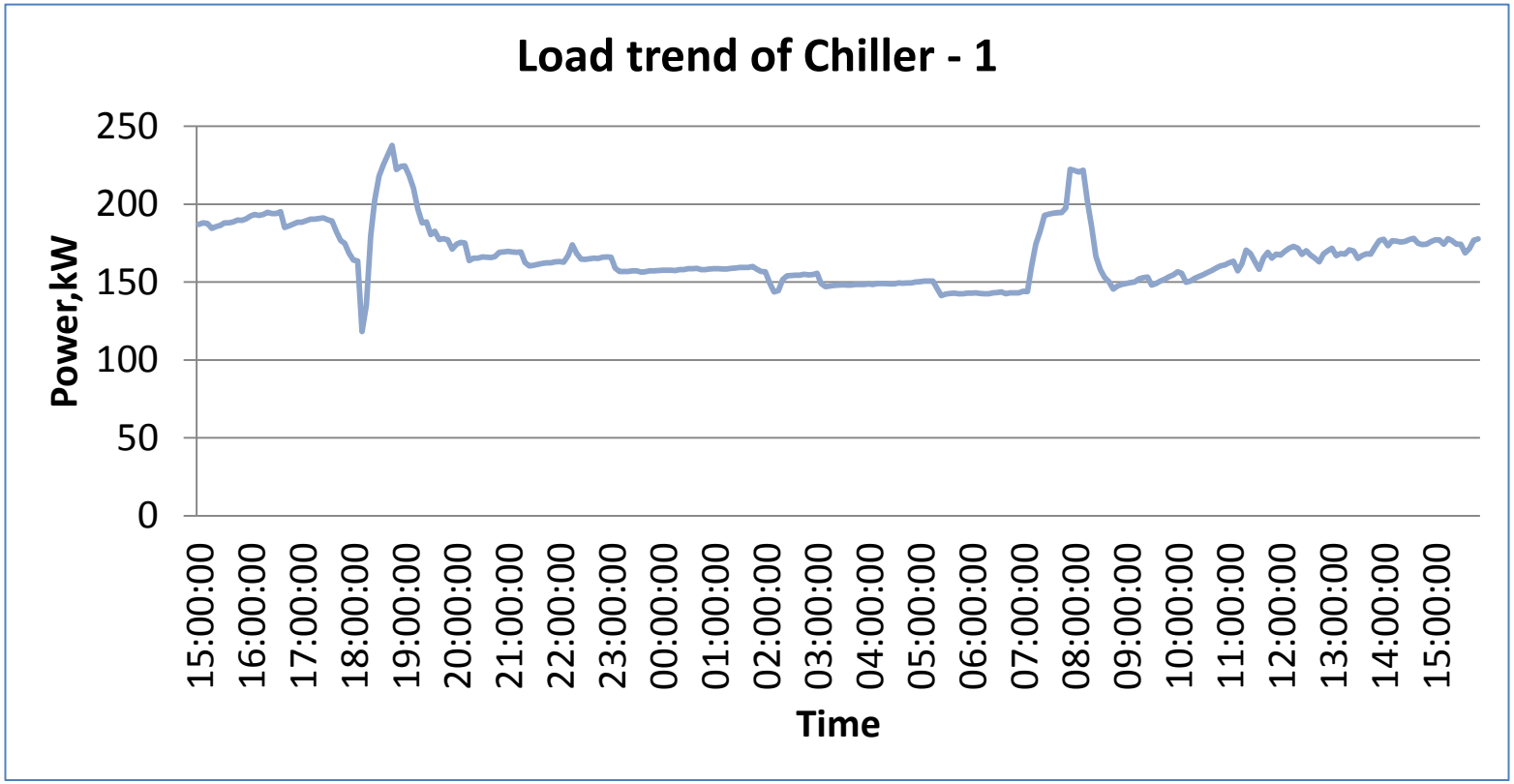
HVAC

S.No	Energy Conservation Measures	Annual Energy Savings Potential	Annual energy cost Savings,	Investment, Cost	Simple payback period
		Electricity, Lakh kWh	Value, Rs Lakh	Rs Lakh	Years
LONG TERM MEASURES					
7	Technology upgradation to Electronically Commutated (EC) fan motors for the AHUs	0.96	8.14	37.62	4.6
	Sub-Total	0.96	8.14	37.62	4.6
	Grand Total	2.57	21.81	39.12	1.8

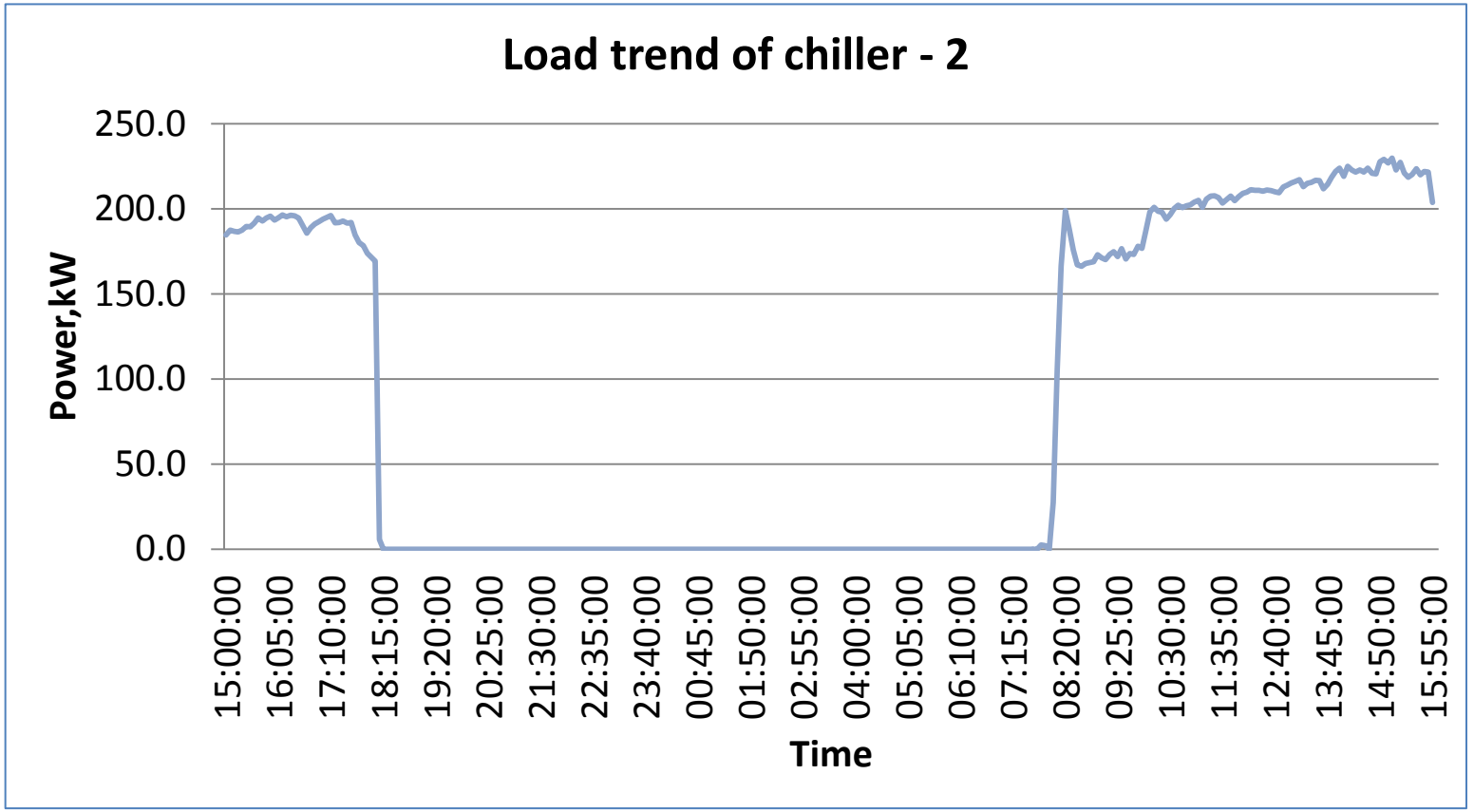
HVAC

Description	Unit	Chiller – 1,2 &3
Type		Air cooled Semi Hermetic screw
Model		FOCS2/CA3602
Make of compressor		Bitzer
No of compressor in each chiller	Nos.	2
Refrigerant		R134A
Type of Evaporator		Shell & Tube - Dx
Make of Evaporator		Climaveneta
Evaporator water flow	m^3/h	93
Entering water temperature (EWT)	^0C	15
Leaving water temperature (LWT)	^0C	7
Differential Temperature	^0C	8
Air cooled condenser		
Number of fans per chiller	Nos.	16
Input power of condenser fans, each	kW	2
Max. Ambient temperature	0C	36
Cooling Capacity	TR	246
Power input to chiller compressor	kW	240.7
Max. Input power including condenser fans	kW/TR	272.7
Specific Energy Consumption	kW/TR	1.11kW/TR

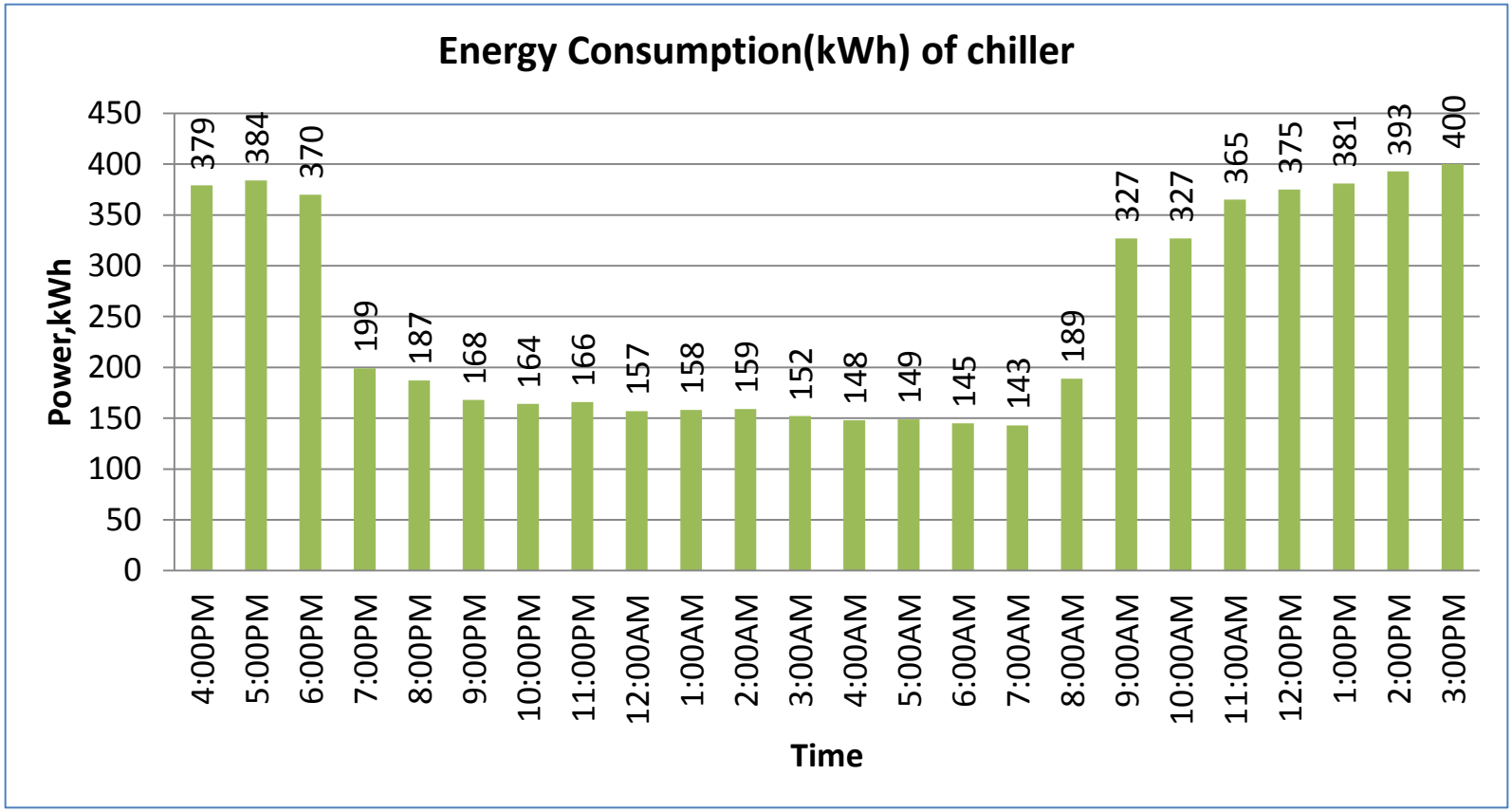
Power consumption trend of Chiller – 1



Power consumption trend of chiller – 2



Total Power consumption (kWh) trend of chillers



Performance – Air cooled Chillers

Particulars	Units	Design Parameters	Chiller - 1	Chiller - 2
Type		**Air cooled, Semi Hermetic Rotary Screw**		
Refrigerant			R134a	
Evaporator water flow	m^3/h	93	98	99
Entering water temperature (EWT)	0C	15	13	13.1
Leaving water temperature (LWT)	0C	7	8	8.1
Differential Temperature	0C	8	5	5
Cooling Capacity	TR	246	162	164
Power input to chiller compressor (including condenser fans)	kW	273	187	190
Specific Energy Consumption(including condenser fans)	**kW/TR**	**1.1**	**1.2**	**1.2**

Ambient air temperature of around 29 ^{0}C & RH of 68%

Energy Conservation Measures - Chillers

1. Switch – off additional operating primary chilled water pumps

Background :Additional primary pumps operated (during day time 2 chiller 4 pumps. Night hours 1 chiller, 3 pumps)

Recommendation : Each chiller operation, operate single primary chilled water pump

Description	Unit	Value
Power consumption of primary pumps (day time) 4 nos.	kW	28.4
Power consumption of primary pumps (night time) 3 nos.	kW	23.0
Energy consumption two pumps during day time (2 pumps)	kW	16.6
Energy consumption single pump during night (1 pump)	kW	8.4
Energy Savings by switching off of two pumps during daytime	kW	11.8
Energy Savings by switching off of two pumps during night time	kW	14.6
Four pumps operating hours	hours	13.0
Three pumps operating hours	hours	11.0
Total energy savings per day	kWh	314.0
Annual operating days	hours	350
Annual Energy Savings	kWh	109900
Annual cost savings (Rs.8.50/kWh)	Rs. Lakhs	9.3
Investment	Rs. Lakh	Nil
Payback period	Years	Immediate

Energy Conservation Measures - Chillers

2. Replace process chilled water pump with optimum size pump

Background :Mismatch in actual demand Vs installed pump capacity.

Recommendation : Replace process pump with optimum size Pump

Description	Unit	Value
Power consumption of process chilled water pump	kW	6.7
Calculated power of new optimum size pump with VSD	kW	4.7
Energy Savings	hours	2.0
Annual operating hours	hours	8400.0
Annual Energy Savings	kWh	16800
Annual cost savings (Rs.8.50/kWh)	Rs. Lakhs	1.4
Investment	Rs. Lakh	1.5
Payback period	Years	1.05

3. Technology up gradation to Electronically Commutated (EC) fan motors for the AHUs

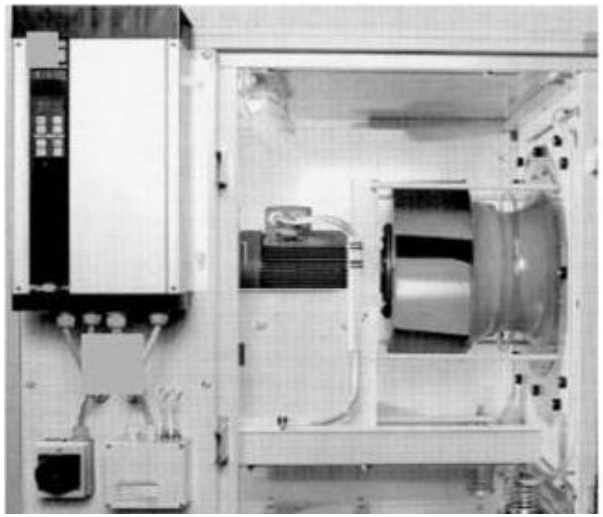
Background

- Plugged/pulley type driven fan motors at present with VFD.
- Frequencies set either auto or manual mode operation
- Based on user side pressure requirements

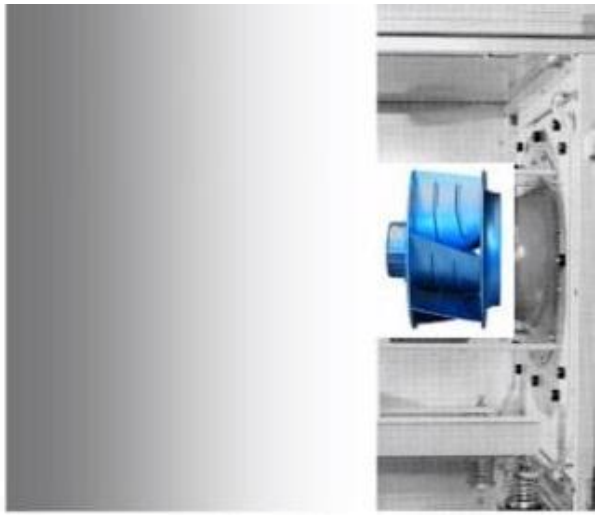
Recommendation

- Convert to direct coupled DC based brushless EC motor driven fans.
- Improved performance, higher efficiency, compact and reliable.

3. Technology up gradation to Electronically Commutated (EC) fan motors for the AHUs



Conventional motor-fan with VFD



EC motors

3. Technology up gradation to Electronically Commutated (EC) fan motors for the AHUs

Energy savings

Particulars	Units	Value
Present total power consumption of the AHUs	kW	85.50
Estimated power savings on technology up gradation	kW	17.1
Annual operating hours (16 hours x 350 days)	hours	5600
Annual energy savings	lakh kWh	0.96
Annual cost savings (Rs. 8.5/kWh)	Rs. Lakh	8.14
Total installed motor capacity	kW	171
Investment	Rs. Lakh	37.62
Payback period	Years	4.62

- 40% of actual verified savings with this technology up gradation.
- Only 20% considered as power consumption with VSD being considered as base case scenario.
- Data considered for evaluation are discussed detailed in the report.

4. Bypass VFDs of AHUVFM01, AHU 521, AHUVFM6, AHUVFM5, AHU516, AHU511, and CSU01

Background

- Installed with VFD but operating at 50 Hz continously. But VFD used for dynamic operations.
- VFD inherent losses range from 2% to 4%.

Recommendation

- Bypass VFDs if dynamic operation not required.

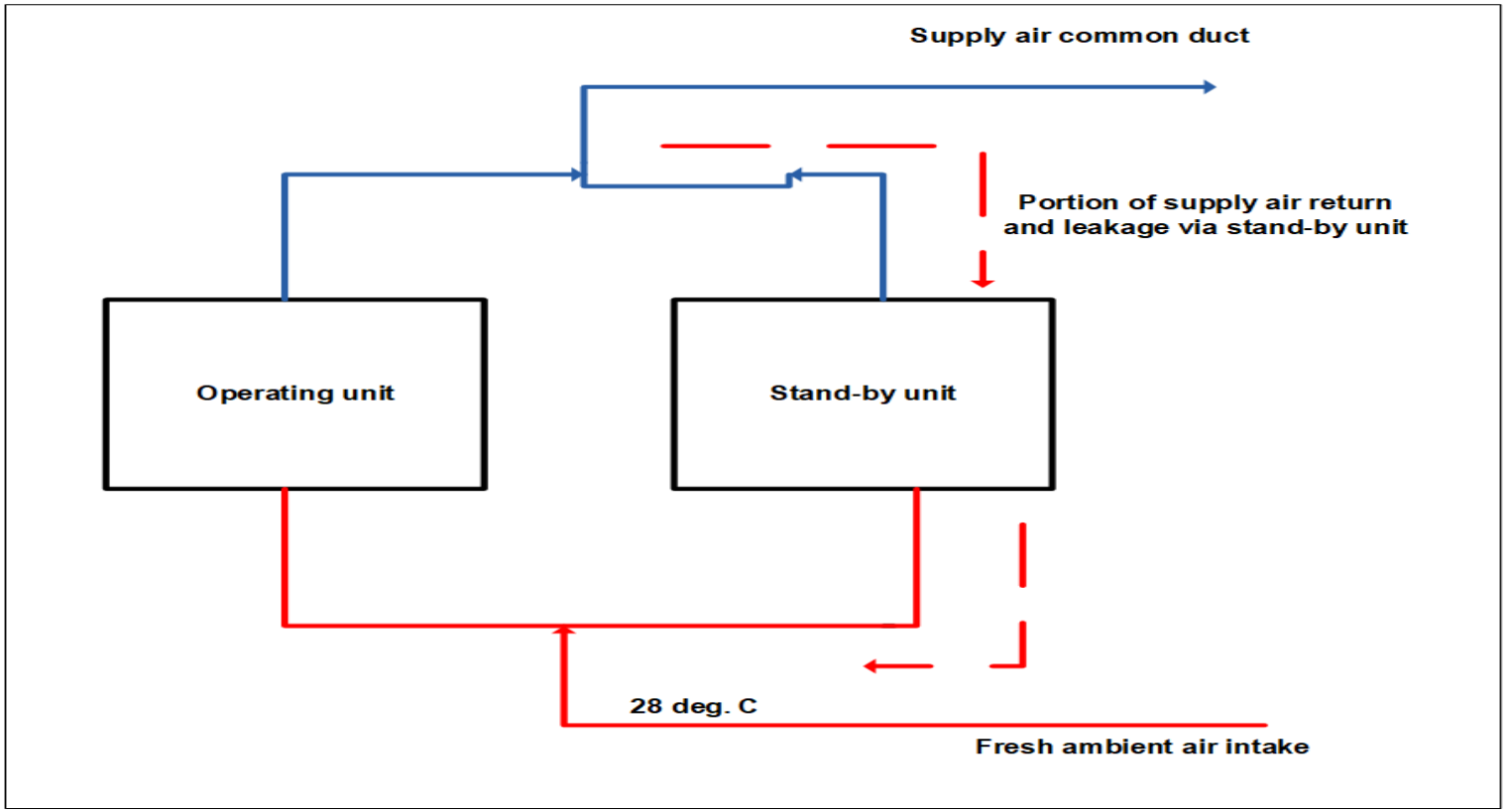
4. Bypass VFDs of AHUVFM01, AHU 521, AHUVFM6, AHUVFM5, AHU516, AHU511, and CSU01

Energy Savings

Particulars	Units	Value
Present total power consumption of the AHUs	kW	20.55
Estimated power savings on technology up gradation	kW	0.411
Annual operating hours (16 hours x 350 days)	hours	5600
Annual energy savings	lakh kWh	0.02
Annual cost savings (Rs. 8.5/kWh)	Rs. Lakh	0.20
Investment	Rs. Lakh	Nil
Payback period	Years	Immediate

5. Avoid leakage of cold supply air via parallel connected stand-by systems for S16/TF/VAU 15A, B and S16/TF/VAU13A

Background



5. Avoid leakage of cold supply air via parallel connected stand-by systems for S16/TF/VAU 15A, B and S16/TF/VAU13A

Recommendation

- Seal the leakage by installing an isolation damper

Energy Savings

Particulars	Units	Value
Equivalent TR loss	TR	0.02
Equivalent cooling load power loss	kW	0.03
Annual operating hours (16 hours x 350 days)	hours	5600
Annual energy savings	**lakh kWh**	**0.32**
Annual cost savings (Rs. 8.5/kWh)	**Rs. Lakh**	**2.70**
Investment	**Rs. Lakh**	**Minimal**
Payback period	**Years**	**Immediate**

- Fan power loss also exists due to recirculation air of around 2656 cfm. However it is not accounted in the above values..

Fans, Blowers and Vacuum pumps

Fans, Blowers & Vacuum pumps

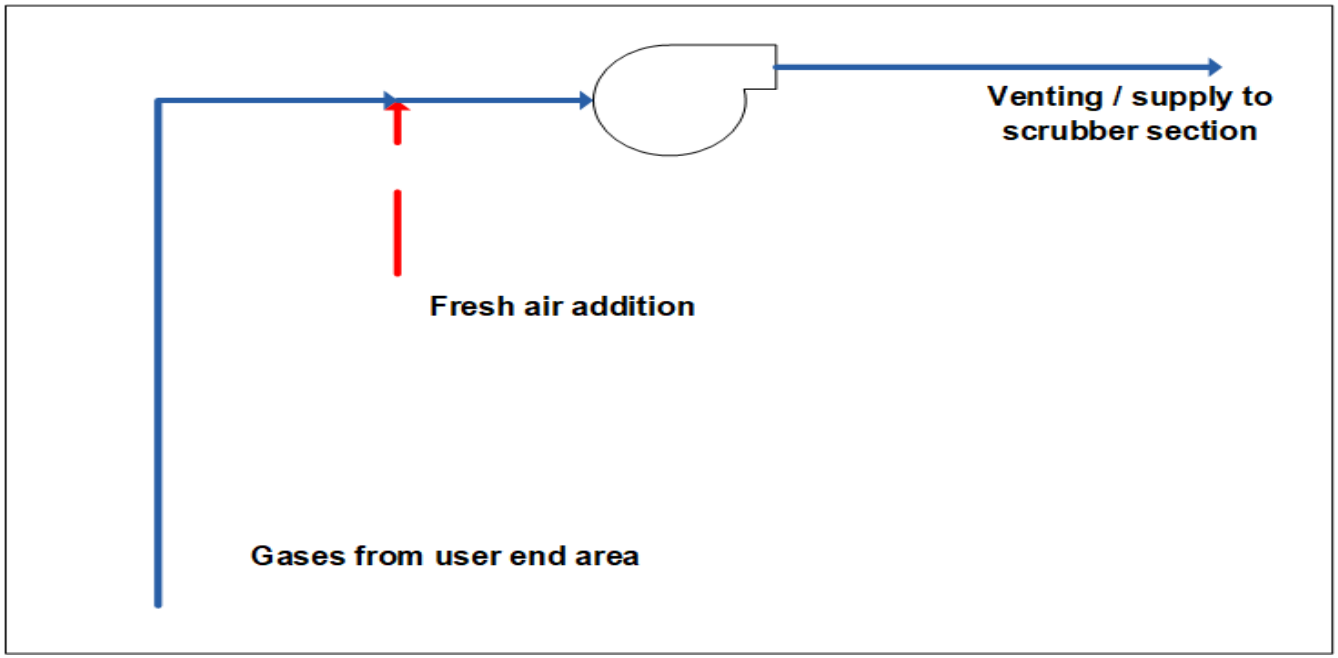
S.No	Energy Conservation Measures	Annual Energy Savings Potential	Annual energy cost Savings,	Investment, Cost	Simple payback period
		Electricity, Lakh kWh	Value, Rs Lakh	Rs Lakh	Years
SHORT TERM MEASURES					
1	Avoid fresh air inclusion at the suction of the scrubber blower for Scrubber 35, 37,38, 39, Fume exhaust 3,4,7,9			Minimal	Immediate
	Switch off Scrubber 27 B blower which is installed improperly	0.11	0.95	Nil	Immediate
	Sub-Total	**0.11**	**0.95**	**0**	**Immediate**
MEDIUM TERM MEASURES					
2	Technology upgradation to Electronically Commutated (EC) fan motors for EAUs and VAUs.	0.52	4.42	13.2	3.0
	Sub-Total	**0.52**	**4.42**	**13.2**	**3.0**
	Total	**0.63**	**5.37**	**13.20**	**2.5**

Vacuum pumps

1. Avoid fresh air inclusion at the suction of the scrubber blower for Scrubber 35, 37, 38, 39, Fume exhaust 3,4,7,9.

Background

- Fresh air addition observed on the suction side of the blower.
- Wastage of power
- Least resistance path by fluid.



Vacuum pumps

1. Avoid fresh air inclusion at the suction of the scrubber blower for Scrubber 35, 37, 38, 39, Fume exhaust 3,4,7,9.

Recommendation

- Close the damper and maintain suitable reduced VFD frequency.
- Standardize required static pressure at user side and operate on pressure feedback in future.

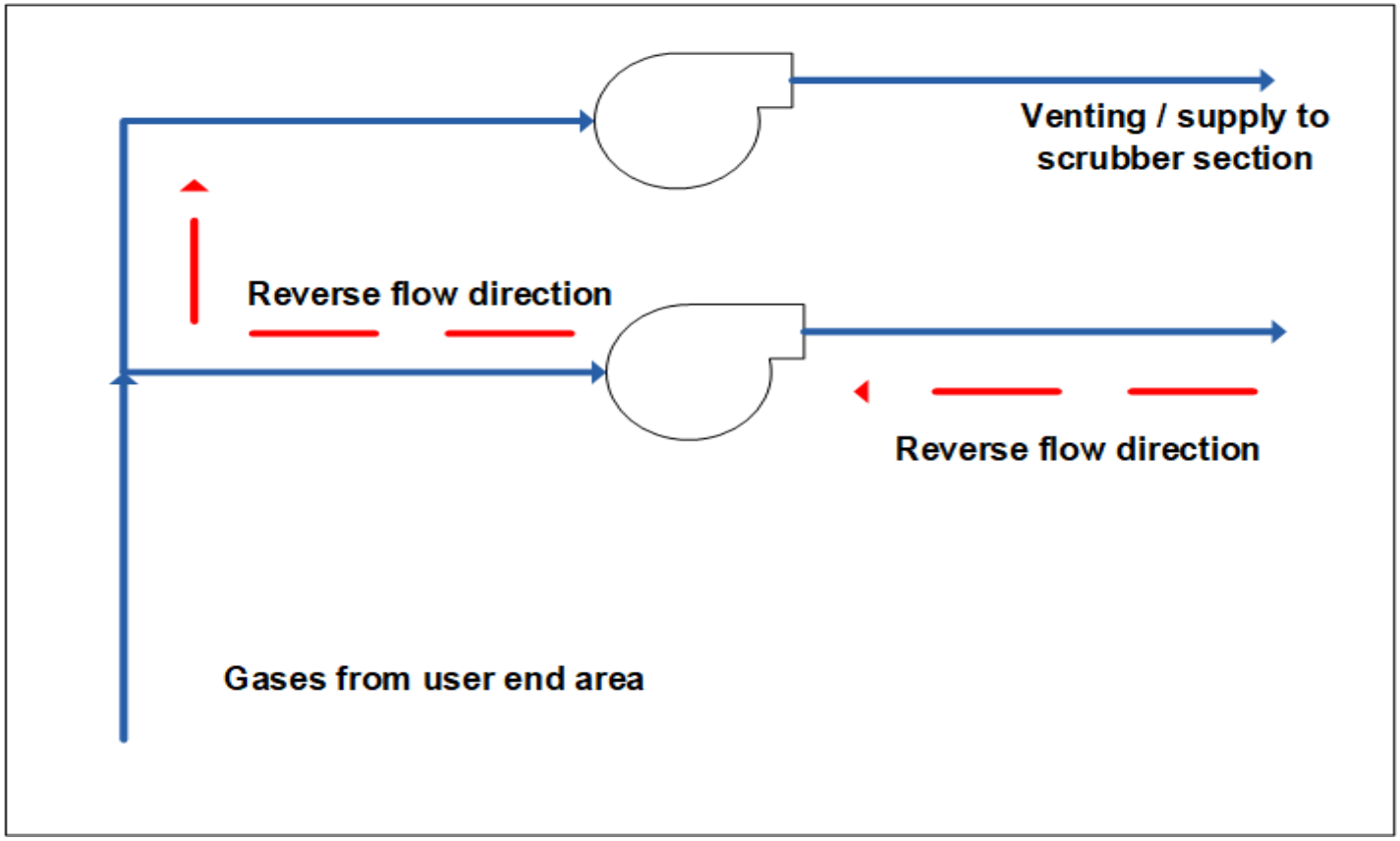
Energy Savings

Particulars	Units	Scrubber 35	Scrubber 37	Scrubber 38	Scrubber 39
Present flow	Cfm	2030.05	4845.87	3986.71	2434.46
Fresh air addition	Cfm	114.29	799.42	799.42	678.3
Percentage fresh air	%	5.63	16.50	20.05	27.86
Particulars	Units	Fume Exhaust system 7	Fume Exhaust system 9	Fume Exhaust system 3	Fume Exhaust system 4
Present flow	Cfm	8123.14	5247.23	9714.22	6902.69
Fresh air addition	Cfm	1883.25	1345.18	429.11	281.6
Percentage fresh air	%	23.18	25.64	4.42	4.08

Blowers and Fans

2. Switch off Scrubber 27 B blower which is installed improperly

Background



Blowers and Fans

2. Switch off Scrubber 27 B blower which is installed improperly

Recommendation

- Rectify the rotation and installation of blower
- For parallel operation, set same frequency for both the blowers.

Energy Savings

Particulars	Units	Value
Estimated power savings (power consumption)	kW	2
Annual operating hours (16 hours x 350 days)	hours	5600
Annual energy savings	lakh kWh	0.11
Annual cost savings (Rs. 8.5/kWh)	Rs. Lakh	0.95
Investment	Rs. Lakh	Nil
Payback period	Years	Immediate

Blowers and Fans

3. Technology up gradation to Electronically Commutated (EC) fan motors for the EAUs and VAUs

Background

- Plugged/pulley type driven fan motors at present with VFD.
- Frequencies set either auto or manual mode operation
- Based on user side pressure requirements

Recommendation

- Convert to direct coupled DC based brushless EC motor driven fans.
- Improved performance, higher efficiency, compact and reliable.

Blowers and Fans

3. Technology up gradation to Electronically Commutated (EC) fan motors for the EAUs abd VAUs

Energy savings

Particulars	Units	Value
Present total power consumption	kW	46.76
Estimated power savings on technology upgradation	kW	9.352
Annual operating hours (16 hours x 350 days)	hours	5600
Annual energy savings	lakh kWh	0.52
Annual cost savings (Rs. 8.5/kWh)	Rs. Lakh	4.45
Total installed motor capacity	kW	60.00
Investment	Rs. Lakh	13.20
Payback period	Years	2.97

- 40% of actual verified savings with this technology up gradation.
- Only 20% considered as power consumption with VSD being considered as base case scenario.
- Data considered for evaluation are discussed detailed in the report and to be confirmed before implementation .




Thank You