ENERGY AUDIT REPORT

OF

ABHAYAPURI COLLEGE

Dist- Bongaigaon, Assam

Audit conducted by

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ACKNOWLEDGEMENT

I wish to extend my sincere thanks and gratitude to the management of Abhayapuri College, dist: Bongaigaon, Assam for giving me the opportunity to conduct the Energy Audit of the college campus. I would like to place on records my special thanks to Dr. S. Nath, Principal and all the faculty and staff of the college for their support, help and cooperation in carrying out this energy audit.

A. Goswami

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1.0. SUMMARY OF THE ENERGY AUDIT:

Details of the energy audit conducted in the campus of Abhayapuri College 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 32300 units of electrical energy from APDCL per year which is based on consumption data for 2019-20.
- Energy Performance Index for the same year is 6.71, which may be considered to be fairly good. (details in para- 6.6)
- Annual cost of electricity (for 2019-20) is Rs 2,92,074.00 This amount is without the surcharge on arrear paid during the year.
- In the whole year of 2018-19 and even from around half year before, the electricity bills were served on assessment basis, on the basis of an assessed consumption of 99.86 Kwh per day. Average per day actual billed unit in the following year - 2019-20 which was based on actual meter readings, was 89.18 Kwh. From the above data, it is seen that the daily consumption considered in 2018-19 for assessed bills was higher than the actual average daily consumption found from meter readings in 2019-20. Even ignoring the fact that normally there is an increasing trend in power consumption, there was over billing to the extent of 11.97% in 2018-19 compared to 2019-20.Thus, in the year 2018-19, overbilling was done to the extent of around 4216 Kwh (billed unit of 18-19, 36512 – billed unit of 19-20, 32296 Kwh). In terms of money, extra billed amount was Rs 28,668.80. **Thus the college had to make an additional payment of around Rs 28,669.00 in the year 2018-19 as a result of non-installation of meter by APDCL.** (details in para- 6.4.1)
- Electricity bills were served at highly irregular intervals for most of the years- 2018-19 and 2019-20. It may be seen in the report that bills were served for periods ranging from 6- 10 months. This caused serious problem for the college authorities to clear the payment on time. As a result, the college had to pay huge amounts as surcharge in 2018-19 and 2019-20. This has been elaborately discussed in para- 6.4.2
- There is scope for saving in power consumption in the lighting system by replacement of existing lights by energy efficient lights. (Details in para- 6.1)
- The room air-conditioners installed in the buildings are with conventional compressors. Though inverter based room air conditioners are judicious options for energy efficient performance, the replacement of the existing room air-conditioners by inverter air-conditioners has not been recommended due to high cost implications and long payback period. Instead, measures for running and maintaining the existing air conditioners for optimum energy efficient performance have been suggested. (Details in para- 6.2)
- Attention is needed in the reactive power management of the campus. The college was deprived from the benefit of power factor rebate in 2018-19, as no power factor record was shown in the bills as the meter was stopped/ damaged. In parts of 2019-20 also, power factor record was not shown

resulting in deprivation of the college from the benefit. Power factor has been found to be properly recorded only in the bills of 2020-21. Since maximum rebate is available at power factor above 0.97, it should be targeted to maintain power factor at around 0.99 consistently throughout the year by installation of APFC panels. In the year 2020-21 (up to Feb'21) the college was deprived from rebate to the tune of Rs 771.00 for not maintaining the power factor above 0.97 in couple of months. This has been elaborately discussed in para- 6.3

- Installation of roof top solar panels has been suggested for utilization of green energy and also to relieve the college from the burden of high electricity bills
- It is also suggested to involve students in energy conservation through launching of enrolment of GREEN VOLUNTEERS from students.

1.2. Summary of recommendations/ Suggestions;

Items	Recommendations/ Suggestions
Lighting system (Details in para-6.1)	i) It is suggested to replace the fluorescent tubes by LED tubes, which will yield an annual saving of Rs 18,751.00 to the college ii) Similarly, it is also suggested to replace the CFL lamps by LED lamps which is likely to save Rs 2614.00 annually. iii) Only few number of incandescent bulbs installed in the college buildings (only 8) should also be changed by LED lamps. This would yield an annual saving of Rs 3376.00
Air conditioners (Details in para-6.2)	Though inverter based room air conditioners are judicious options for energy efficient performance, Though inverter based room air conditioners are judicious options for energy efficient performance, the replacement of the existing room air-conditioners by inverter air-conditioners has not been recommended due to high cost implications and long payback period. Instead, measures for running and maintaining the existing air conditioners for optimum energy efficient performance have been suggested. However whenever new ACs are procured either for new installation or for replacement of existing ones, it is suggested that inverter based ACs with BEE star rating (if available) should be procured.
Reactive Power Management (Details in para-6.3)	It is recommended to maintain power factor at around 0.99 consistently throughout the year by installation of APFC panels. On the basis of annual consumptions of 2019-20, there is a potential to save Rs 6395.00 per year through rebates on power factor with maintenance of power factor above 0.97.
Students' involvement in energy conservation (Details in para-7)	i) Awareness should be created among the students to inculcate the habit of switching off the fans, lights and air-conditioners whenever no student is present in the class room, laboratory etc. This may reduce the power consumption to a great extent and will avoid wastage of power. Such habits will also help the students in saving power at their homes. **ii)** It is suggested to form a society of GREEN

	VOLUNTEERS from students to take up energy conservation and environmental activities in the place of study, home and society including creating awareness among the students and society.
Installation of roof top solar plant (Details in para-8)	It is suggested to explore the feasibility of installing roof top solar plant in the college building. Initially it is suggested that a roof top plant of 10/15 KWp be installed. There are two business models for installation of solar PV plant- CAPEX & RESCO which are explained in the relevant para. It is shown that if a solar plant of 10 KWp is installed in RESCO model, annual saving to the college should be around Rs 43,099.00.

2,0. SCOPE OF WORK:

The scope of this energy audit includes-

- Collection of all relevant data, documents, electricity bills, log books relating to electricity use operation etc.
- Inspection of the buildings and installations.
- 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 and other power loads including electrical distribution system.

3.0. BASIC DATA OF THE CAMPUS:

3.1. The campus houses a combination of multistoried as well as Assam type buildings accommodating administrative offices, class-rooms, laboratories, conference rooms etc. Power supply is taken in the campus at single point from APDCL in 11KV through a 63KVA, 11/0.433KV transformer.

Table-1: Main buildings

Sl. No	Buildings	Floor area (Sqm)		Purpose of use
		Excluding corridor	Including corridor	
1	Front RCC Building			
	Gr. floor	589.18	786.81	Principal, Vice Principal's rooms, administration/ staff office, GB room, TCR, smart classrooms etc.
	1st floor	619.96	759.58	Education department, classrooms, seminar hall,

				library, reading room etc.
	2nd floor	577.86	776.12	Class rooms, IT lab, data centre, tech meeting rooms etc.
2	New RCC Building			
	Gr. floor	125.42	194.54	Class room
	1st floor	125.42	194.54	Class room
3	Physics, Chemistry Block- AT	608.57	653.58	Class rooms, laboratories, Teachers' common room etc of Physics & Chemistry departments
4	Back Block- AT	401.92	508.83	Geo TCR, labs, class rooms etc.
5	Hall North Zoo- Botany Block- AT	802.19	1017.44	Labs, classrooms, TCR, halls, etc of Bot & Zoo department
6	KKHSOU- Canteen- Nano Lab Block- AT	282.05	344.39	Nano lab, class room, IQAC room, KKH, Canteen etc.
7	Room 3 & 4 Block (Middle Block)- AT	430.02	637.06	TCRs of Philosophy, Assamese, History, Arabic and classrooms.
8	Room-20 & 21- AT	218.23	344.34	Class rooms
9	Union Body Room- AT	26.57	26.57	Union body office
	Total	**4807.39**	**6243.80**	

3.2. Observations on the available documents/ data relating to electricity use:

The analysis made in this report is mainly based on the electricity bills available on records and produced before the auditor. However, few bills could be found from records. The consumptions and amount of these bills are assessed from the meter readings from the immediate previous and next bills and prevailing tariff respectively. In specific, following observations are made in respect to the electricity bills from APDCL on the basis of which analysis are made-

3.2.1. For the entire year 2018-19, electricity bills were served on the basis of assessed consumptions as the meter was reportedly stopped/ damaged. In fact, most of the bills in the preceding year also were served on assessment basis only.

a) Bills were served rather irregularly and even one bill was served for a period of about six months (184 days, from 3-10-18 to 05-04-19). As a result, it became difficult for the college to clear the huge amount of accumulated bill. Due to this, the college had to pay huge amount in terms of surcharge on arrears.

b) Bills were served considering a consumption of around 99.86 units per day, which was almost 11.97% higher than the average billed units of 89.18 per day for the year 2019-20 which was based on actual meter reading.

c) As the bills were not based on meter readings, no data in respect to the power factor were available in the bills. From the data recorded in the bills of subsequent years (2020-21 where proper records of power factor were available in the bills) after installation of the new meter, it is seen that the actual power factor of the college ranges from 0.95 to 0.99. Thus, the college was deprived from the rebate on power factor due for power factor of 0.95 and above. 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%

3.2.2. Bills were served on the basis of meter readings from 2019-20 onwards effective from 05-04-2019. However, in this year also, there were issues relating to submission of bills and data recorded on the bills:

a) First bill of 2019-20 was served for a period of almost 10 months (302 days, from 05-04-19 to 01-02-20). This also caused a huge burden for payment as the bill amount was very high. Consequently, the college had to pay extra amount by way of surcharge on arrears.

b) Though the bill (05-04-19 to 01-02-20) was served on the basis of meter readings, the relevant data like maximum recorded demand, power factor etc, were missing. Also, the bill was not prepared as per applicable tariff as the LTMU, power factor rebates were not shown.

3.2.3. In the year 2020-21, bills were served almost regularly, except for the first two bills which had some anomalies-

a) The first bill was served for a period of 61 days (from 01-04-20 to 01-06-20).

b) The bill had shown a power factor of 0.85 which seemed to be unrealistic when compared with the power factors recorded in other bills which ranged from 0.95 to 0.99. The maximum recorded demand was not shown in the bill.

c) The second bill was served for a period of 60 days- from 02-08-20 to 31-07-20. Apart from the period, which was for two months, this bill had properly shown all the relevant data like maximum demand, power factor etc.

d) All the subsequent bills for the year were however found to be normal with proper records of all relevant data.

3.3. Basic electricity data of the campus:

The electricity data made available to the auditor along with data collected/ acquired from site visit, interactions with the faculty and 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)	39 KW (46 KVA)		
2	Supply Voltage from utility	11 KV		
3	Installed transformer capacity	1 X 63 KVA		
4	Installed capacity of DG set	1 X 62.5 KVA (3 Phase) 1 X 15 KVA (1-Phase		
		Total- 77.5 KVA		
5	Annual Electricity Consumption Data	2018-19	2019-20	2020-21 (up to Feb'21)
5.1	Annual electricity consumption from utility (as per bills from utility)	36512 Kwh (Assessed bill, not based on meter)	32300 Kwh	25210.41 Kwh
5.2	Annual electricity consumption from DG set	Data not available	Data not available	Data not available
5.3	Total annual electricity consumption (5.1 + 5.2)	36512 Kwh	32300 Kwh	25210.41 Kwh
6	Annual Cost of electricity	2018-19	2019-20	2020-21(up to Feb'21)
6.1	Purchased from utility(including elect charge, fixed charge & elect duty etc after considering all admissible rebates including surcharge on arrear)	Rs 3,57,379.00 (Assessed bill, not based on meter)	Rs 3,66,263.00	Rs 2,62,095.00
6.2	Cost of HSD consumed by DG sets	NA	NA	NA
6.3	Total electricity cost	Rs 3,57,37900	Rs 3,66,263.00	Rs 2,62,095.00
7.0	Major loads apart from light, fan, and small equipment, appliances etc-			
7.1	Unitary air- conditioners	15 X 1TR 5 X 1.5 TR 2 X 2 TR		
7.2	Water pump	5 X 0.5 HP		

4.0. ELECTRICITY CONNECTION & POWER CONSUMPTION DETAILS-

4.1. Power connection in the campus is provided in 11 KV. The substation consists of 1 X 63 KVA, 11/ 0.433KV transformer. From

4.2. The contract demand for the campus is 39KW (46KVA).

4.3. The college campus has 2 (two) DG sets- 1X 62.5 KVA (3-phase) and 1X 15 KVA (1- phase) to cater for the standby power needs.

4.4. Electrical energy consumptions from APDCL source:

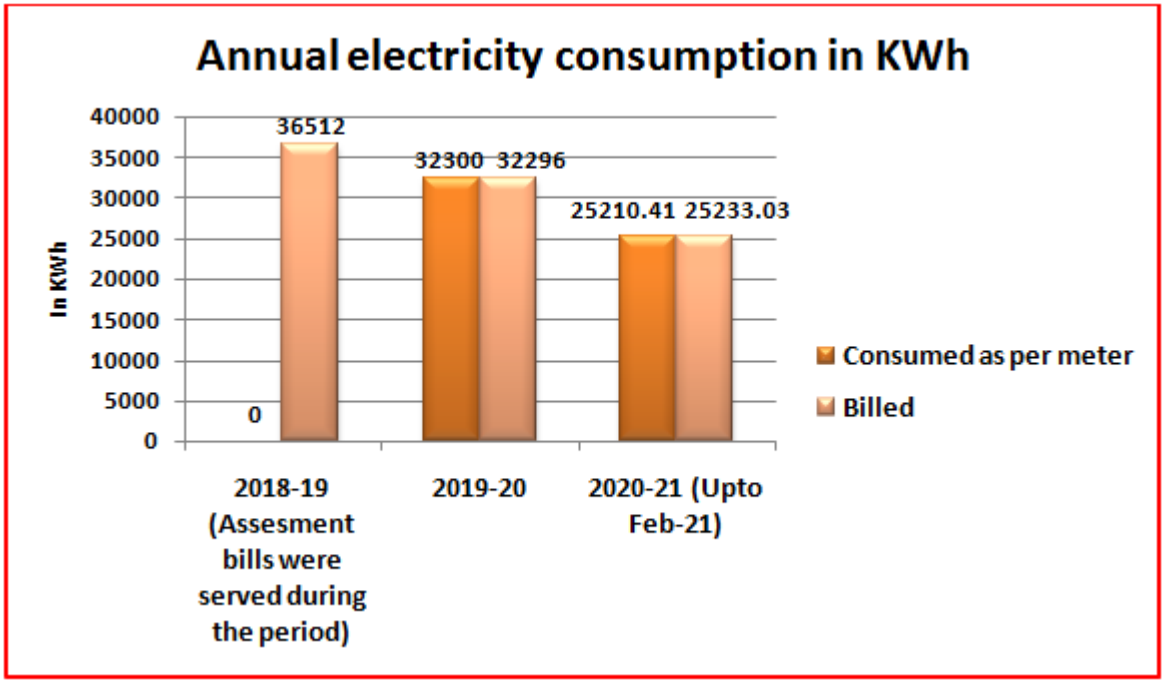
Electricity consumption details of the college campus for the years 2018-19, 2019-20 & 2020-21 (up to Feb'21 are furnished in Annexure-1. The summary of electricity consumption data from APDCL are shown Table-3 below-

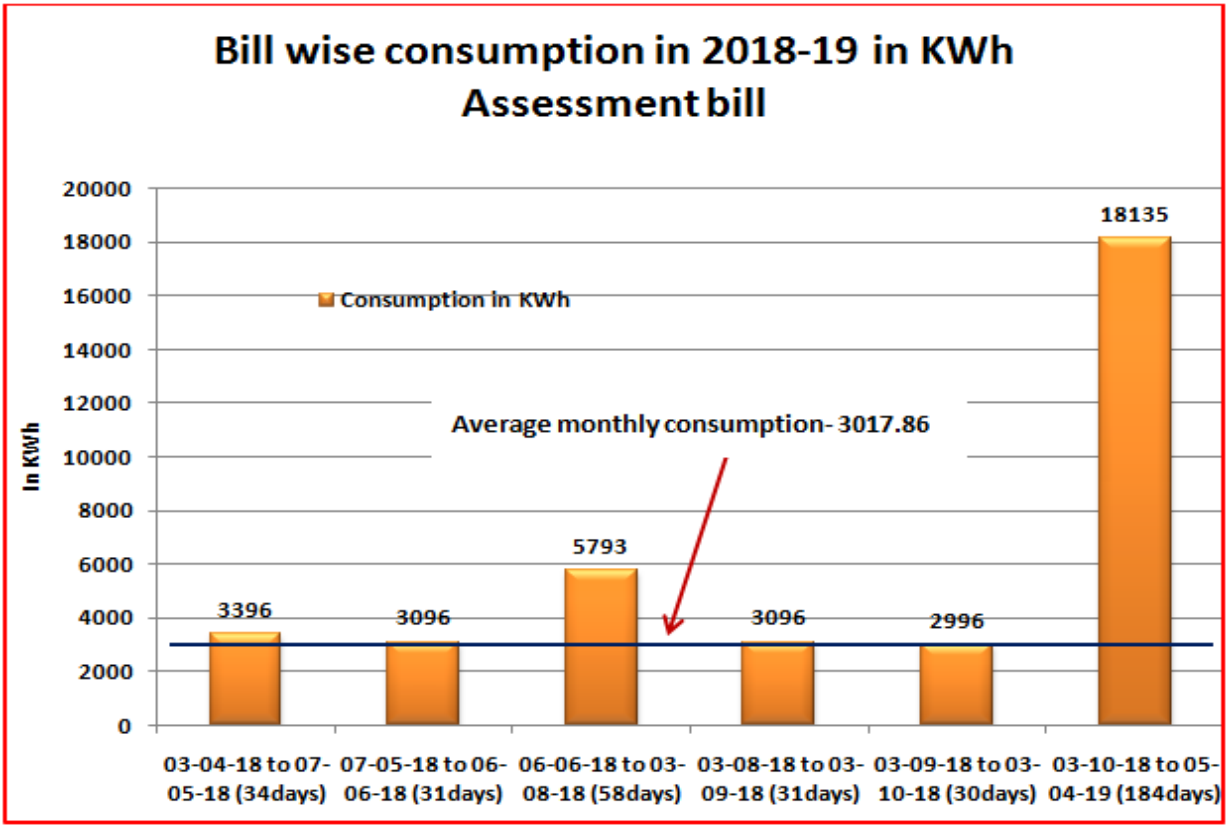
Table-3
Summary of electricity consumption & other important data from APDCL bills

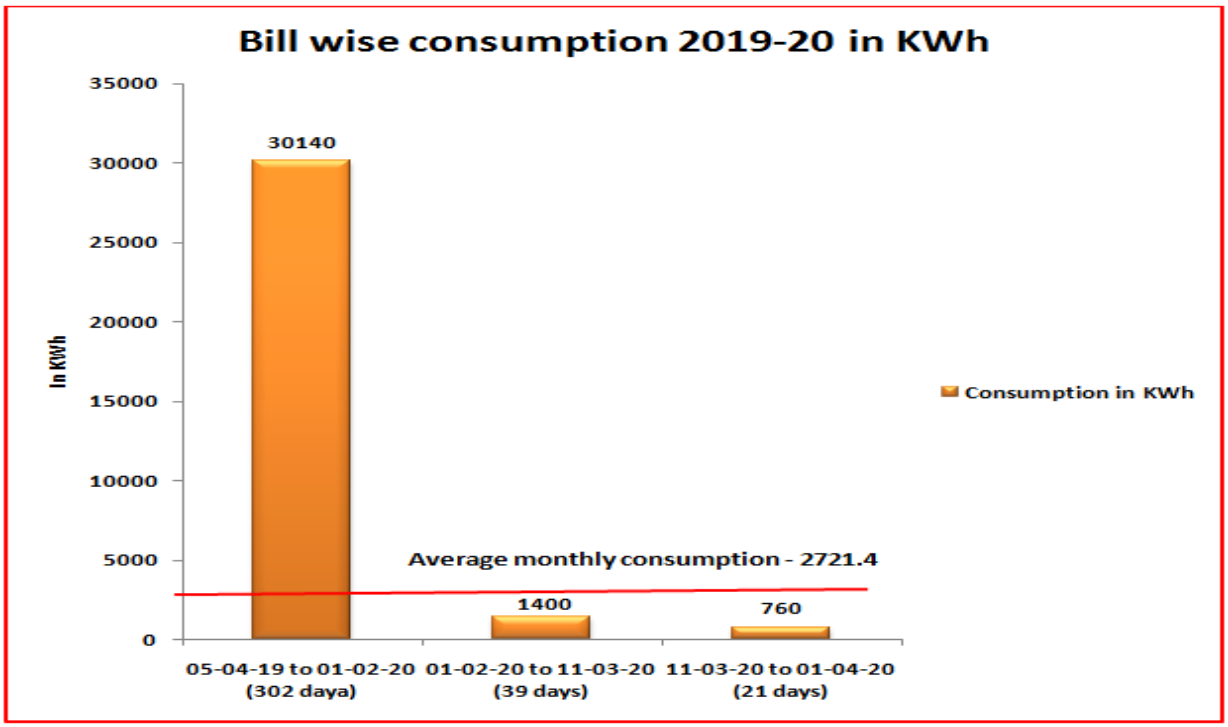
Sl. No	Description	Data		
		2018-19	**2019-20**	**2020-21 (up to Feb'21)**
1	Total Electricity consumption (KWh)	37011 (assessed bill)	32300	25210.41
2	Total units billed	36512	32866	25233.03
3	Monthly average electricity consumption (KWh)	3017.96	2721.4	2291.85
4	Total annual electricity cost without surcharge on arrear (Rs)	3,18,238.00	2,92,074.00	2,41,682.00
5	Total annual surcharge paid on arrear (Rs)	39,141.00	74,549.00	20413.00
6	Total annual electricity cost including surcharge on arrear	3,57,379.00	3,66,623.00	2,62,095.00
7	Monthly average electricity cost , on data at sl-4 (Rs)	26,519.83	24339.50	21971.10
8	Maximum recorded monthly power factor	NA	0.95 (In the bill: 01-02-20 to 11-03-20))	0.99 (June-Aug'20
9	Minimum recorded monthly power factor	NA	NA	0.85 (In the bill: 01-04-20 to 01-06-20))
10	Maximum recorded demand (KVA)	NA	NA	23.52 (Oct.20)
11	Minimum recorded demand (KVA)	NA	NA	9.28 (Dec'20 & Jan'21)

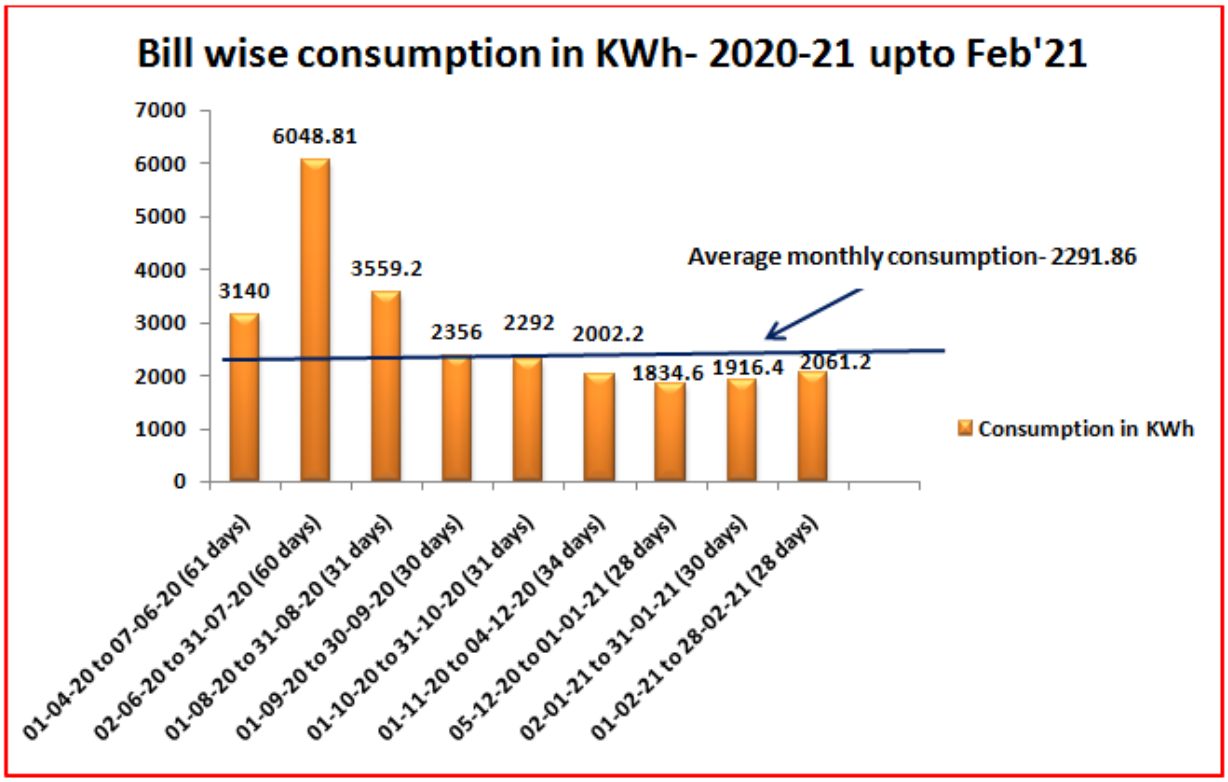
It may be noted that as per tariff, the unit billed (sl-2 of the table) is calculated after adding 3% towards metering done on the LT side (LTMU charge) of the

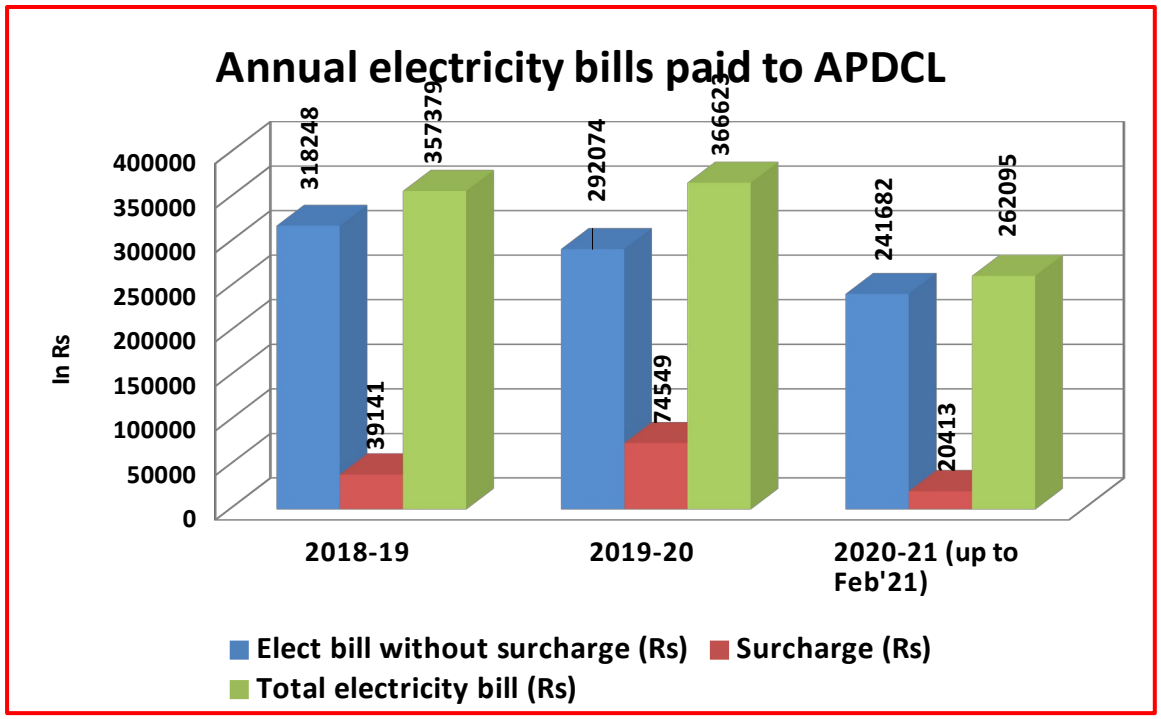
transformer and adding or deducting penalty or rebate on power factor, as applicable, on consumed units. However, in the assessment bills served in 2018-19 and also in the first bill of 2019-20, these details were not shown.

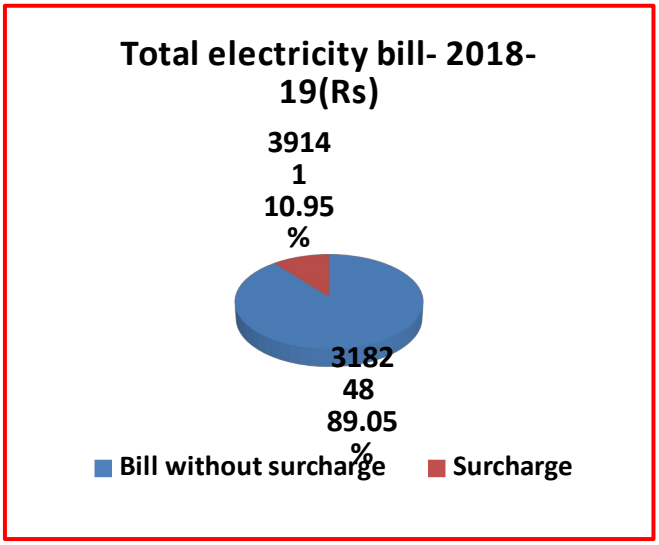


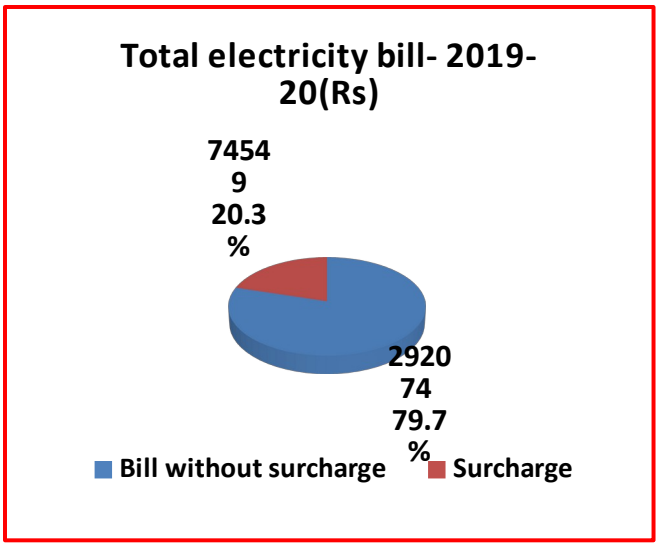


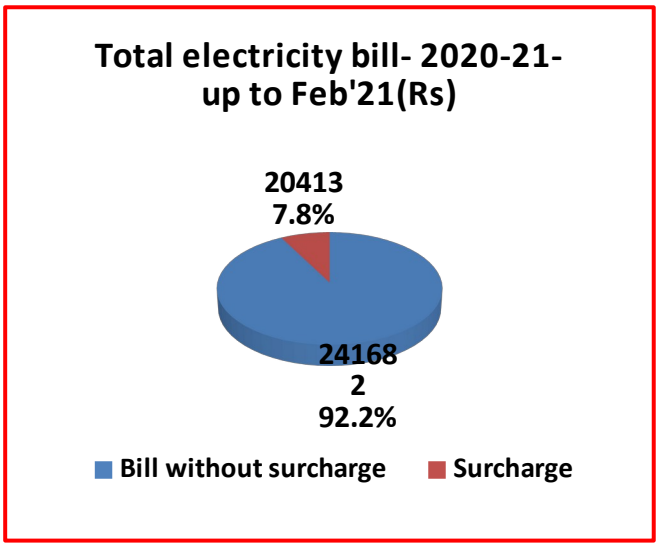

Bill wise consumption 2019-20 in KWh
35000
30000
25000
20000
15000
10000
5000
0
In KWh
30140
1400
760
Average monthly consumption - 2721.4
05-04-19 to 01-02-20 (302 daya)
01-02-20 to 11-03-20 (39 days)
11-03-20 to 01-04-20 (21 days)
Consumption in KWh


Bill wise consumption in KWh- 2020-21 upto Feb'21
7000
6000
5000
4000
3000
2000
1000
0
3140
6048.81
3559.2
2356
2292
2002.2
1834.6
1916.4
2061.2
Average monthly consumption- 2291.86
01-04-20 to 07-06-20 (61 days)
02-06-20 to 31-07-20 (60 days)
01-08-20 to 31-08-20 (31 days)
01-09-20 to 30-09-20 (30 days)
01-10-20 to 31-10-20 (31 days)
01-11-20 to 04-12-20 (34 days)
05-12-20 to 01-01-21 (28 days)
02-01-21 to 31-01-21 (30 days)
01-02-21 to 28-02-21 (28 days)
Consumption in KWh


Annual electricity bills paid to APDCL
In Rs
400000
350000
300000
250000
200000
150000
100000
50000
0
318248
39141
357379
292074
74549
366623
241682
20413
262095
2018-19
2019-20
2020-21 (up to Feb'21)
Elect bill without surcharge (Rs)
Surcharge (Rs)
Total electricity bill (Rs)


Total electricity bill- 2018-19(Rs)
39141
10.95 %
318248
89.05 %
Bill without surcharge
Surcharge





4.5. Standby DG Set:

4.5.1. The college has 2 (two) DG sets- 62.5KVA and 15KVA. However details of operating data and log book were not available. The college authorities are requested to maintain the record of date wise operation data with on-off timings, HSD stock and procurement details for post audit review.

5.0. ELECTRICAL LOADS:

Main electrical load in the college consists of lights, fans, split type air-conditioners and laboratory instruments and appliances and few low capacity water pumps and water coolers. Details of lights, fans and air- conditioners are shown in Table-4, below-

Table-4
Details of lights, fans & air-conditioners

Building	Floor area (Sqm) Excl corridor (Incl corridor)	Fan	Lights					UPS	AC
			LED bulb	CFL bulb	Inc bulb	LED tube	Fl. tube		
RCC Gr Floor (Front block)	433.57 (585.58)	36	1	31	0	12	5	1X3KVA	2X1TR 1X1.5TR
RCC 1st Floor (Old part)	289.32 (368.98)	19	0	10	0	7	18		4X1TR 1X1.5TR
RCC 1st Floor (Old part, Central Library)	330.64 (390.60)	26	13	8	0	6	1		3X1.5TR
RCC 2nd Floor (Old part)	238.94 (287.63)	27	0	0	0	11	4		6X1TR
RCC 2nd Floor (Old part- RCC1, RCC2 Block)	338.92 (488.49)	21	0	12	0	10	0	1X30KVA	1X1TR 2X2TR
RCC Building (New Part, GF)	155.61 (201.23)	14	0	5	0	2	14		
New RCC Building (Room RCC-6&7)	250.84 (389.07)	16	0	0	0	12	0		
Physics, Chemistry Block- AT	608.57 (653.58)	29	3	10	4	6	14	1X3KVA	
Back Block- AT	401.92 (508.83)	23	9	2	2	0	1		
Hall North Zoo-Botany Block- AT	802.19 (1017.44)	44	0	14	0	6	11		
KKHSOU-Canteen- Nano Lab Block- AT	282.05 (344.39)	16	1	7	2	0	11		2X1TR
Room 3 & 4 Block (Middle Block)- AT	430.02 (637.06)	46	4	1	0	19	14		
Room-20 & 21- AT	218.23 (344.34)	17	0	0	0	9	0		
Union Body Room-AT	26.57 (26.57)	1	0	0	0	0	1		
Total	**4807.39 (6243.79)**	**335**	**31**	**100**	**8**	**100**	**94**	**2X3KVA 1X30KVA**	**15X1TR 5X1.5TR 2X2TR**

5.1. It may be seen from the above table that while LED lights (lamps and tubes) are being installed in the college, still there are substantial numbers of CFL lamps and fluorescent tube lights. Also, there are handful numbers of incandescent lamps in the college building.

5.2. Split air conditioners installed are with conventional compressors, not the latest energy efficient versions like inverter types.

6.0. REVIEW & ANALYSIS OF THE DATA & THE SUGGESTIONS/ RECOMMENDATIONS:

6.1. Lighting system:

6.1.1. Replacement of fluorescent tube by LED tube: There seems to be energy saving potential by replacement of fluorescent tubes by LED tubes. The 36 W fluorescent tubes may be replaced by 18 W LED tubes which has better light output the than the fluorescents. The power input comparison of the two types are shown in Table-6 below-

Table-6
Input power comparison of fluorescent tube with LED tube

Type of light	Lamp watt	Ballast factor	Input power drawn (watt)
Fl. tube	36	0.88	40.9
LED tube	18	1	18
Difference			22.9

The difference in input power drawn by one LED (18 W) tube against one fluorescent tube (36 W) is shown in the above table. Saving in power consumption and corresponding amount in Rs per year by replacement of 94 fluorescent tubes are shown in Table-7. The assessment is based on consideration of average burning hours per day as 6 hours and yearly college opening days as 220 days.

Table-7
Saving by replacement of fluorescent tubes by LED tubes

No of lights	Difference in input power per light	Hours of operation per day	No of opening days per year	Saving in power consumption per year per light (2X3X4)	Saving in power consumption per year by replacement of all fl. tubes (1X5)	Yearly saving in Rs at supply tariff of Rs 6.60 per Kwh
1	2	3	4	5	6	7
94	22.9 W	6 hrs	220 days	30228 Wh 30.228 Kwh	2841432 Wh 2841.4 Kwh	18,751.00

6.1.2. Replacement of Compact Fluorescent lamps (CFL) by LED lamps: There are altogether 100 CFL lamps of different wattage in the college buildings. CFLs are considered to have lower efficiency in terms of light

output per watt (light efficacy) compared to LED lamps. LEDs have also better advantage in terms of life (total burning hours). Moreover, CFLs (also, all fluorescent lamps) are considered to be environmentally harmful for disposal as they contain some amount of mercury. Considering the above advantages, the CFL lamps may be changed by LED lamps. It may be mentioned that cost of LED lamps and CFL lamps are almost similar. It is therefore suggested that all CFL lamps may be changed by 12W LED lamps. Consequent saving in power consumption and corresponding amount in Rs per year due to replacement of 100 CFL lamps by LED lamps are shown in Table-8. The assessment is based on consideration of average burning hours per day as 6 hours and yearly college opening days as 220 days. While actually, wattage of CFL lamps installed are different, in the assessment, CFL lamps are considered as 15W on uniform basis.

Table-8
Saving by replacement of CFL lamps by LED lamps
(Replacement of 15 W CFL lamps by 12 W LED lamps)

No of lamps	Difference in input power per lamp	Hours of operation per day	No of opening days per year	Saving in power consumption per year per lamp (2X3X4)	Saving in power consumption per year by replacement of all CFL lamps (1X5)	Yearly saving in Rs at supply tariff of Rs 6.60 per Kwh
1	2	3	4	5	6	7
100	3 W (15-12) W	6 hrs	220 days	3960 Wh 3.96 Kwh	396000 Wh 396.00 Kwh	2,614.00

6.1.3. Replacement of incandescent lamps by LED lamps:

The population of incandescent lamps in the college building is very nominal, only 8. Considering the fact that LED lamps consume almost 75 to 80% less energy than incandescent lamps, use of incandescent lamps should be avoided. As such, the incandescent lamps, though nominal, should be replaced by LED lamps. All incandescent lamps may be replaced by 12 W LED lamps. Assessment of saving, considering the incandescent bulbs as 60 W, is shown in Table-9 below-

Table-9

Saving by replacement of incandescent lamps by LED lamps

(Replacement of 60 W Incandescent lamp by 12 W LED lamp)

No of lamps	Difference in input power per lamp	Hours of operation per day	No of opening days per year	Saving in power consumption per year per lamp (2X3X4)	Saving in power consumption per year by replacement of all CFL lamps (1X5)	Yearly saving in Rs at supply tariff of Rs 6.60 per Kwh
1	2	3	4	5	6	7
8	48 W (60-12) W	6 hrs	220 days	63360 Wh 63.36 Kwh	506880 Wh 506.880 Kwh	3376.00

6.2. Air-conditioners:

6.2.1. There are altogether 22 split air- conditioners (15 X 1TR + 5 X 1.5TR + 2 X 2TR) in the college buildings which constitute the major share of power consumption during the summer. Air conditioners are with conventional compressors and not with energy efficient inverter compressors. While the air conditioners based on inverter technology are considered to be much more energy efficient compared to the conventional air conditioners, considering the cost implications and long payback period as the use of ACs is limited to only few months of a year, replacement of the existing ACs has not been suggested. However, it is recommended that whenever new air-conditioners are purchased for new installation or replacement of any of the existing ones, inverter air-conditioners with energy efficient star labeling by BEE (Bureau of Energy Efficiency), if available, should be purchased.

6.2.2. It is to be mentioned that the energy efficiency data provided by the manufacturer for a particular model are achieved under the designed weather conditions and most importantly, if the air-conditioners are properly maintained. Few tips for use of the air-conditioners are suggested below to achieve optimum energy efficiency-

a) Govt of India has now made the default temperature setting of 24ºC mandatory for all room air-conditioners. This means that all new room air-conditioners henceforth will come with default temperature setting of 24ºC. It is to be noted that approximately 5-6% power consumption can be reduced by raising one degree centigrade temperature setting of the air conditioners. For example, if temperature setting is increased from 20ºC to 24ºC, power consumption will be reduced by 20%, considering 5% reduction per ºC. **Therefore, it is recommended that temperature setting of all room air-conditioners (unless for specific application), should be maintained at 24ºC.**

b) All air conditioned spaces should be properly sealed to avoid entry of ambient air, and windows should be curtained to avoid outside heat gain.

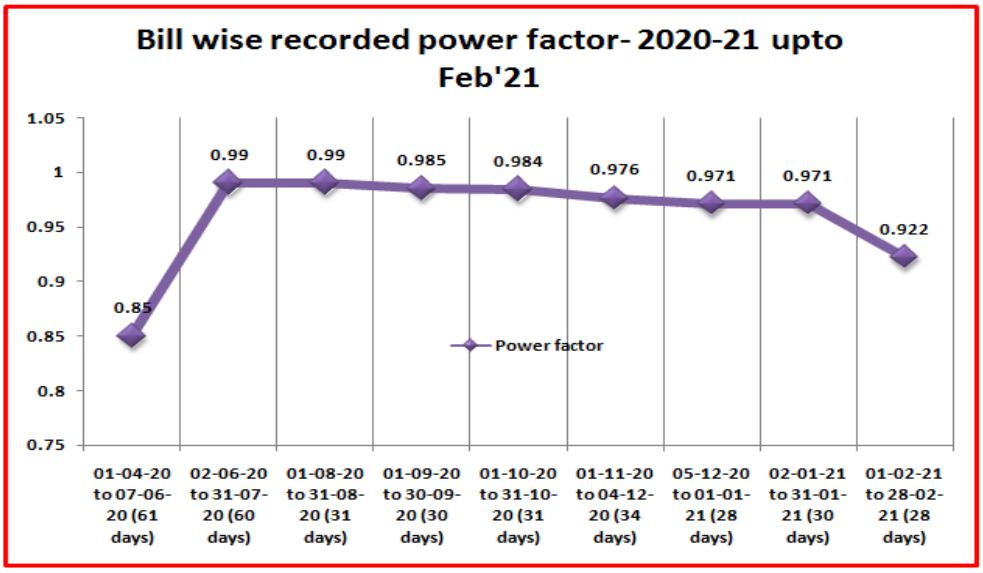
c) Air conditioners should be properly maintained. Particular attention should be given to clean the air filters of the indoor units regularly and also the condenser coils of the outdoor units. Dirt and dust deposits result in clogging of the air filters which causes increase in power consumption besides reducing the cooling effect. Dirty and clogged air filters cause as high as 10-12% more power consumption.

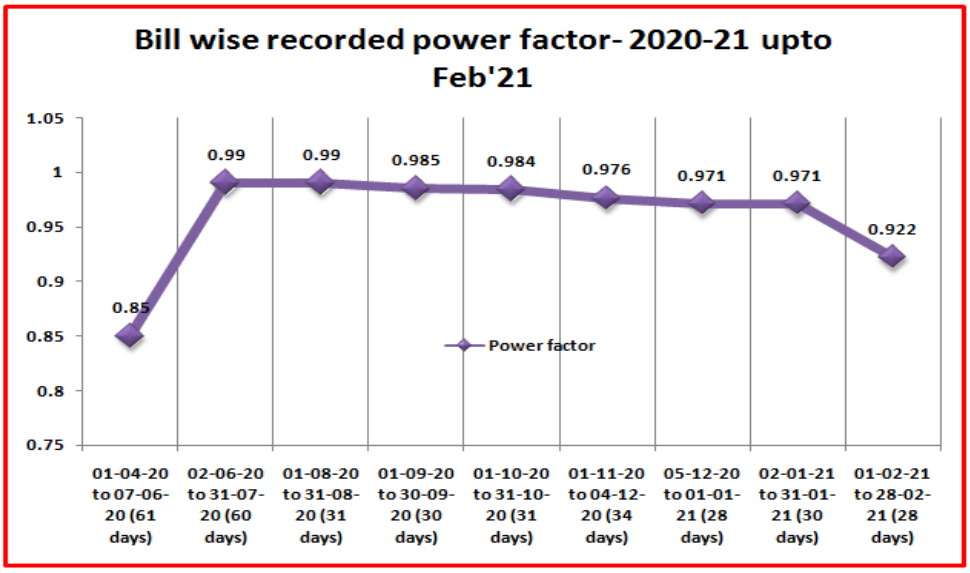
6.3. Reactive power management :

6.3.1. As mentioned in para 3.2.1(c), APDCL tariff has provision for rebate on power factor 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%

6.3.2. In whole of 2018-19 and part of 2019-20, the college has been deprived of the benefit of this rebate on power factor for absence of records of power factor in the bills. Actual data of power factors are only available in the bills of 2020-21. After carefully examining the data for 2020-21 also, the power factor (0.85) shown in the bill for the period 01-04-20 to 01-06-20, seems to be unrealistic and suspected to be erroneous as the same is inconsistent with the recorded power factors in all the subsequent months.

6.3.3. As maximum rebate of 3% is available on power factor from 0.97 to 1.0, it should be targeted to maintain the power factor consistently in every month above 0.99 to derive the maximum benefit. For maintaining the power factor at such level consistently, APFC (Automatic Power Factor Correction) panels need to be installed. **To decide the capacity and specification of the APFC panel, actual data of maximum demand and power factor for the whole year is necessary. The relevant data available for the college is for the year 2020-21, which cannot be considered to be actual and realistic as most of the periods were under lockdown due to pandemic.** Nevertheless, the data are shown in the charts below-





6.3.4. The rebates on power factor received against receivable (if power factor was maintained at 0.99 in every month) in 2020-21, up to Feb'21 are shown in the table below-

Table-10

Rebates on power factor Achievable against actual

Description	**2020-21 (up to Feb'21)**	
	In Kwh	**In Rs (@6.60kwh)**
Annual consumption	25210.41	----------
Rebate achievable (3%)	756.31	4,991.65
Actual rebate obtained	639.52	4,220.83
Difference	116.79	**(Loss) 770.82**

It may be noted that above data are for 2020-21 which may be below the normal consumption as most of the periods in the year were under lockdown. Moreover, the data are for 11 months only (up to Feb'21).

6.3.5. Considering the basis for yearly consumption of 2019-20, during which the college was normally functioning except for the last week, annual consumption may be taken as 32300 Kwh. On that basis, yearly achievable rebate on power factor is 969.00 Kwh (3% of 32300) and yearly achievable rebate in terms of money would be Rs 6395.00 (at energy charge of Rs 6.60).

6.4. Review of yearly consumption and bill amounts:

6.4.1. It may be seen that the whole year of 2018-19 and even from around half year before, the bills were served on assessment basis, considering an assessed consumption of 99.86 Kwh per day. Average per day actual billed unit in the following year - 2019-20 which was based on meter reading, was 89.18 Kwh. It may be seen from above that average daily consumption considered by APDCL for serving assessed bills in 2018-19 was higher than the average daily consumption found from actual meter readings in 2019-20. Even if we ignore the fact that normally there is an increasing trend in power consumption, there was over billing to the extent of 11.97% in 2018-19 compared to 2019-20.

Thus, in the year 2018-19, overbilling was done to the extent of around 4216 Kwh (billed unit of 18-19, 36512 – billed unit of 19-20, 32296 Kwh). In terms of money, extra billed amount was Rs 28,668.80. **Thus, the college had to make an additional payment to the tune of Rs 28,669.00 in the year 2018-19 as a result of non-installation of meter by APDCL.**

6.4.2. From the data shown in table-3 and also in the charts, the college had to pay Rs 39,141.00, Rs 74,549.00 and Rs 20,413.00 as surcharge on arrears in the years 2018-19, 2019-20 and 2020-21 respectively, These constituted 10.95%, 20.3% and 7.8% of the total billed amounts of the respective years.

6.5. Ceiling fans:

There are 335 ceiling fans in the college buildings, most of which are old fans. Presently, star labeled ceiling fans are available under BEE star labeling scheme. It is suggested that whenever, new fans are procured, only 5 star rated ceiling fans are selected.

6.6. Building Energy Performance Index:

The Energy Performance Index of the buildings in the campus, which is denoted by electricity consumption in Kwh per year per sqm of built up area for the years 2018-19 & 2019-20 are as follows-

2018-19: 7.6 Kwh/ Sqm

2019-20: 6.71 Kwh/ Sqm

As consumption data for full 2020-21 is not available, the EPI for 2020-21 has not been calculated. Moreover, as a long period in the year was under lockdown, the calculated index would not be realistic. From the index calculated for the two years as shown above, EPI for 2018-19 cannot be considered as actual since consumptions for the year was not based on actual meter reading. **Therefore, EPI of 6.71 (for the year 2019-20) may be considered as realistic figure for the analyzed period.**

7.0. STUDENTS' INVOLVEMENT IN ENERGY CONSERVATION:

7.1. It is highly essential and also will prove to be beneficial for the college, to create awareness among the students to inculcate the habit of switching off the fans, lights and air-conditioners whenever no student is present in the class room, laboratory etc. This may reduce the power consumption to a great extent and will avoid wastage of power. Such habits will also help the students in saving power at their homes.

7.2. Formation of GREEN VOLUNTEERS

It is suggested to form a society of GREEN VOLUNTEERS from students to take up energy conservation and environmental activities in the place of study, home and society including creating awareness among the students and society. They may also take up the responsibility of easy measures like switching off the fans, lights and air-conditioners whenever no student is present in the class room, laboratory etc. as suggested at 6.7.1 above. They may also be encouraged to organize awareness programmes on energy conservation and environment.

8.0 INSTALLATION OF SOLAR ROOF TOP PLANT:

There is scope for installation of roof top solar plant in the college building. Considering the roof top spaces, it is feasible to install solar plants of around 100 KWp capacity on the roof tops of the buildings. However, a feasibility study shall have to be conducted to actually assess the capacity. As per the recent energy audit conducted by this energy auditor in Guwahati, roof solar plants have been found to generate 3.28 Kwh per KWp per day on the basis of yearly average in Guwahati weather, which should be similar to Abhayapuri.

There are two options available for executing the project- CAPEX or RESCO. In CAPEX mode entire capital expenditure is borne by the owner and the plants remain as the property of the owner. In RESCO mode, the agency bears the investment and also maintains the system. The owner shall have to buy the units generated from the plant as per purchase agreement with the RESCO agency as per agreed tariff. Present solar tariff is around Rs 3.00 per Kwh. The capital cost on the other hand is around Rs 40,000.00 per KWp for grid interactive solar plants.

It is suggested that initially a plant of 10/15 KWp capacity may be installed. Considering execution in RESCO mode, calculation for a 10 KWp plant is shown below-

Table-11
Saving from installation of a 10 KWp roof top solar plant

Capacity (KWp)	Yearly generation from solar @ 3.28 Kwh/ day/ KWp (Kwh)	Purchase cost for solar @ Rs 3.00 per Kwh (Rs)	Cost, if purchased from APDCL @ Rs 6.60 per Kwh (Rs)	Yearly saving (Rs)
10	11972 Kwh	35,916.00	79,015.00	43,099.00

A. Goswami

ANNEXURE-1

POWER CONSUMPTION AND BILLING DETAILS FOR 2018-19, 2019-20 & 2020-21 (UP TO FEB'21

Period of bill	Unit Consm'd (billed) (KWh)	Max. demand recorded	PF as per bill	Rebate on power factor (KWh)	Amount billed (Rs)	Surcharge on arrear (Rs)	Total amount (Rs)
2018-19							
03-04-18 to 07-05-18 (34 days)	3396 (3396)	NA	NA	Nil	29,453	610	30,063
07-05-18 to 06-06-18 (31 days)-Assessed	3096 (3096}	NA	NA	Nil	27,429	---	27,429
06-06-18 to 03-08-18 (58 days)	5793 (5793)	NA	NA	Nil	50,212	4,543	54,755
03-08-18 to 03-09-18 (31 days)	3096 (3096)	NA	NA	Nil	26,835	6,737	33,572
03-09-18 to 03-10-18 (30 days)-Assessed	2996 (2996)	NA	NA	Nil	26,715	------	26,715
03-10-18 to 05-04-19 (184 days)	18135 (18135)	NA	NA	Nil	1,57,594	27,251	1,84,845
Total (2018-19)	**36512 (36512)**				**3,18,238**	**39,141**	**3,57,379**
2019-20							
05-04-19 to 01-02-20 (302 days)	30140 (30140)	NA	NA		2,66,437	32,601	2,99,038
01-02-20 to 11-03-20 (39 days)	1400 (1386)	NA	0.95	14	16,644	41,948	58,592
11-03-20 to 01-04-20 (21 days)-Assessed	760 (760)	NA	NA	NA	8,993	----	8993

Total (2019-20)	**32300 (32286)**			**14**	**2,92,074**	**74,549**	**3,66,623**
2020-21 (up to Feb'21)							
01-04-20 to 01-06-20 (61 days)	3140 (3140)	NA	0.85	0	32,429	13290	45,719
02-06-20 to 31-07-20 (60 days)	6048.81 (6043.4)	13.92	0.99	186.91	54,266	--	54,266
01-08-20 to 31-08-20 (31 days)	3559.20 (3556)	23.36	0.99	109.98	31,042	3,000	34,042
01-09-20 to 30-09-20 (30 days)	2356.00 (2353.9)	21.72	0.985	72.80	22,505	3810	26,315
01-10-20 to 31-10-20 (31 days)	2292.00 (2289.9)	23.52	0.984	70.82	22,269	--	22,269
01-11-20 to 04-12-20 (34 days)	2002.2 (2000.4)	20.37	0.976	61.87	20881	--	20,881
05-12-20 to 01-01-21 (28 days)	1834.6 (1832.95)	9.28	0.971	56.69	18,482	313	18,795
02-01-21 to 31-01-21 (30 days)	1916.4 (1914.67)	9.28	0.971	59.22	19,462	--	19,462
01-02-21 to 28-02-21 (28 days)	2061.2 (2101.81)	13.72	0.922	21.23	20,346	--	20,346
Total- 2020-21 (up to Feb'21)	**25210.41 (25233.03)**			**639.52**	**2,41,682.**	**20,413**	**2,62,095**

Notes-

1. Bills for the period 07-05-18 to 06-06-18 and 03-09-18 to 03-10-18 have not been found on record. The data against the bills shown are on the basis of the average consumption as per which all the bills in 2018-19 were served (as the meter was defective during the period). However, surcharge on arrear has not been shown in absence of actual record.
2. Bill for the period 11-03-20 to 01-04-20 has not been found on record. The data shown against the period is based on consumption calculated by deducting present meter reading of the previous bill from the previous meter reading of the next bill and amount found on the basis of prevailing tariff. The power factor, rebate/ penalty on power factor and surcharge on arrear have not been shown in absence of actual data.