ENERGY AUDIT REPORT

OF

ROYAL GLOBAL UNIVERSITY

Betkuchi, Guwahati

Audit conducted by

A. Goswami,
Retd. S. E. & Head, Engg Section, IIT Guwahati,
Certified Energy Auditor
Regd. No. EA0460

ACKNOWLEDGEMENT

I wish to extend thanks and gratitude to the management of Royal Global University, Guwahati for giving me the opportunity to conduct the Energy Audit of its campus. I would like to place on records my special thanks to all the officials, operation and maintenance staff of the University for their support, help and cooperation in carrying out this energy audit.

A. Goswami

CONTENTS

1.0. SUMMARY OF THE ENERGY AUDIT:

Details of the energy audit conducted in the Royal Global University are furnished in this report under different sections. The report is based on detailed study including analysis of available data as well as findings based on inspections. The entire exercise is aimed to detect wastage of energy in one hand and to identify energy saving potential on the other.

1.1. Key findings –

- The campus consumes 1413568 units of electrical energy from APDCL. In addition, it uses 198208 units from its 165 KWp solar roof top systems as per data available for 2019-20.
- Thus, total consumption is 1611776 units including solar generation without considering generations from standby DG sets as per data available for 2019-20.
- Annual cost of electricity (for 2019-20) is Rs 1,79,17,513.00. Out of which, cost share by solar and DG sets are Rs 4,95,524.00 and Rs 20,60,955.00 respectively.
- Performance of the roof top solar system has been found to be satisfactory. With total generation of 198208 units in 2019-20, generation per KWp per day on yearly average has been found to be 3.28 KWh, which is quite satisfactory in Assam climate. (para- 4.6.1, Table-4)
- Generation from solar has given saving of Rs 10,10,861.00 to the University in 2019-20 (para 4.6.1, Table-4)
- The HVAC system accounts for 49.5% of the total yearly consumptions of the university.
- There is energy saving potential along with consequent improvement in performance of the chilled water based AC system. (para- 6.2.3)
- On inspection, the 33KV "indoor" type VCB panel in the substation is found to be installed under some make shift type of shed. Immediate attention is needed for housing the panel under proper indoor location. Otherwise, there is possibility of insulation failure due ingress of rain water and moisture. Moreover, the functioning of the numerical relay will be effected by moisture.
- Urgent attention is needed in the reactive power management of the campus. The University has lost Rs 2,18,984.00 and Rs 1,45,981.00 in 2018-19 & 2019-20 respectively for failing to avail the maximum benefit from rebate on better power factor. While the power factor recorded is lower than the value to qualify for maximum rebate, one APFC panel has been found to be in uncharged condition. The APFC panel needs to be put to service urgently to avail the benefit of maximum rebate on power factor.
- The main panels installed in the substation, does not have meters in the outgoing feeders to monitor/ record power consumptions. In absence of power consumption data it is difficult to analyze power consumptions to identify losses/ wastage.
- There is huge gap between recorded maximum demand and contract demand which indicates that the contract demand is over estimated. Needs review of the connected load. (para-6.5)

- Main distribution panels in the buildings, particularly in A, B & C blocks requires up gradation. Lack of space coupled with increase in load over the years, have made the arrangement critical and risky.

1.2. Summary of recommendations/ Suggestions;

Items	Recommendations/ Suggestions
Chilled water based AC system	i) Since, the system is old, it is highly essential to conduct performance assessment of the central AC plant to measure the actual efficiency and to identify the losses. ii) The VFD system installed in the secondary chilled water pumps should be made functional to control the chilled water flow through pressure sensor mechanism. iii) The AHUs should be provided with VAV (Variable Air Volume) system through use of VFD in the fans. iv) It is noticed that there are considerable infiltration and exfiltration in the air system particularly in the hostels as the doors and windows are often kept open. v) There is further possibility of using VFD in cooling tower fans for optimally control the fans. vi) With the above control system, power consumption in the chilled water AC system could be reduced from 20 to 40%.
Reactive power management	Urgent attention is needed in the reactive power management of the campus. The University has lost Rs 2,18,984.00 and Rs 1,45,981.00 in 2018-19 & 2019-20 respectively for failing to avail the maximum benefit from rebate on better power factor. While the power factor recorded is lower than the value to qualify for maximum rebate, one APFC panel has been found to be in uncharged condition. The APFC panel needs to be put to service urgently to avail the benefit of maximum rebate on power factor. The power factor needs to be improved to 0.99.
Lighting system	It seems that all the LED lights are used for indoor and outdoor lighting of the campus. Hence there is not much scope for electricity saving in terms of installation of energy efficient lighting. However, appropriate presence detector based control may be used to switch off lights particularly in class rooms, selected common corridors and toilets in all the blocks when not occupied. This may reduce the consumption in lighting by around 20-30%.
Contract demand	There is huge gap between recorded maximum demand and contract demand which indicates that the contract demand is over estimated. While the maximum recorded demand in 2019-20 is 703 KVA, contract demand is 2824 KVA. In fact, due to the contract demand of 2824 KVA, the University is paying fixed charge of Rs 4,51,840.00 per month (@ Rs160.00 per KVA). It is shown that if contract demand is reduced to 1700KW (2000 KVA), which seems to be realistic, the university can save Rs 1,45,269.00 per month and Rs 17,43,228.00 per year. Needs review of the connected load. (details shown in para-6.5)

Storage water heaters	Storage water heaters may be converted with heat pumps which would provide about 50% saving in electric consumptions. Payback period of installation of heat pumps is around 5/ 6 years.
Renovation of the electrical system	Suggested in the key findings (para 1.1)

2,0. SCOPE OF WORK:

In this energy audit can be termed as preliminary energy audit. This means that measures, recommendations suggested requires further measurements and evaluation, post implementation.

Scope includes-

- Collection of all relevant data, documents, log books relating to electricity use operation etc.
- Inspection of the installations/ plants.
- Interview, interactions with management, operation and maintenance personnel.
- Analyze the data to evaluate assess energy use and to suggest measures to save energy use and improve performance.
- Scope includes all sectors like HVAC, lighting, water heating, and other power loads including electrical distribution system.

3.0. BASIC DATA OF THE CAMPUS:

3.1. The campus houses several multistoried buildings accommodating administrative offices, class-rooms, laboratories, conference rooms and hostels for students. Power supply is taken in the campus at single point from APDCL. While the power supply was originally taken in 11KV, the same was upgraded to 33KV w.e.f. August'2019 along with major extension of load. Main buildings of the campus are shown in Table-1 below. The blocks- A, B, C, D, E, E & F are utilized as class rooms and laboratories along with administrative offices and conference rooms etc. In addition, there are two hostel buildings to accommodate boys and girls.

Table-1: Main buildings

Name	Purpose of use	No of floors
Block-A	Class rooms, laboratories, administrative offices etc.	5
Block-B		5
Block-C		5
Block-D, E,F		5
Boys, Hostel	Student accommodation of around 250 capacity	6
Girls' Hostel	Student accommodation of around 250 capacity	6

3.2. Basic electricity data of the campus:

The electricity data made available to the auditor along with data collected/ acquired from site visits, interactions with the operating & maintenance staff, have been analyzed with the objective of assessing the energy saving potentials, which are elaborately stated in the following sections of the report. The key electricity data of the campus are shown in Table-2.

Table-2 : Basic data of electricity in the campus

Sl No	Details	Data	
1	Sanctioned load KW (KVA)	797.78 KW (938.82 KVA)- Up to Jul'2019 2400.00 KW (2823.53 KVA)- W.e.f. Aug'2019	
2	Installed capacity of DG set	1 X 500 KVA 1 X 320 KVA 1 X 250 KVA	
		Total- 1070 KVA	
3	Supply Voltage from utility	33 KV – W.e.f. Aug'2019 11 KV- Prior to Aug'2019	
4	Installed transformer capacity	1X3000KVA, 33/0.433KV- W.e.f. Aug'2019	
5	Installed capacity of SPV- roof-top	165 KWp	
6	Annual Electricity Consumption Data 2019-20	2019-20	2018-19
6.1	Annual electricity consumption from utility (as per bills from utility)	1413568 Kwh	1683130 Kwh
6.2	Annual electricity consumption from roof-top SPV (as per bills from solar power company)	198208 Kwh	Nil
6.3	Annual electricity consumption from DG set	Data not available	Data not available
6.4	Total annual electricity consumption (6.1 + 6.2 + 6.3)	1611776 Kwh	1683130 Kwh
7	Annual Cost of electricity	2019-20	2018-19
7.1	Purchased from utility(including elect charge, fixed charge & elect duty etc after considering all admissible rebates)	Rs 1,53,61,034.00	Rs 1,53,64,688.00
7.2	Purchased from solar company	Rs 4,95,524.00	Nil
7.4	Cost of HSD consumed by DG sets (Rs 65.00/ ltr considered for 2019-20)	Rs 20,60,955.00	NA
7.3	Total electricity cost	Rs 1,79,17,513.00	Rs 1,53,64,688.00
8.0	Installed capacity of the Air conditioning systems		
8.1	Water cool chillers	574 TR	
8.2	VRV/VRF System	636 HP	
8.3	Split AC (approx. total capacity)	45 TR	

4.0. ELECTRICITY CONSUMPTION DETAILS-

4.1. Power connection in the campus is provided in 33 KV. The substation consists of 1 X 3000 KVA, 33/ 0.433KV transformer, which is protected by 33KV indoor VCB panel. The 33 KV connection has been provided with effect from Aug'2019. Prior to that, the power connection was taken in 11 KV.

4.2. The contract demand for the campus has also been extended with effect from Aug'2019 to 2400.00 KW (2823.53 KVA). Prior to that, contract demand was 797.78 KW (938.82 KVA).

4.3. The University has also installed roof top solar system of total capacity 165 KWp on the roof tops of several buildings. As per records available, the roof top solar system has started generating power with effect from April'2019.

4.4. The University has 3 (three) DG sets of 500 KVA, 320 KVA & 250 KVA capacity to cater for the standby power needs.

4.5. Electrical energy consumptions from APDCL source:

Electricity consumption details of the University for the year 2018-19 & 2019-20 are furnished in Annexure-1 and Annexure-2 respectively. The summary of electricity consumption data from APDCL are shown Table-3 below-

Table-3
Summary of electricity consumption & other important data from APDCL

Sl. No	Description	Data	
		2018-19	2019-20
1	Total Electricity consumption (KWh)	1683130	1413568
2	Monthly average electricity consumption (KWh)	140261	117797
3	Total annual electricity cost (Rs)	15364688.00	15361034.00
4	Monthly average electricity cost (Rs)	1280390.66	1280086.16
5	Minimum recorded monthly power factor	0.910 (July'18)	0.85 (March'20)
6	Maximum recorded monthly power factor	0.994 (Dec'18)	0.99 (Feb'20)
7	Maximum recorded demand (KVA)	964 (Sept'18)	703 (May'19)
8	Minimum recorded demand (KVA)	155 (Jan'19)	130.50 (Feb'20)

4.6. Electricity use from roof top solar system:

Roof top solar power system was installed in the University in 2018-19 on the roof tops of Blocks-A, B, C & Girls' hostel. The total capacity of the system is **165 KWp.**

4.6.1. Installation of solar power system has given considerable saving to the University. This is because the revenue for solar power is Rs 2.50 per

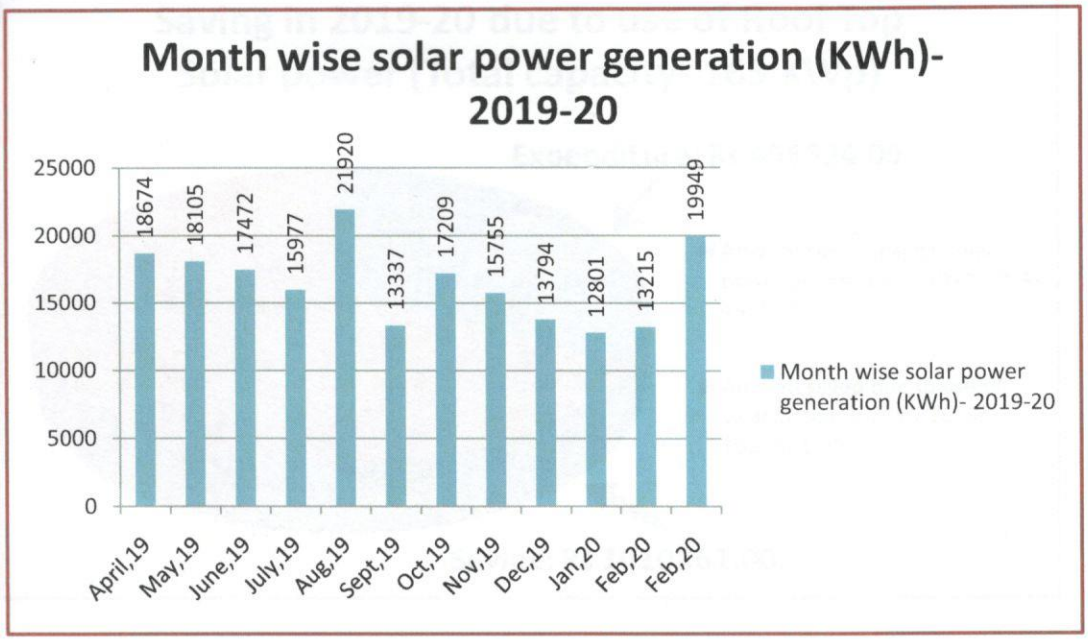
KWh against the prevailing APDCL tariff of Rs 7.60 per KWh. Month wise solar power generation for the year 2019-20 along with amount saved by the University, month wise and yearly solar generation per day (KWh/day) and .solar generation per day per KWp of installed capacity (KWh/day/KWp) are shown in the table below-

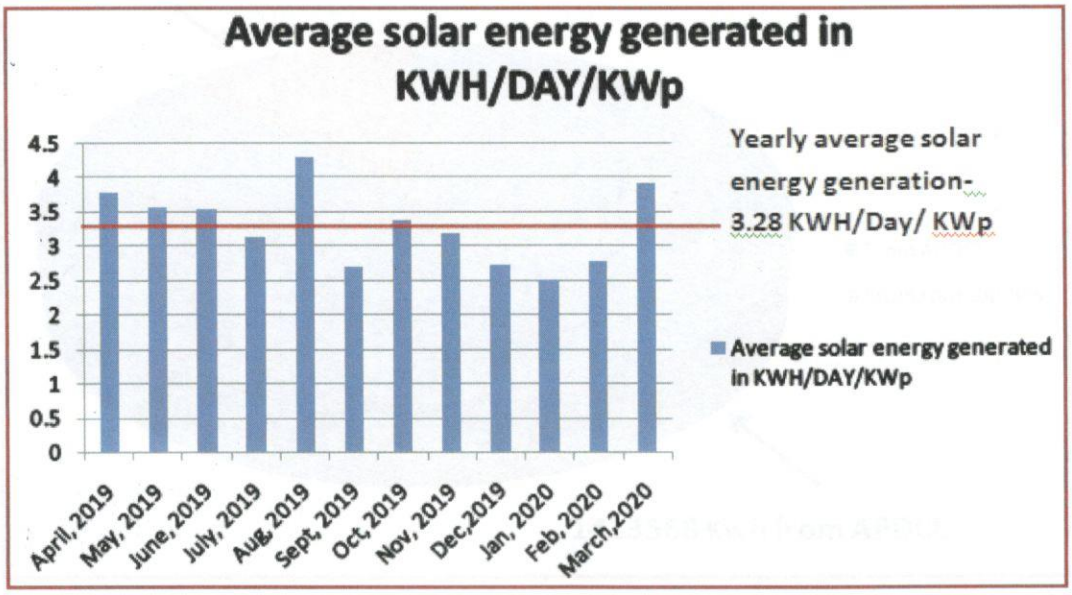
Table-4

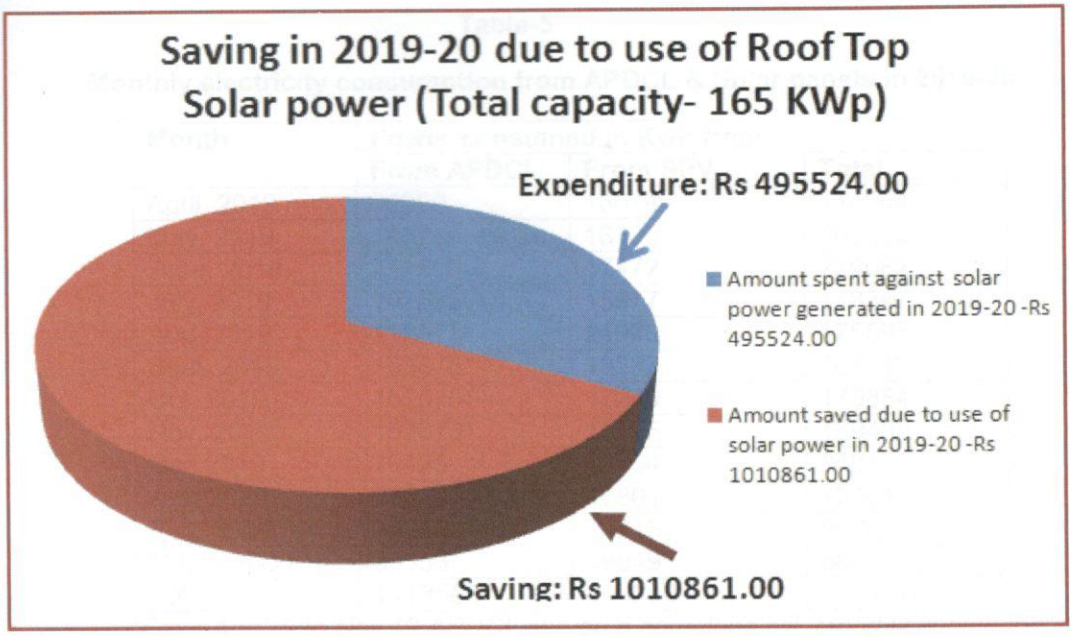
Solar power generation data for 2019-20 (Installed capacity- 165 KWp)

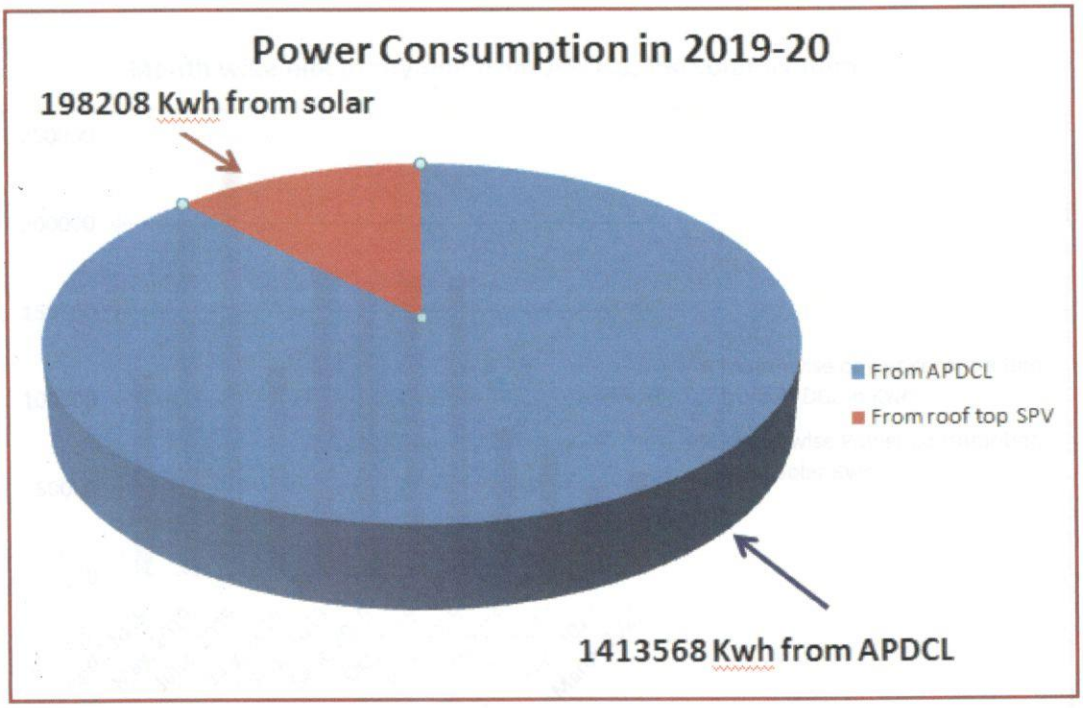
Month	Units generated (KWh)	Amount paid against solar energy consumption (Rs)	Amount saved (Rs) *	Solar generation in KWh/day	Solar generation in KWh/day/ KWp
April,19	18674	46685.00	95237.40	622.46	3.77
May,19	18105	45263.00	92335.50	584.03	3.54
June,19	17472	43680.00	89107.20	582.4	3.53
July,19	15977	39943.00	81482.70	515.38	3.12
Aug,19	21920	54800.00	111792.00	707.09	4.28
Sept,19	13337	33343.00	68018.70	444.56	2.69
Oct,19	17209	43023.00	87765.90	555.12	3.36
Nov,19	15755	39388.00	80350.50	525.16	3.18
Dec19	13794	34485.00	70349.40	444.96	2.70
Jan,20	12801	32003.00	65285.10	412.93	2.50
Feb,20	13215	33038.00	67396.50	455.68	2.76
March20	19949	49873.00	101739.90	643.51	3.90
Total	198208	495524.00	1010860.80		
Yearly Average				541.55 (Yearly average/ KWh/day)	3.28 (Yearly average KWh/day/ KWp

**Amount saved is calculated by multiplying the solar energy used during the month by the difference between the APDCL energy charge for the concerned month and the fixed solar energy charge of Rs 2.50/ Kwh.*


Month wise solar power generation (KWh)- 2019-20
25000
20000
15000
10000
5000
0
18674
18105
17472
15977
21920
13337
17209
15755
13794
12801
13215
19949
April,19
May,19
June,19
July,19
Aug,19
Sept,19
Oct,19
Nov,19
Dec,19
Jan,20
Feb,20
Feb,20
Month wise solar power generation (KWh)- 2019-20


Average solar energy generated in KWH/DAY/KWp
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
April,2019
May, 2019
June,2019
July, 2019
Aug,2019
Sept, 2019
Oct,2019
Nov, 2019
Dec,2019
Jan, 2020
Feb,2020
March,2020
Yearly average solar energy generation- 3.28 KWH/Day/ KWp
Average solar energy generated in KWH/DAY/KWp





4.6.2. Monthly power used from solar system against the power consumed from APDCL in the year 2019-20 is shown in the table-5 below-

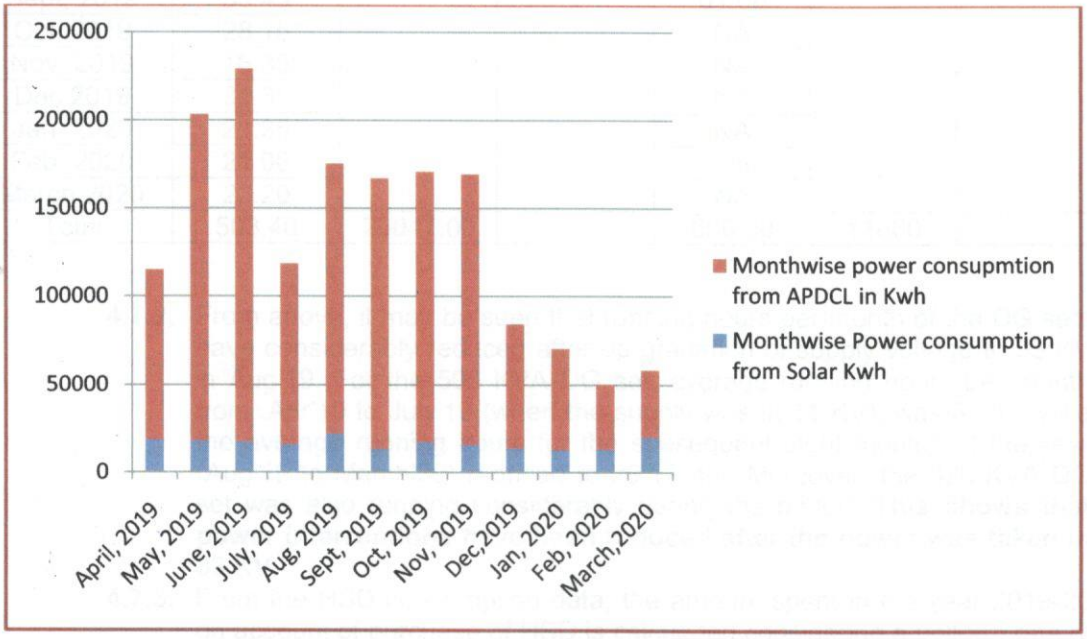
Table-5

Monthly electricity consumption from APDCL & Solar panels in 2019-20

Month	Power consumed in Kwh from		
	From APDCL	From SPV	Total
April, 2019	96290	18674	114964
May, 2019	185230	18105	203335
June, 2019	211610	17472	229082
July, 2019	102370	15977	118347
Aug, 2019	153675*	21920	175595
Sept, 2019	153675*	13337	167012
Oct, 2019	153675*	17209	170884
Nov, 2019	153675*	15755	169430
Dec,2019	70425	13794	84219
Jan, 2020	57600	12801	70401
Feb, 2020	36990	13215	50205
March,2020	38353	19949	58302
Total	1413568	198208	1611776

**From Aug'19 to Nov'19 APDCL served a combined bill. Monthly consumptions shown as average of four months.*

Month wise electricity use from APDCL Vs Solar system



4.7. Standby DG Set:

4.7.1. The University has 3 (three) DG sets- 500KVA, 320KVA and 250KVA. However from the log book for 2019-20, operation records of two DG

sets- 500KVA and 320KVA only have been obtained. From records it is seen that while the 500 KVA DG set was under operation for the whole year, the 320 KVA DG set was running only up to 16-09-2019. Moreover, the way records were maintained, assessment of monthly data in respect to only running hours could be possible. Therefore, consumption of HSD is shown on yearly basis. Moreover, there is no record of units of electricity consumed from the DG sets, which could have given more realistic efficiency parameter of Kwh/ ltr of HSD. From the data available in the log book, the running hours and HSD consumptions of the DG sets for 2019-20 are shown in Table-6 below-

Table-6
Operation data of DG Sets for the year 2019-20

Month	500 KVA DG Set			320 KVA DG Set		
	Running hrs (hrs)	HSD consum-ption (ltr)	HSD consum-ption (ltr/hr)	Running hrs (hrs)	HSD consum-ption (ltr)	HSD consumpt-ion (ltr/hr)
April, 2019	53.35	20047.00	39.80	120.40	11660	19.23
May, 2019	72.35			126.00		
June, 2019	94.00			137.00		
July, 2019	49.50			22.00		
Aug, 2019	57.35			139.50		
Sept, 2019	33.45			61.00		
Oct, 2019	28.15			NA		
Nov, 2019	16.35			NA		
Dec,2019	31.35			NA		
Jan, 2020	21.35			NA		
Feb, 2020	21.00			NA		
March,2020	23.20			NA		
Total	503.40	20047.00		606.30	11660	

4.7.2. From above, it may be seen that running hours per month of the DG sets have considerably reduced after up gradation of supply voltage to 33 KV in Aug'19. For the 500 KVA DG set, average running hours per month from .Apr'19 to July'19 (when the supply was in 11 KV), was 67.30 while the average running hours for the subsequent eight months of the year (Aug'19 to March'20) reduced to 29.12 hrs. Moreover, the 320 KVA DG set was also running considerably during the period. **This shows that power interruptions have been reduced after the power was taken in 33 KV.**

4.7.3. From the HSD consumption data, the amount spent in the year 2019-20 on account of purchase of HSD is calculated considering a uniform rate of Rs 65.00 per ltr for the period and shown in the table-7.

Table-7
Cost of HSD for running the DG sets in 2019-20

HSD consumption in 2019-20 (ltr)			Rate of HSD (Rs)	Amount (Rs)
500 KVA	320 KVA	Total		
20047.00	11660.00	31707.00	65.00	2060955.00

5.0. HVAC INSTALLATIONS :

5.1. The university has three types of HVAC systems- Water cooled chillers, VRV/ VRF systems and unitary air conditioners (split type). The capacity of the systems are shown in table-8

Table-8
Installed capacity of the air conditioning system

Type of system	Units	Total
Water cooled chillers	135TR X 2 180 TR X 1 124TR X 1	574 TR
VRV/ VRF	204HP (Daikin) 400HP (Mitsubishi) 32HP (Voltas)	636 HP
Unitary (split type)	Total 45TR	45 TR

5.2. The chilled water based AC system provides air conditioning in A, B bocks and Boys' & Girls' hostels. Chilled water is supplied through underground chilled water pipes from the AC plant to the buildings. The plant consists chillers as stated above with primary and secondary chilled water pumps, condenser pumps and cooling towers.

5.3. It is noted that the secondary chilled water pumps are provided with VFDs (Variable Frequency Drives). But, all the VFDs are kept in manual mode. This defeats the very purpose of installation of VFDs in the pumping system. VFDs are installed to regulate the chilled water flow by change of speed through pressure sensors to achieve power saving.

5.4. Approximate share of electrical demand by the air conditioning system is shown in Table-9 below-

Table-9
Approximate maximum demand of the air-conditioning system

Sl No	System	Capacity	Max electrical demand in KW/ unit capacity	Total demand in KW
1	Water cooled chiller plant	574 TR	**I.0 KW/ TR (including AHU fans)	574
2	VRV/ VRF			
2.1	Daikin	204 HP	0.9 KW/ HP*	183.6

2.2	Voltas	32 HP	0.9 KW/ HP*	28.8
2.3	Mitsubishi	400 HP	0.80 KW/ HP	320
3	Unitary	45 TR	1.3 KW/ TR	58.5
Total demand				1164.90 Say 1165

**Being older generation system, electrical demand is relatively more than the newer generation system.*

***Break up for water cooled chiller*

Chiller	*0.65 KW/ TR*
Pumps	*0.12 KW/ TR*
Cooling Towers	*0.05 KW/ TR*
AHU fans	*0.18 KW/TR*
Total	*1.0 KW/ TR*

5.5. The AHUs installed inside the buildings have virtually no control to regulate flow based on heat load inside. Thus, it seems there is huge wastage of power considering the wide seasonal, day to day and day/ night variations of load. Variable Air Volume (VAV) control through application of VFD on fans would have saved 20 to 50% power consumption by fans.

6.0. REVIEW OF THE SYSTEM & SUGGESTIONS/ RECOMMENDATIONS:

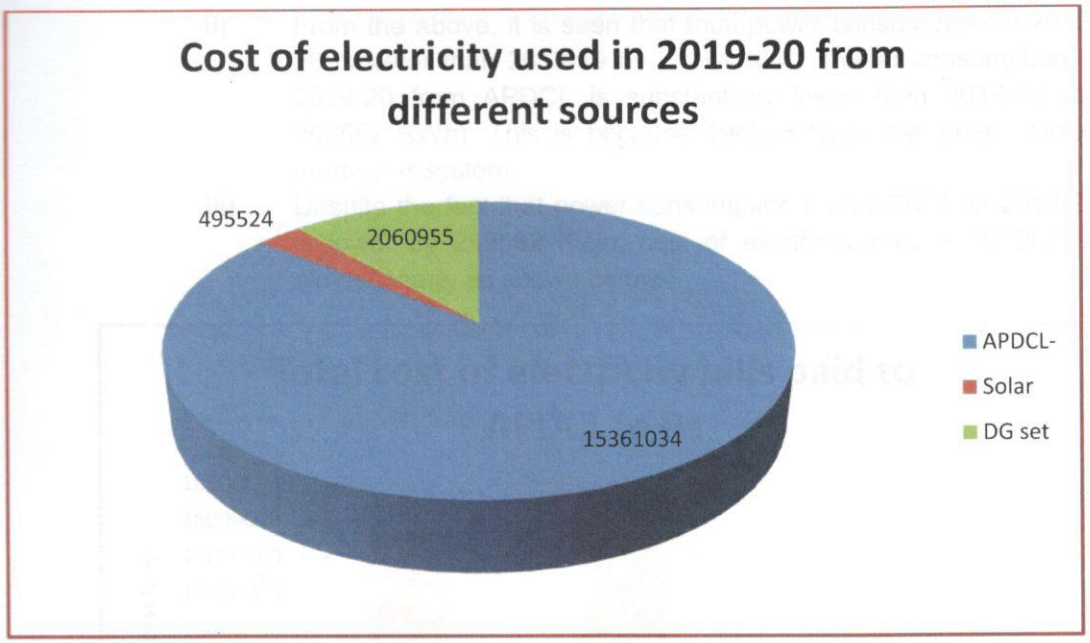
6.1. Electrical power use:

6.1.1. Cost break up of electricity used from different sources: Electricity is used in the campus from three sources- APDCL, solar system and DG sets. The cost break up for the three sources for 2019-20 are shown in the table-10 below-

Table-10

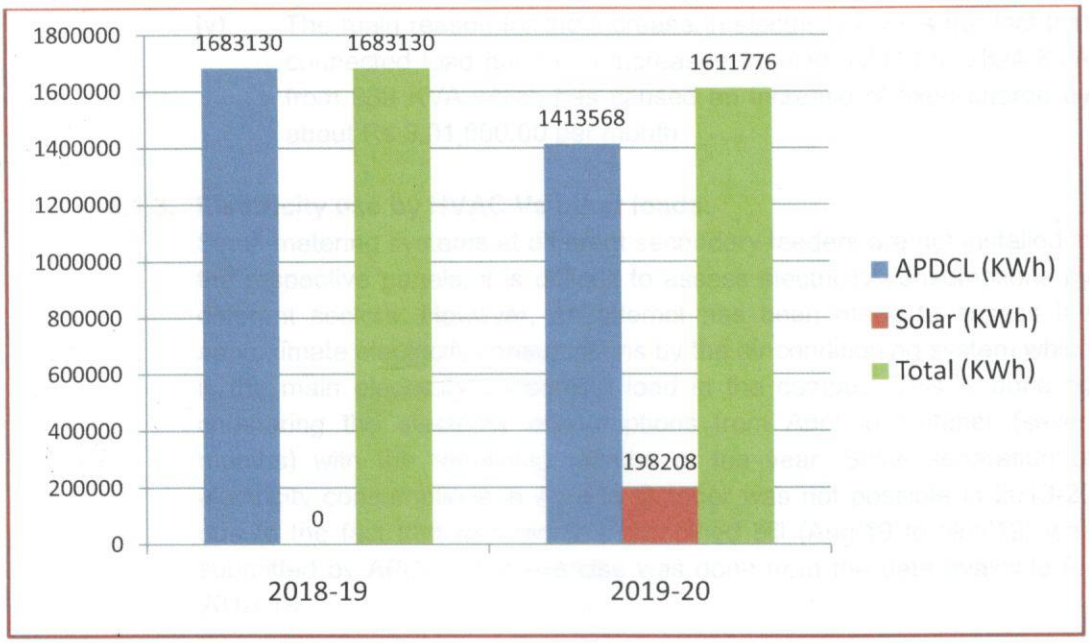
Cost break up of electricity used in 2019-20 from different sources

Sources	Cost in Rs
APDCL-	1,53,61,034.00
Solar	4,95,524.00
DG set	20,60,955.00
Total	**1,79,17,513.00**



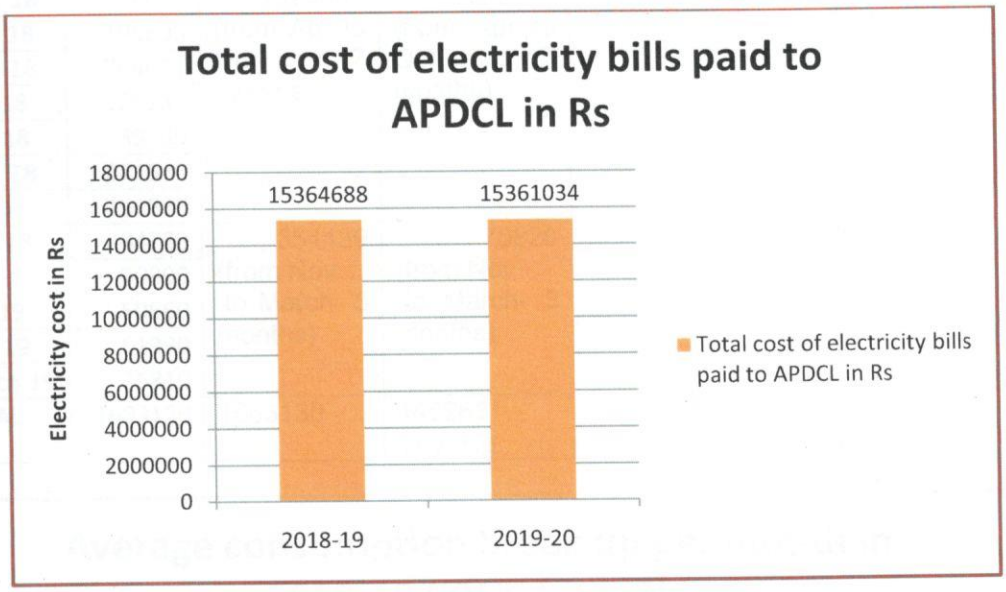
6.1.2. Electricity consumption pattern:

i) Total electricity consumption in the year 2018-19 and 2019-20 has been compared below-



ii) From the above, it is seen that total power consumption in 2019-20 is lower than 2018-19 by 71354 KWh. Power consumption in 2019-20 from APDCL is substantially lower than 2018-19 (by 269562 KWh). This is because 198208 KWh has been utilized from solar system.

iii) Despite the fact that power consumption from APDCL in 2019-20 is lower by 269562 KWh, cost of electricity paid to APDCL is almost same, as shown below-



iv) The main reason for the increase in electricity cost is the fact that connected load has been increased from Aug'2019 to 2824 KVA from 939 KVA which has caused an increase of fixed charge by about Rs 3,01,600.00 per month.

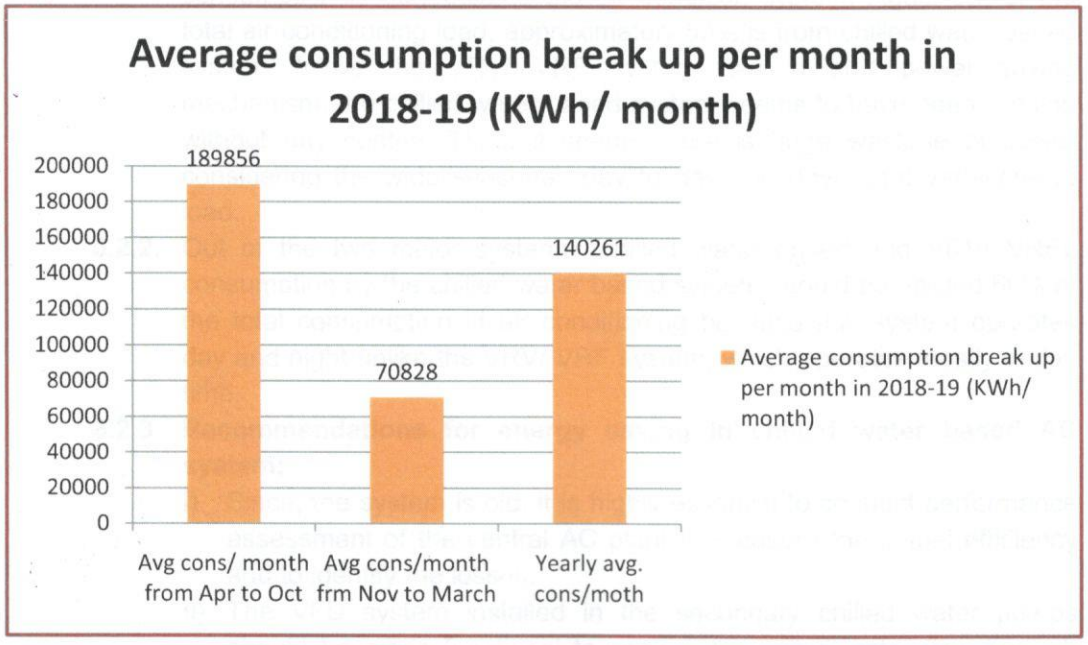
6.1.3. Electricity use by HVAC Vs other loads:

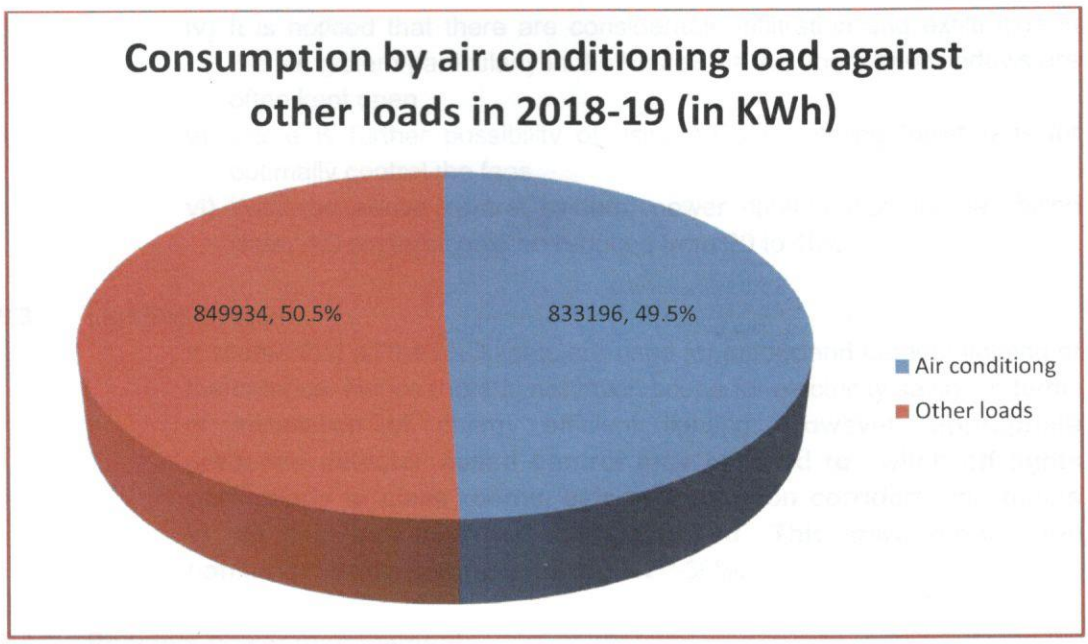
Since metering systems at different secondary feeders are not installed in the respective panels, it is difficult to assess electricity consumptions by different sectors. However, an attempt has been made to assess the approximate electricity consumptions by the air conditioning system which is the main electricity consuming load in the campus. This is done by comparing the electricity consumptions from April to October (seven months) with the remaining months of the year. Since separation of electricity consumptions in April to October was not possible in 2019-20 due to the fact that four month's combined bill (Aug'19 to Nov'19) was submitted by APDCL, the exercise was done from the data available for 2018-19.

Table-11

Electricity consumption break up of air conditioning load in 2018-19

Month	Consumption (KWh)	Total cons. break up (KWh)	Avg.monthly cons break up (KWh/m)	Approx. consumption by AC system	Percentage of total consumption
April, 18	128680	1328991 (from Apr to Oct- 7 months)	189856 (from Apr to Oct- 7 months)	833196	49.5%
May, 18	198600				
June, 18	204081				
July, 18	124730				
Aug, 18	239540				
Sept, 18	271530				
Oct, 18	161830				
Nov, 18	84789	354139 (from Nov to March- 5 months)	70828 (from Nov to March- 5 months)		
Dec,18	80890				
Jan, 19	50660				
Feb, 19	61990				
March,19	75810				
TOTAL	1683130	1683130	140261 Yrly avg		





6.2. Review of the air conditioning system:

6.2.1. As it is shown above that nearly 50% of the annual electricity consumption is attributed to the air condition system. Again out of the total air conditioning load, approximately 50% is from chilled water based system. While the VRV/ VRF system has in built power saving mechanism, the chilled water based system seems to have been running without any control. Thus, it seems there is huge wastage of power considering the wide seasonal, day to day and day/ night variations of load.

6.2.2. Out of the two major systems (chilled water based and VRV/ VRF), consumption by the chilled water based system should be around 60% of the total consumption in air conditioning because this system operates day and night unlike the VRV/ VRF system, which operates mostly in day time.

6.2.3. Recommendations for energy saving in chilled water based AC system:

i) Since, the system is old, it is highly essential to conduct performance assessment of the central AC plant to measure the actual efficiency and to identify the losses.

ii) The VFD system installed in the secondary chilled water pumps should be made functional to control the chilled water flow through pressure sensor mechanism.

iii) The AHUs should be provided with VAV (Variable Air Volume) system through use of VFD in the fans.

iv) It is noticed that there are considerable infiltration and exfiltration in the air system particularly in the hostels as the doors and windows are often kept open.

v) There is further possibility of using VFD in cooling tower fans for optimally control the fans.

vi) With the above control system, power consumption in the chilled water AC system could be reduced from 20 to 40%.

6.3. Lighting system:

It seems that all the LED lights are used for indoor and outdoor lighting of the campus. Hence there is not much scope for electricity saving in terms of installation of energy efficient lighting. **However, appropriate presence detector based control may be used to switch off lights particularly in class rooms, selected common corridors and toilets in all the blocks when not occupied. This may reduce the consumption in lighting by around 20-30%.**

6.4. Reactive power management:

6.4.1. Power factor of the load in the campus as per the electricity bills from APDCL for the years 2018-19 & 2019-20 varies from 0.85 to 0.994. Power factors recorded in the months from April to October seems to be lower than those recorded in the moths November to March. The lower power factor in April to October is contributed by the air conditioning load. The power factors recorded in the monthly bills for 2018-19 and 2019-20 are shown below-

Monthly power factors for 2018-19 & 2019-20

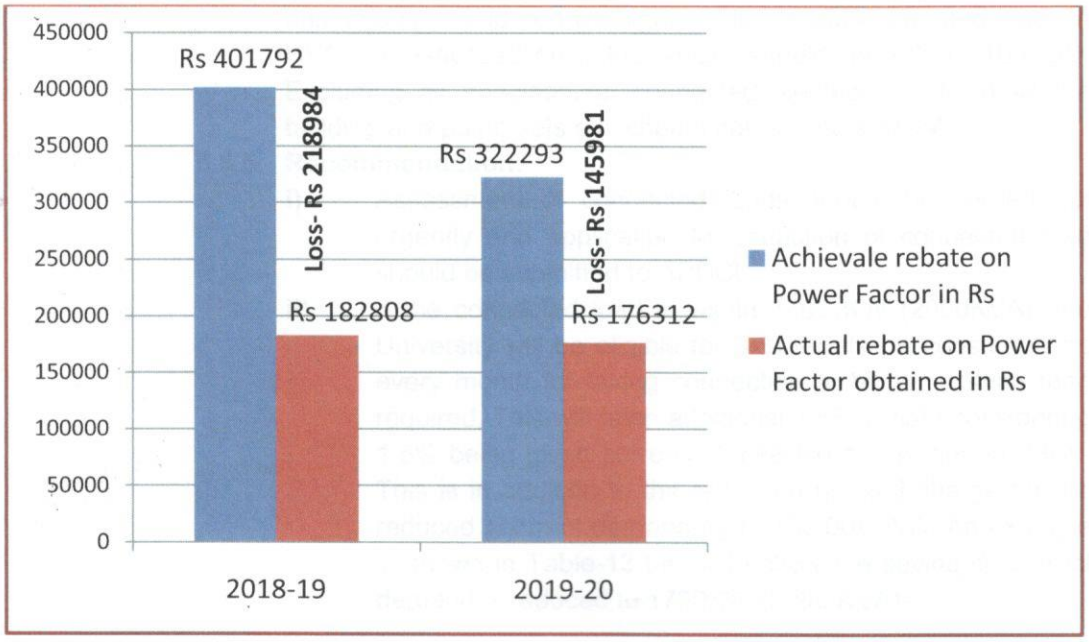
6.4.2. It is to be noted that as per the APDCL tariff, rebate on power factor is admissible in percentage of monthly consumptions as follows- from 0.85 to 0.95 - 1 %, from 0.95 to 0.97 – 2% and from 0.97 to 1.0 – 3%

6.4.3. From records, it is seen that rebate on power factor received by the University is 1% in majority of the monthly bills and in couple of bills, mainly in the winter months, rebates of 2% and 3% have been received. By proper reactive power management, 3% rebate is achievable. Considering the achievable target power factor of 0.99, achievable rebates and consequent monetary values are shown against actual rebates received in table-12 below

Table-12
Rebates on power factor Achievable against actual

Description	2018-19		2019-20	
	In Kwh	In Rs (@8.00/kwh)	In KWh	In Rs (@7.60/kwh)
Annual consumption	1674130	----------	1413568	----------
Rebate achievable (3%)	50224	4,01,792.00	42407	3,22,293.00
Actual rebate obtained	22851	1,82,808.00	23199	1,76,312.00
Difference	27373	**(Loss) 2,18,984.00**	19208	**(Loss) 1,45,981.00**

Rebates on power factor achievable Vs achieved in Rupees



6.4.4. From above, it may be seen that the University is incurring loss due to low power factor. Losses are Rs 2,18,984.00 and Rs 1,45,981.00 in 2018-19 and 2019-20 respectively.

6.4.5. Recommendation: It is noticed that one APFC panel is lying idle outside the substation building. It is not known why the APFC panel is kept uncharged. The APFC panel should be immediately connected to the bus, to improve power factor up to 0.99

6.5. Maximum Demand:

6.5.1. It is seen that the maximum demand as recorded in the electricity bills, are 910 KVA in Sept' 2018 (for 2018-19) and 703 KVA in May''2019 (2019-20). This is against the new contract demand of 2824 KVA, effective from Aug'2019 and the previous contract demand of 939 KVA. applicable prior to Aug'2019.

6.5.2. The fall in maximum contract demand in 2019-20 is due to contribution from solar system

6.5.3. It is noted that there is huge gap between actual recorded maximum demand and contract demand. In fact, due to the contract demand of 2824 KVA, the University is paying fixed charge of Rs 4,51,840.00 per month (@ Rs160.00 per KVA).

6.5.4. It shown in para 5.4, Table-9 that the total connected load of the HVAC system, which is considered to be the major electrical load, is 1165 KW. This is including the connected loads of the AHUs and FCUs installed in the buildings and assessment is based on unit values considered on higher side. Actual connected load on HVAC, if assessed on actual value, should be within 1100 KW. Excluding air conditioning, connected electrical loads in all the building and pump sets etc. should not exceed 600 KW.

6.5.5. Recommendation:

i) Assessment of connected loads should be carried out urgently and application for reduction of connected load should be submitted to APDCL.

ii) If the connected load is within 1700 KW (2000KVA), the University will be eligible for 3 % rebate on consumptions every month for taking connection at higher voltage than required. This will fetch additional 1.5% rebate considering 1.5% being given currently for taking connection in 33KV. This is in addition to the reduction in fixed charge for the reduced contract demand @ Rs160.00/ KVA. An example is shown in Table-13 below to show the saving if contract demand is reduced to 1700KW (2000 KVA)-

Table-13

Monthly & yearly saving if contract demand is reduced to 1700KW (2000KVA)

	Present demand of 2824 KVA	**Reduced demand of 2000 KVA**
Fixed charge/ month @ Rs 160.00	Rs 4,51,840.00	Rs 3,,20,000.00
Rebate on supply voltage on Avg monthly consumption in 2019-20-117797 KWh	Rs 1,34,29.00 (1.5% on 117797 X Rs 7.60)	Rs 2,68,58.00 (3.0% on 117797 X Rs 7.60)
Amount after rebate	Rs 4,38,411.00	Rs 2,93,142.00
Saving per month		**Rs 1,45,269.00**
Saving per year		**Rs 17,43,228.00**

6.6. Electrical storage water heaters:

6.6.1 Presently there are altogether about 20 nos 100 Ltr and 3nos 50 Ltr electric storage water heaters in the hostels. Many of these storage water heaters are running inefficiently without proper thermostatic controls

6.6.2 .**Recommendation:** Storage water heaters may be converted with heat pumps which would provide about 50% saving in electric consumptions. Payback period of installation of heat pumps is around 5/ 6 years.

ANNEXURE-1

POWER CONSUMPTION DATA FOR 2018-19

Month	Power consumed in Kwh from			Max demand recorded in APDCL bill (KVA)	Power factor recorded in APDCL bill	Rebate received on PF (Kwh)
	From APDCL	From SPV	Total			
April, 2018	128680	Nil	128680	462	0.946	1286.80
May, 2018	198600	Nil	198600	754	0.918	1986.00
June, 2018	204081	Nil	204081	793	0.912	2040.81
July, 2018	124730	Nil	124730	666	0.910	1247.30
Aug, 2018	239540	Nil	239540	964	0.919	2395.40
Sept, 2018	271530	Nil	271530	910	0.913	2715.30
Oct, 2018	161830	Nil	161830	876	0.923	1681.30
Nov, 2018	84789	Nil	84789	546	0.974	2543.67
Dec,2018	80890	Nil	80890	181	0.994	2426.70
Jan, 2019	50660	Nil	50660	155	0.963	1013.20
Feb, 2019	61990	Nil	61990	216	0.969	1239.80
March,2019	75810	Nil	75810	415	0.971	2274.30
TOTAL	1683130	Nil	1683130			22850.61

ANNEXURE-2

POWER CONSUMPTION DATA FOR 2019-20

Month	Power consumed in Kwh from			Max demand recorded in APDCL bill (KVA)	Power factor recorded in APDCL bill	Rebate received on PF (Kwh)
	From APDCL	From SPV	Total			
April, 2019	96290	18674	114964	681	0.940	962.90
May, 2019	185230	18105	203335	703	0.927	1852.30
June, 2019	211610	17472	229082	697	0.917	2116.10
July, 2019	102370	15977	118347	650	0.930	1023.70
Aug, 2019	153675*	21920	175595	697.50	0.964	12294.00
Sept, 2019	153675*	13337	167012			
Oct, 2019	153675*	17209	170884			
Nov, 2019	153675*	15755	169430			
Dec,2019	70425	13794	84219	427.50	0.989	2112.75
Jan, 2020	57600	12801	70401	175.50	0.989	1728.00
Feb, 2020	36990	13215	50205	130.50	0.99	1109.70
March,2020	38353	19949	58302	Not recorded	0.85	0.00
TOTAL	1413568	198208	1611776			23199.45

**Bills from Aug'19 to Nov'19 was submitted by APDCL as a merged bill. The consumptions shown as average for the concerned months*