CONFIDENTIAL

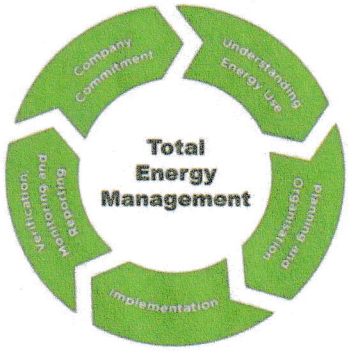
ENERGY, GREEN and ENVIRONMENT AUDIT

AT

J.J. College of Arts and Science (Autonomous)

Re-Accredited by NAAC with "A" Grade in 3rd Cycle
Affiliated to Bharathidasan University – Tiruchirappalli
J.J. Nagar, Sivapuram, Pudukkottai – 622 422

October 2020



Self Study Report 4th Cycle
Criteria 7

7.1.2. The Institution has facilities for alternate sources of energy and energy conservation measures
7.1.3. Describe the facilities in the Institution for the management of the following types of degradable and non-degradable waste
7.1.4. Water conservation facilities available in the Institution
7.1.6. Quality audits on environment and energy regularly undertaken by the Institution

Submitted by:

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ABBREVIATIONS

Abbreviation	Description
AC	Air-Conditioner
°C	Degree Celsius
TANGEDCO	Tamil Nadu Generation and Distribution Corporation
CFL	Compact Fluorescent Lamp
DG	Diesel Generator
TEM	Total Energy Management
FTL	Fluorescent Tube Lamp
kW	Kilo watt
kWh	Kilowatt hour
JJC	J.J. College of Arts and Science
SEC	Specific Energy Consumption
TR	Tons of Refrigeration
IoT	Internet of Things
UVKS	UVK Susnomics Engineering Private Limited

1. EXECUTIVE SUMMARY

This Report is the outcome of energy audit conducted at J.J. College of Arts and Science (JJC), Pudukottai, Tamil Nadu during Nov 2020. It was conducted by UVK Susnomics Engineering Private Limited, an ISO Certified & CRISIL HIGH Rated company.

Based on an invitation to Energy, Green & Environment Audit from J.J. College of Arts and Science, UVKS agreed to audit to explore the potential for reducing the energy costs through energy-efficiency measures at the campus. The energy audit of JJC concentrated on proven concepts throughout the campus.

1.1. COLLEGE PROFILE

Description	Status
Name of College	J.J. College of Arts and Science (Autonomous)
Place	J.J. Nagar, Sivapuram Post, Pudukkottai - 622 422
State	Tamil Nadu
Affiliating University	Bharathidasan University
Status of the College	Self - Financing
Type of College	Co-Educational
No. of Departments	17
No.of Programmes	51
Date of establishment	17.01.1994
Date of conferment of the Autonomous Status	17.08.2012
Location of the College	Rural

The audit consisted of an on-site survey, discussions with JJC personnel, followed by a technical evaluation of applicable measures that could reduce energy consumption. The site visit encompassed study of all energy consuming sources, covering JJC old and new blocks.

The summary of the main findings and list of energy conservation measures are presented in this report which had the consent of the JJC top management team for further action and development consideration

1.2. ABOUT COLLEGE

J.J. College of Arts and Science is a NAAC Accredited with Grade A in 3rd Cycle. JJC has over 13 Buildings over 150-class rooms& auditorium, well equipped laboratories, canteen, kitchen, students' hostel and parking lot. The brief of the college programmes is given below:

17 U.G. PROGRAMMES	13 P.G. PROGRAMMES	11 M.PHIL PROGRAMMES	8 PH.D PROGRAMMES
5200 STUDENTS	193 FACULTY MEMBERS	15 RESEARCH GUIDES	50 RESEARCH SCHOLARS

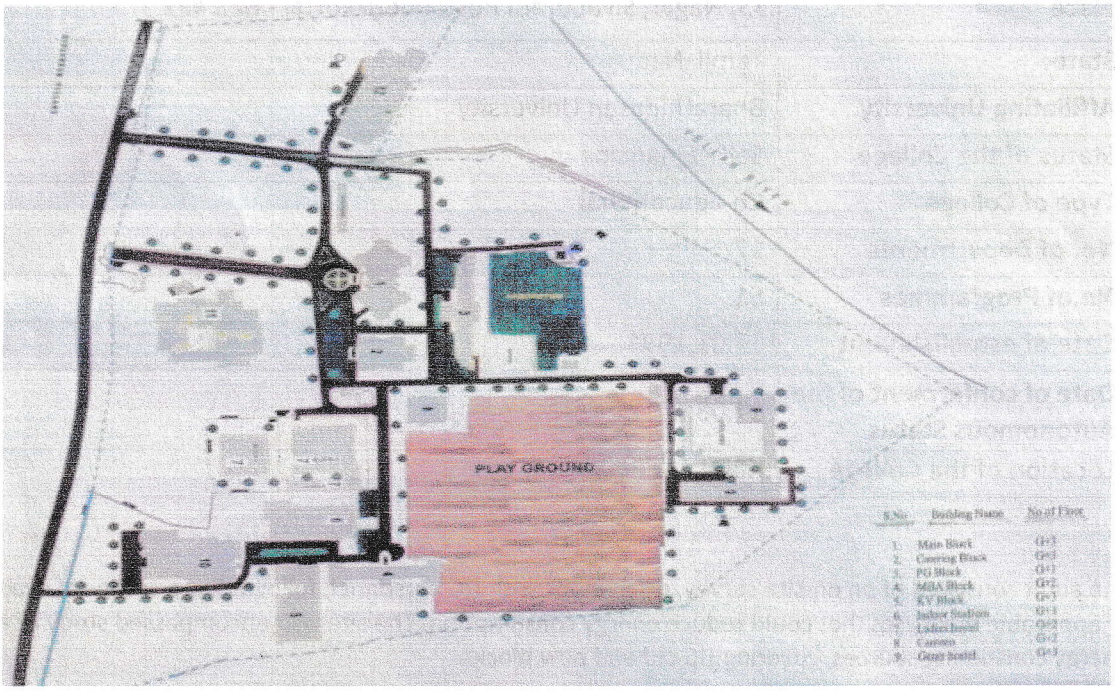


Fig 1.1: Campus Layout

Electricity requirements of the JJC campus is met from the Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO) as prime power source to meet the entire electricity requirement of the campus as well as a 43.5KVA Solar Rooftop Plant and captive diesel generator sets. The major loads at JJC are air-conditioning, lighting, fans, computers and pumps.

2. ENERGY SCENARIO

Electricity, diesel and LPG are the major energy sources. Electricity is consumed all around the campus by the equipment (lights, fans, computers, pumps & ACs). Diesel is used as fuel for Diesel Generator (DG) sets and to run College Buses (Shuttle).

2.1. ENERGY SOURCES AND CONSUMPTION DATA AT THE JJC

JJC utilizes Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO) as prime power source to meet the entire electricity requirement of the campus as well as a 42.5 kWp Solar Rooftop Plant. The electricity demand during power failures is met by diesel fired captive power generation sets. Annual JJC electricity consumption during Jan – December 2019 was 307,794 kWh. Table 2.1 gives the electricity consumption of the all the buildings of JJC from Jan '19 to Dec '19 based on the EB bill.

Table 2.1: Electricity consumption of J.J. College of Arts and Science for Jan '19 to Dec '19

Blocks	Calendar year 2019	
	kWh	Cost
Canteen block	3,990	37,338
Indoor stadium	11,010	108,081
KIM Block	23,140	215,634
MBA Block	25,720	235,283
Gents hostel	49,439	405,677
PG block	18,640	168,545
Ladies hostel	77,689	644,344
Main building	72,850	612,170
Total	**282,478**	**2,427,072**

Main building electricity consumption is estimated because of the non-availability of the EB bill. It can be noted that compared to 2019 the electricity consumption in 2020 has dropped by 45% majorly due to COVID Pandemic. Installation of Solar Power Plant in June'2020 as made an impact as well.

Diesel consumption and the cost are estimated with the data provided by JJC during the UVKS Energy Audit. It was informed that all the diesel related logged data are lost during the flood. Table 2.2 represents the estimated diesel consumption of JJC for Jan '19 to Dec '19

Table 2.2: Estimated Diesel consumption of J.J. College of Arts and Science for Jan '19 to Dec '19

Month	Diesel consumption	Diesel cost
	Litres	Rs.
Jan-18	500	39,060
Feb-18	800	60,824
Mar-18	400	29,712
Apr-18	450	32,526
May-18	100	7,228
Jun-18	350	26,439
Jul-18	600	50,178
Aug-18	150	12,545
Sep-18	800	68,032
Oct-18	200	16,828
Nov-18	435	36,601
Dec-18	435	37,110
Total	5,220	417,082

Table 2.3: LPG consumption of J.J. College of Arts and Science for Jan '19 to Dec '19

Months	No. of cylinders	Total cost
Jan-19	69	99,707
Feb-19	64	106,722
Mar-19	61	107,055
Apr-19	47	82,866
May-19	51	59,250
Jun-19	51	65,182
Jul-19	85	107,500
Aug-19	72	90,979
Sep-19	81	101,990
Oct-19	57	73,800
Nov-19	77	105,875
Dec-19	73	105,421
Total	**790**	**1,106,347**

2.2. ELECTRICITY DISTRIBUTION AND BREAKDOWN OF ELECTRICITY CONSUMPTION

JJC utilizes Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO) as prime power source to meet the entire electricity requirement of the campus as well as a 43.5 kVA Solar Rooftop Plant. The electricity distribution at the JJC campus is divided into two lines one for the entire west side the campus covering J.J. College of Engineering and Technology (JJCCET), J.J. College of Pharmacy (JJCCP) & Girls Hostel and the other line for the entire east side covering J.J. College of Arts & Science & Boys Hostel as shown in Figure 2.2.1.

2.2.1. Electrical SLD of J.J. College Arts and Science

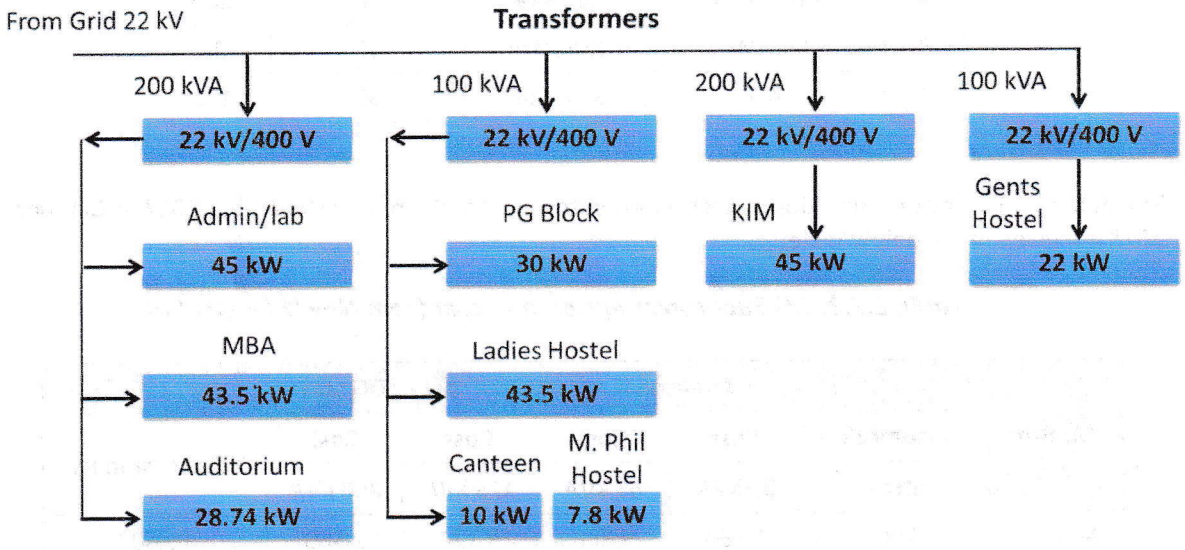


Figure 2.2.1: Electricity distribution at J.J. College of Arts and Science

2.2.2. Diesel Generators

As a stand-by source of power, four diesel generator (DG) sets of different capacities are installed in the J.J. College of Arts and Science. The name plate details of the installed DG sets are given in the below table:

Table 2.2.2: List of DG sets installed at J.J. College of Arts and Science

S. No.	Description	Make	Frequency	kVA
1	CM225s	Kirloskar	50	63
2	KG254M1	Kirloskar	50	200
3	KG184C	Kirloskar	50	30
4	NA	Kirloskar	50	125

The details of Energy Consumption of Diesel Generator sets for the period November 2017 to October 2018 are given in the below table:

Table 2.2.3: DG Fuel consumption and cost from Nov '17 – Oct '18

Month	Fuel consumption and cost of DG sets					
	Consumption	Cost	Cost	Cost	Cost	Total cost in Rs.
	litres	30 kVA	63 kVA	125 kVA	200 kVA	
Nov-17	200	1,560	9,360	3,120	1,560	15,600
Dec-17	Nil	Nil	Nil	Nil	Nil	Nil
Jan-18	500	3,900	23,400	7,800	3,900	39,000
Feb-18	800	6,240	37,440	12,480	6,240	62,400
Mar-18	400	3,120	18,720	6,240	3,120	31,200
Apr-18	450	3,510	21,060	7,020	3,510	35,100
May-18	100	780	4,680	1,560	780	7,800
Jun-18	350	2,730	16,380	5,460	2,730	27,300
Jul-18	600	4,680	28,080	9,360	4,680	46,800
Aug-18	150	1,170	7,020	2,340	1,170	11,700
Sep-18	800	6,240	37,440	12,480	6,240	62,400
Oct-18	200	1,560	9,360	3,120	1,560	15,600

Figure 2.2.3: Diesel Generator Sets & Name plates at J.J. College of Arts and Science

2.2.3. Sub Panel Infra

Figure 2.2.4: LT panel at J.J. College of Arts and Science

2.3. LOAD DETAILS

The major electrical equipment installed in JJC are lighting, fans, computers, pumps and ACs. The identified list of electrical equipment and its average consumption per day is given in the below tables:

2.3.1. List of ACs installed in J.J. College of Arts and Science

S. No.	ACs Location	Name plate Details								Operating hours	Avg consumption per day
		Make	Type	Qty	Capacity	Power	Current	Cooling capacity	Type of Refrigerant		
				Nos.	TR	V	A	W	Type	h	
1	Main+Lab	Carrier	Hi-wall Split	10	1.5	230	0.4	7,031	R22	1	16
2	Main+Lab	Carrier	Hi-wall Split	8	1.8	230	0.7	7,500	R22	1	18
3	Canteen	Carrier	Hi-wall Split	4	1.5	230	0.4	7,031	R22	1	6
4	KIM	Carrier	Hi-wall Split	17	1.5	230	0.4	7,031	R22	1	26
5	KIM	Carrier	Ductable	2	8.5	415	15	9,000	R22	1	51
6	PG Block	Carrier	Ductable	4	3.0	415	1.4	7,500	R22	1	36
7	PG Block	Hitachi	Hi-wall Split	5	1.5	230	0.4	7,031	R22	1	8
8	MBA	Carrier	Hi-wall Split	18	1.5	230	0.4	7,031	R22	1	28
9	MBA	Hitachi	Split Inverter	6	1.5	230	0.4	7,000	R410	1	9
10	Auditorium	NA	Window	1	1.5	230	0.4	7,031	R22	1	2
11	Auditorium	Carrier	Hi-wall Split	1	1.5	230	0.4	7,031	R22	1	2
12	Auditorium	Daikin	Ductable	10	10.0	380	19.5	10,888	R22	0.5	50
Total Per day Consumption											251

2.3.2. List of plug loads installed in J.J. College of Arts and Science

Sl. No.	Description	Quantity	Capacity	Operating hours per day	Load	Energy consumption
		Nos.	W	Hours	%	kWh
1	PCs	448	130	3	10	17
2	Printers/Scanners	23	700	2	10	5
3	Water coolers	6	500	1	10	1
4	CCTV& Biometric	20	100	2	10	1
Total kWh consumption per day						24

2.3.3. List of lights installed in J.J. College of Arts and Science

Present System								
S.No.	Location	Description	Qty	Type of lamp	No.of lamps/ fixture	Rated lamp power with ballast	Operating hours	Energy consumption
						watt	hours	kWh/day
		A	B	C	D	E	F	G=(BxDxExF)/ 1,000
1	Main Building	1X100	1	FTL	1	100	6	0.60
2	Main Building	1X12	9	LED	1	12	6	0.65
3	Main Building	2X12	8	CFL	2	12	6	1.15
4	Main Building	1X18	24	LED	1	18	6	2.59
5	Main Building	1X20	1	CFL	1	20	6	0.12
6	Main Building	1X36	272	FLT	1	40	6	65.28
7	Main Building	2X36	25	FLT	2	40	6	12.00
8	Main Building	4X36	1	FLT	4	40	6	0.96
9	Main Building	3X5	1	CFL	1	5	6	0.03
10	Main Building	1X8	10	CFL	1	8	6	0.48
11	Main Building(Lab Block)	1X1	15	LED	1	1	6	0.09
12	Main Building(Lab Block)	1X11	1	LED	1	11	6	0.07
13	Main Building(Lab Block)	1X12	22	LED	1	12	6	1.58
14	Main Building(Lab Block)	2X12	3	LED	2	12	6	0.43
15	Main Building(Lab Block)	1X15	12	LED	1	15	6	1.08
16	Main Building(Lab Block)	2X15	2	LED	2	15	6	0.36
17	Main Building(Lab Block)	1X20	1	CFL	1	20	6	0.12
18	Main Building(Lab Block)	4X20	4	LED	4	20	6	1.92
19	Main Building(Lab Block)	1X36	102	FLT	1	40	6	24.48
20	Main Building(Lab Block)	2X36	10	FLT	2	40	6	4.80
21	Main Building(Lab Block)	4X36	4	FLT	4	40	6	3.84
22	Main Building(Lab Block)	1X5	34	LED	1	5	6	1.02
23	Main Building(Lab Block)	1X500	4	Halogen	1	500	6	12.00
24	Mens Hostel	1X36	354	FLT	1	40	6	84.96
25	KIM	1X20	70	CFL	1	20	6	8.40
26	KIM	1X36	153	FLT	1	40	6	36.72
27	KIM	2X36	67	FLT	2	40	6	32.16
28	Ladies Hostel	1X12	5	LED	1	12	6	0.36
29	Ladies Hostel	1X20	3	CFL	1	20	6	0.36
30	Ladies Hostel	1X24	20	LED	1	24	6	2.88
31	Ladies Hostel	1X36	400	FLT	1	40	6	96.00
32	Ladies Hostel	2X36	3	CFL	2	36	6	1.30
33	Ladies Hostel	1X5	2	LED	1	5	6	0.06
34	Ladies Hostel	1X7	3	CFL	1	7	6	0.13
35	Ladies Hostel	1X70	4	SVL	1	70	6	1.68
36	PG Building	1X14	1	CFL	1	14	6	0.08
37	PG Building	1X15	2	LED	1	15	6	0.18
38	PG Building	1X20	8	CFL	1	20	6	0.96
39	PG Building	1X36	116	FLT	1	40	6	27.84
40	PG Building	2X36	61	FLT	2	40	6	29.28
41	PG Building	1X5	8	LED	1	5	6	0.24
42	PG Building	1X500	2	Halogen	1	500	6	6.00
43	PG Building	3X90	3	CFL	3	90	6	4.86
44	MBA Building	1X36	152	CFL	1	36	6	32.83
45	MBA Building	2X36	48	CFL	2	36	6	20.74
46	MBA Building	3X36	14	CFL	3	36	6	9.07
47	Street Lights In Campus	1x50	38	CFL	1	50	6	11.40
48	Street Lights In Campus	1x24	28	CFL	1	24	6	4.03
49	Street Lights In Campus	1x15	6	LED	1	15	6	0.54
50	Street Lights In Campus	1x65	3	CFL	1	65	6	1.17
51	Street Lights In Campus	1x20	15	CFL	1	20	6	1.80
52	Street Lights In Campus	2x36	24	CFL	2	36	6	10.37
53	Street Lights In Campus	1x40	3	CFL	1	40	6	0.72
54	Street Lights In Campus	1x1000	16	Halogen	1	1,000	1	16.00
55	Street Lights In Campus	1x50	26	LED	1	50	6	7.80
56	Street Lights In Campus	1x30	5	LED	1	30	6	0.90
		Total Daily Consumption						**587.47**

2.3.4. List of fans installed in J.J. College of Arts and Science

S.No	Present system				
	Description	No. of fans	Power consumption of each fan	Operating hours per day	Electricity consumption
		Nos.	watt	hours	kWh/day
		A	B	C	D=AxBxC /1,000
1	MBA Building	36	36	36	36
2	MBA Building	5	5	5	5
3	Auditorium Building	39	39	39	39
4	Auditorium Building	4	4	4	4
5	Auditorium Building	7	7	7	7
6	Men's Hostel	72	72	72	72
7	Men's Hostel	1	1	1	1
8	Canteen	17	17	17	17
9	KIM	62	62	62	62
10	KIM	2	2	2	2
11	Main Building + Lab	6	6	6	6
12	Main Building + Lab	77	77	77	77
13	Main Building + Lab	4	4	4	4
14	Ladies Hostel	57	57	57	57
15	PG	24	24	24	24
16	PG	6	6	6	6
	Total Daily Consumption				419

From the above tables, the average consumption per day is identified to be around 1,279 kWh which accounts annually about 2,30,220 kWh

3. ENERGY COST DATA

Per Capita Electricity Consumption and Cost

The per capita electricity expenditure comes out to be Rs. 430 per annum, and the per capita electricity consumption on a student comes out to be 55 kWh per annum. The per capita cost and consumptions are given in detail in the following table:

Table 3.1: Per Capita Electricity consumption and cost data

Per Capita Electricity consumption and cost data			
	kWh	**Rs.**	
Total JJC Consumption	307,794	2,393,737	
	Total Capita in the Campus	**per capita kWh consumption per year**	**per capita electricity cost per year**
Total JJC Campus	5563 (Students 5318 + Teaching 190 + Non-Teaching 55)	55	430

4. LIST OF RECOMMENDED ENERGY SAVINGS OPPORTUNITIES AT J.J. COLLEGE OF ARTS AND SCIENCE

Area	TEM No. & Description	Annual CO_2 savings	Annual Energy Savings	Annual LPG savings	Recurring Annual Cost Savings	One-time cost of implemen tation	Payback Period
		tons	kWh	kg	Rs.	Rs.	months
HVAC System	TEM AC1 Option 1: Install AC Energy Saver for identified existing ACs to save energy consumption	This scheme is economically not viable					
	TEM AC1 Option 2: Replace identified conventional ACs with energy efficient inverter ACs to reduce energy consumption	This scheme is economically not viable					
	Sub-total: HVAC system	**Schemes are not economically viable**					
Electrical & Lighting Systems	TEM E1: Replace existing FTL lamps with energy-efficient LED lamps at identified locations	26	31,123	0	267,658	1,656,500	74
	TEM E2: Replace existing CFL lamps with energy-efficient LED lamps at identified locations	7	8,807	0	76,284	409,100	64
	TEM E3: Replace existing 1,000 W metal halide lamps with energy-efficient LED lamps	12	14,106	0	121,314	368,000	36
	TEM E4: Replace existing ceiling fans with energy-efficient fans	44	53,073	0	456,430	3,175,200	83
	Sub-total: Electrical & Lighting systems	**88**	**107,110**	**0**	**921,685**	**5,608,800**	**73**
Kitchen	TEM K1: Replace conventional type kitchen LPG burners with energy-efficient burner to save gas consumption	4	0	3,002	220,977	670,000	36
	Sub-total: Kitchen	**4**	**0**	**3,002**	**220,977**	**670,000**	**36**
Green Audit	TWM1: Replace identified ball taps with piller taps to save water consumption	Water savings cost is not estimated because of the non-availability of the water consumption and cost data					
	Grand Total	**91**	**107,110**	**3,002**	**1,142,662**	**6,278,800**	**66**

Each saving scheme is elaborated with further details in the following pages.

4.1. Brief description of energy saving measures

TEM E1: Replace existing FTL lamps with energy-efficient LED lamps at identified locations

PRESENT SYSTEM

- 36 W T12, 4 feet Fluorescent Tube Lamps (FTLs) luminaires are installed in various locations in JJC and JJC hostel interiors.
- These luminaires are wired with copper/aluminum ballasts results in 15-20% power loss
- Low lamp life of T8/T12: < 5,000 burning hours – means more replacement costs
- Lamp efficacy is only <65 lumens/watt necessitating more lamps to be installed
- Lumen depreciation with usage is high (>30% towards end of life)
- Because of the low lumen output more number of luminaries need to achieve the required luminance levels

PROPOSAL

- Retrofit/Replace 1x36 W 4 feet, T8 Fluorescent Tube Lamps (FTL) with 20 W 4 feet LED lamp and 2x36 W with 40 W LED.
- The proposed lamp has the following benefits:
    - Same size, shape and fits into existing fixtures, thus can be retrofitted in existing luminaries
    - Provides same color quality, brightness effect with lower lighting power of only 18 W

ESTIMATED BENEFITS

Recurring annual cost savings	: Rs. 267,658
Capital Investment	: Rs. 1,656,500
Payback Period	: 74 months
Savings measurement	: Direct

TEM E2: Replace existing CFL lamps with energy-efficient LED lamps at identified locations

PRESENT SYSTEM

- Conventional Compact Fluorescent Lamps (CFLs) luminaires are installed in various locations such as Main Building, MBA building and street lights of JJC and JJC hostel interiors.
- Low lamp life of T8/T12: < 5,000 burning hours – means more replacement costs
- Lamp efficacy is only <65 lumens/watt necessitating more lamps to be installed
- Lumen depreciation with usage is high (>30% towards end of life)
- Because of the low lumen output more number of luminaries need to achieve the required luminance levels

PROPOSAL

- Retrofit/Replace 1x36 W 4 feet, T8 Fluorescent Tube Lamps (FTL) with 20 W 4 feet LED lamp and 2x36 W with 40 W LED.
- The proposed lamp has the following benefits:
    - Same size, shape and fits into existing fixtures, thus can be retrofitted in existing luminaries
    - Provides same color quality, brightness effect with lower lighting power of only 18 W

ESTIMATED BENEFITS

Recurring annual cost savings	: Rs. 76,284
Capital Investment	: Rs. 409,100
Payback Period	: 64 months
Savings measurement	: Direct

TEM E3: Replace existing 1,000 W MH lamps with energy-efficient LED lamps at identified locations

PRESENT SYSTEM

- JJC campus has around 16 nos. of 1,000 W Metal Halide (MH) lamps installed in the outdoor areas
- Rated burning hours of existing lamps are less than 10,000 hrs and more than 30% lumen depreciation at the end of the life

PROPOSAL

- Replace existing 1,000 W MH street light fixtures with high efficiency LED luminaires
- The proposed fixtures would giving > 90 lumens/watt, at 210 W rated power
- Life >30,000 burning hours, <10% lumen maintenance throughout life

ESTIMATED BENEFITS

Recurring annual cost savings	: Rs. 121,314
Capital Investment	: Rs. 368,000
Payback Period	: 36 months
Savings measurement	: Direct

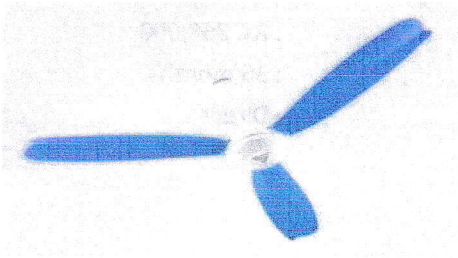
TEM E4: Replace identified ceiling fans with energy-efficient fans

PRESENT SYSTEM

- JJC has around 385 nos., of conventional ceiling fans are installed and operated in the class rooms, labs and hostels at the college campus
- Ceiling fans are the major loads at the JJC campus.
- Rated power for the existing fans are around 80 W and will consume around 80 watts at full speed

PROPOSAL

- Replace existing conventional fan with high energy-efficient fans
- The rated power of the proposed fans will be around 35 W at maximum speed and will consume power varying 10 W to 35 W based on the speed
- The proposed fan is available with variance of color and comes with handy irresistible remote



PROPOSED FAN

ESTIMATED BENEFITS

Recurring annual cost savings	: Rs. 461,430
Capital Investment	: Rs. 3,175,200
Payback Period	: 83 months
Savings measurement	: Direct

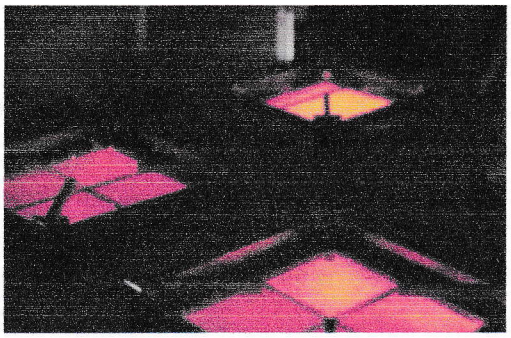
TEM K1: REPLACE CONVENTIONAL TYPE LPG FIRED STOVES WITH ENERGY-EFFICIENT BURNER TO SAVE GAS CONSUMPTION

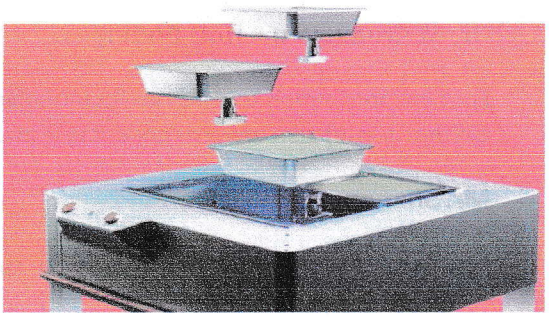
PRESENT SYSTEM

- 4 kitchen gas stoves are installed with conventional type burners
- Maximum thermal efficiency of conventional type burner is in the range of 36 - 45 %
- For ease of ignition purpose the idle gas is continuously blown in each kitchen gas burners irrespective of gas stove usage. See typical pictures in the following section of existing type burners

PROPOSAL

- Replace conventional type LPG gas stove and burners with patented energy-efficient radiant heating technology using the same LPG. The 24 gas stoves are recommended for replacement with the new radiant heating stoves.
- The proposed heating system thermal efficiency is in the range of 65 - 68 % which is equivalent to about 30 % savings in LPG
- Proposed heating system is indirect heating, so it improves even heat distribution over the vessel/pan and there is no carbon soot formation on the vessels
- This scheme is successfully implemented in several UVKS client and staff canteens across India including Taj and ITC group of hotels.





PROPOSED ENERGY-EFFICIENT STOVES

ESTIMATED BENEFITS

Recurring annual cost savings	: Rs. 220,977
One-time cost of implementation	: Rs 670,000
Payback period	: 36 months
Savings measurement	: Direct

5. GREEN AND ENVIRONMENT AUDIT

JJC is spread over 46 acres and has an apparent green cover of about one-fourth to one-third of the total area. JJC campus houses four blocks, two hostels, two kitchens, ten dining halls, workshops, laboratories, class rooms, indoor and outdoor sports facilities, medical facilities, lawns and gardens.

Sustainability is practiced at JJC since inception incorporating green features and practices in its facilities and operations There is consistent awareness campaign on sustainability covering the entire campus and JJC presently employs the 3 R's policy of Reduce, Recycle and Reuse. Any type of waste generated in the campus is segregated and managed for recycling or reusing or for safe disposal. The types of waste generated include vegetable & food waste, garden waste, cooking oil waste, paper waste, e-waste, plastic and non-biodegradable waste and sewage and all are addressed as part of daily and continuous green management. There are good examples of converting waste to useful materials. For instant, as food & vegetable waste is converted as manure through vermicomposting. Items like paper waste and e-waste are responsibly recycled using external specialist agencies. JJC awareness campaigns not only cover its own campus but public avenues as well in the vicinity.

JJC actively supports renewable energy. The campus has a solar energy station of 43.5 kW capacity that caters to the lighting & fans of Main Block and Laboratory wing block. Rain water harvesting is extensively done in the campus and water as a resource is respected. Sewage is treated and used for gardening and flushing. All vehicles of JJC are regularly checked for emissions with "pollution under control" certification from authorized agencies.

JJC Sustainability Champions

Dr. M Arumugam – HoD Botany

For his Contribution towards green initiatives and in Waste Management (Kitchen Waste, Food Waste, Garden waste) also towards conducting awareness Programs in E-Waste Management

Mr. Shanmugasundaram

For his initiative towards up-gradation of subpanels for enhancing safely measures.

5.1. *Pictures of the Green Campus*

5.2. List of Plants in Campus

S. No	Plant Name	Family	Common name	Total No. of Species
1	*Acacia leucophloea* (Roxb.) Willd.	Leguminosae	White-bark acacia	1
2	*Agave americana* L.	Asparagaceae	Sentry plant	2
3	*Albizia lebbeck* (L.) Benth.	Leguminosae	Albizia	9
4	*Albizia saman* (Jacq.) Merr.	Leguminosae	Rain Tree	9
5	*Allamanda cathartica* L.	Apocynaceae	Golden Trumpet	2
6	*Alstonia scholaris* (L.) R. Br.	Apocynaceae	Blackboard Tree	3
7	*Azadirachta indica* A.Juss.	Meliaceae	Neem Tree	145
8	*Bambusa* sp.	Myrtaceae	Bamboo	1
9	*Bauhinia variegata* L.	Leguminosae	Bauhinia	8
10	*Borassus flabellifer* L.	Arecaceae	Palmyra palm	2
11	*Bougainvillea glabra* Choisy	Nyctaginaceae	Paper flower	5
12	*Cassia fistula* L.	Leguminosae	Golden shower tree	3
13	*Casuarina equisetifolia* L.	Casuarinaceae	Whistling pine	17
14	*Ceiba pentandra* (L.) Gaertn.	Malvaceae	Kapok tree	1
15	*Citrus medica* L.	Rutaceae	Citron	2
16	*Cocos nucifera* L.	Arecaceae	Coconut tree	6
17	*Cordia sebestena* L.	Boraginaceae	Scarlet cordia	3
18	*Crateva adansonii* DC.	Capparaceae	Sacred barna	1
19	*Crescentia alata* Kunth	Bignoniaceae	Mexican calabash	2
20	*Cycas revoluta* Thunb.	Cycadaceae	Sago palm	9
21	*Dalbergia latifolia* Roxb.	Leguminosae	Rosewood	9
22	*Delonix regia* (Hook.) Raf.	Leguminosae	Flame tree	16
23	*Dracaena* sp.	Asparagaceae	Dragon tree	2

S. No	Plant Name	Family	Common name	Total No. of Species
25	*Dypsis lutescens* (H.Wendl.) Beentje & J.Dransf.	Arecaceae	Bamboo palm	2
26	*Ficus benghalensis* L.	Moraceae	Indian banyan	2
27	*Ficus benjamina* L.	Moraceae	Weeping fig	1
28	*Ficus religiosa* L.	Moraceae	Sacred fig	1
29	*Gmelina arborea* Roxb.	Lamiaceae	Gamhar	16
30	*Guettarda speciosa* L.	Rubiaceae	Sea randa	1
31	*Ixora coccinea* L.	Rubiaceae	Jungle geranium	10
32	*Lannea coromandelica* (Houtt.) Merr.	Anacardiaceae	Indian ash tree	50
33	*Lawsonia inermis* L.	Lythraceae	Henna tree	2
34	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae	Wild tamarind	11
35	*Manilkara hexandra* (Roxb.) Dubard	Sapotaceae	Khirni tree	1
36	*Millingtonia hortensis* L.f.	Bignoniaceae	Indian cork tree	1
37	*Mimusops elengi* L.	Sapotaceae	Spanish cherry	4
38	*Morinda coreia* Buch.-Ham.	Rubiaceae	Indian mulberry	30
39	*Moringa oleifera* Lam.	Moringaceae	Drumstick tree	3
40	*Nerium oleander* L.	Apocynaceae	Oleander	9
41	*Nyctanthes arbor-tristis* L.	Oleaceae	Night-flowering jasmine	1
42	*Peltophorum pterocarpum* (DC.) K.Heyne	Leguminosae	Copperpod	23
43	*Phoenix roebelenii* O'Brien	Arecaceae	Dwarf date palm	2
44	*Phoenix sylvestris* (L.) Roxb.	Arecaceae	Silver date palm	3
45	*Phyllanthus emblica* L.	Phyllanthaceae	Indian gooseberry	1
46	*Plumeria rubra* L.	Apocynaceae	Common white frangipani	2
47	*Polyalthia longifolia* (Sonn.) Thwaites	Annonaceae	Ashoka	6
48	*Pongamia pinnata* (L.) Pierre	Leguminosae	Indian beech	56

S. No	Plant Name	Family	Common name	Total No. of Species
49	*Pseuderanthemum* sp.	Acanthaceae	Yellow-vein eranthemum	1
50	*Psidium guajava* L.	Myrtaceae	Yellow guava	1
51	*Pterocarpus santalinus* L.f.	Leguminosae	Red sandalwood,	2
52	*Roystonea regia* (Kunth) O.F.Cook	Arecaceae	Royal palm	47
53	*Sansevieria roxburghiana* Schult.	Asparagaceae	Indian bowstring hemp	5
54	*Santalum album* L.	Santalaceae	East indian sandalwood	1
55	*Sapindus emarginatus* Vahl	Sapindaceae	Leaf soapnut	2
56	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese cassia	5
57	*Spathodea campanulata* P.Beauv.	Bignoniaceae	African tulip tree	2
58	*Sphagneticola calendulacea* (L.) Pruski	Compositae	Chinese wedelia	2
59	*Syzygium cumini* (L.) Skeels	Myrtaceae	Malabar plum,	7
60	*Tabebuia rosea* (Bertol.) Bertero ex A.DC.	Bignoniaceae	Rosy trumpet tree	6
61	*Tabernaemontana divaricata* (L.) R.Br. ex Roem. & Schult.	Apocynaceae	Pinwheel flower	2
62	*Tamarindus indica* L.	Leguminosae	Leguminous tree	10
63	*Tarlmounia elliptica* (DC.) "H.Rob., S.C.Keeley, Skvarla & R.Chan"	Asteraceae	Curtain creeper	3
64	*Tecoma stans* (L.) Juss. ex Kunth	Bignoniaceae	Trumpet flower.	5
65	*Tectona grandis* L.f.	Lamiaceae	Teak	8
66	*Terminalia catappa* L.	Combretaceae	Leadwood tree	5
67	*Thespesia populnea* (L.) Sol. ex Correa	Malvaceae	Portia tree	3
68	*Volkameria inermis* L.	Lamiaceae	Glory bower	3
69	*Wrightia tinctoria* R.Br.	Apocynaceae	Pala indigo plant	2
70	*Ziziphus jujuba* Mill.	Rhamnaceae	Jujube	1
71	*Morinda citrifolia* L.	Rubiaceae	Indian mulberry	1
72	*Manilkara hexandra* (Roxb.) Dubard	Sapotaceae	Khirni tree	1

5.3. *Measurement of Noise Levels*

The campus was divided into zones and the degree of noise pollution assets vis a vis premises Norms. The results are as follows:

Table 5.3 Sound level measurement at various locations inside JJC Campus

Sl. No	Sampling Place	Sound Level (dB)
1.	College Gate	52.1 dB
2.	College Office	48.2 dB
3.	Principal's Room	35.2 dB
4.	Canteen	46.8 dB
5.	Indoor Stadium	42.0 dB
6.	Staff Room	36.8 dB
7.	Library	35.2dB

5.4. *IAQ in Campus*

Air quality assessment of the Campus during the period from April to December 2019. The parameter like humidity and CO_2 levels. The table shows that humidity and CO_2 fluctuate according to the session and food fall.

Table 5.4 Air quality assessment from Apr '18 – Dec '19

Months	PM 2.5 (ppm)	Humidity (%)	CO_2 (ppm)
Apr 2018	68.5	50.2	462
Aug 2018	59.8	48.2	492
Dec2018	135.2	47.3	536
Apr 2018	152.2	46.3	582
Aug 2018	172.3	48.3	621
Dec2018	162.2	50.2	582
Apr 2019	113.4	51.2	550
Aug 2019	69.2	53.2	523
Dec 2019	72.3	51.2	531

5.5. *Vehicular Pollution Level*

The number of vehicle and pollution is maximum 248 in the second quarter. So too is the pollution level 129USQI similarly the last quarter has the no. of vehicles as 263 and pollution level as (123 US AQI). These reflect the no. of activities going on like examination and admission etc.

The following Table gives details of number of vehicles and periodic specific pollution in air quality.

Table 5.5: Number of vehicles and periodic specific pollution in air quality.

S. No	Period	No. of Vehicles	Pollution Level
1.	January	227	112US AQI
2.	April	284	129US AQI
3.	July	206	104US AQI
4.	October	263	123US AQI

5.6. Waste Management

The Waste Disposal practices were studied for periodicity and effectiveness. The extent of generation of waste of various types like bio-waste, food waste and e-waste was measured in quantity or numbers on a periodical basis and the action taken for the disposal of waste was reviewed. The status of the vermicomposting yard, platform and the botanical nursery were reviewed vis-a-vis the cost and returns. The audit team noted that there was scope for establishing a waste water treatment recycling plant.

5.7. E-Waste Awareness Programs

E- Waste is usually disposed of by open action through deep pit burial. Possibility for repair and recycling are examined before disposal of computer, electronic and electrical equipment's, the ones in working condition are donated to schools in adopted villages.

6. WATER AUDIT

Water requirement of all the buildings of JJC campus is met by the 8 borewells. One rainwater harvesting pit is located near hostel building in which all the rainwater is collected for ground water recharge.

All the sewage water is drained out of JJC. It is recommended to install suitable capacity Sewage Treatment Plant (STP) to treat all the sewage water and re-use it for gardening and flushing to reduce the raw water consumption.

One RO plant is installed for treating raw water inside JJC campus. It is also recommended to divert the RO reject to STP treated water for water re-use.

6.1. Water fixtures in JJC

S. No.	Building	Area	Water fixture	Fixture type	Quantity
1	Men's Hostel	Common restroom - Male	Urinal	Push Type	15
2	Men's Hostel	Common restroom - Male	Wash basin	Round Type	58
3	Men's Hostel	Common restroom - Male	Closet(Indian)	Tap	57
4	Men's Hostel	Kitchen	Wash basin	T Tap	4
5	Men's Hostel	Dining Hall	Wash basin	T Tap	21
6	Men's Hostel	Bathroom	Tap	Round Type	62
7	Ladies Hostel	Common restroom	Closet(Indian)	Round Type	29
8	Ladies Hostel	Common restroom	Tap	T Tap	105
9	Ladies Hostel	Common restroom	Wash basin	Round Type	8
10	Main+Lab	Rest Rooms	Closet(Indian)	Round Type	39
11	Main+Lab	Rest Rooms	Shower	Round Type	1
12	Main+Lab	Rest Rooms	Tap	T Tap	10
13	Main+Lab	Rest Rooms	Urinal	Push Type	37
14	Main+Lab	Rest Rooms	Wash basin	Round Type	50
15	KIM	Rest Rooms	Fixtures	Round Type	82
16	PG Bloch	Rest Rooms	Fixtures	Round Type	177

6.2. Analysis of water samples (MPN index)

Sample No.	Location from where samples were collected	MPN Index (per 100 ml)	Water Quality
1	Open Well	00	**Outstanding (Portable)**
2	Indoor Stadium	00	**Outstanding (Potable)**
3	Catering Block	00	**Outstanding (Potable)**
4	Canteen	00	**Outstanding (Potable)**
5	**Office (Backside)**	**07**	**Good (non-Potable)**

6.3. *Analyses of various parameters of water sample collected from college campus*

S.No	Location from where samples collected	TDS (ppm)	Conductance	pH	Salinity (ppm)
1	Open Well	207	292	7.84	141
2	Indoor Stadium	215	301	7.98	146
3	Catering Block	219	309	8.43	149
4	Canteen	216	305	8.22	148
5	Office Backside	362	321	8.6	154

Table 6.3 shows particulars of total dissolved solids (TDS), Conductance, pH and Salinity of Water samples collected from different locations in the Campus. The maximum TDS was observed in the sample collected from the well behind the office and least was in the sample from the open well. Conductance was maximum in the sample from bore well behind the office and the least conductance was observed in the sample from open well. pH too was the highest in the bore well sample (8.6pH) and the least pH was in open well sample (7.84). In salinity too, this trend was reflected. The maximum salinity was observed in the sample from the bore well behind the office and the least was in the open well sample.

6.4. *Average Value of Ion Content in College Tap Water*

IONS	UNIT (ppm)
Sodium	**16.2**
Potassium	**5.6**

Table 6.4 shows the details of ion content in the College tap water in ppm. Sodium and Potassium ions were present 16.2ppm and 5.6 ppm respectably.

7. OTHER GREEN INITIATIVES

7.1. Solar Investments

JJC has invested in a 43.5 kWp Rooftop Solar Power plant on the roof of PG Block. This initiative was done in June'2020. Net Metering to be installed in January 2021.

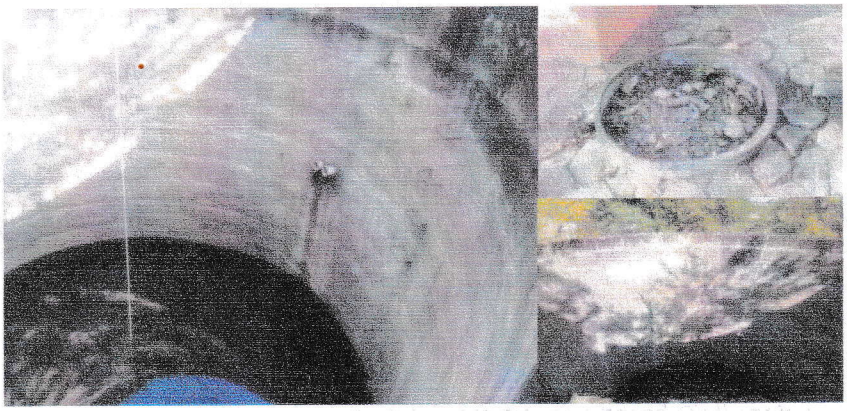
Solar water heater is installed for meeting the hot water requirements of the JJC campus. Currently, the solar water heater system is impaired and it is recommended to rectify the system for bringing it to operation to reduce the electricity consumption for hot water generation.

The environmental benefits of of installing solar PV system is indicated in the figure below:

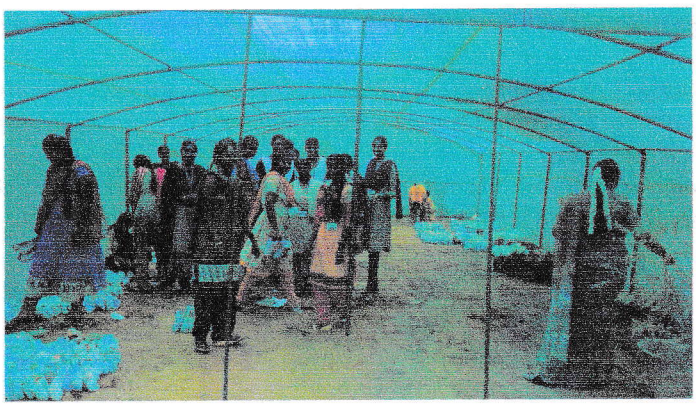
Fig 7.1 Environmental benefits of solar PV system from the day of installation

7.2. *Rain Water Harvesting*

Rainwater harvesting (RWH) is the collection and storage of rain, rather than allowing it to run off. Rainwater is collected from a roof-like surface and redirected to a tank, cistern, deep pit (well, shaft, or borehole), aquifer, or a reservoir with percolation.



7.3. *Seed Plantation Initiatives*



7.4. Sapling Distribution

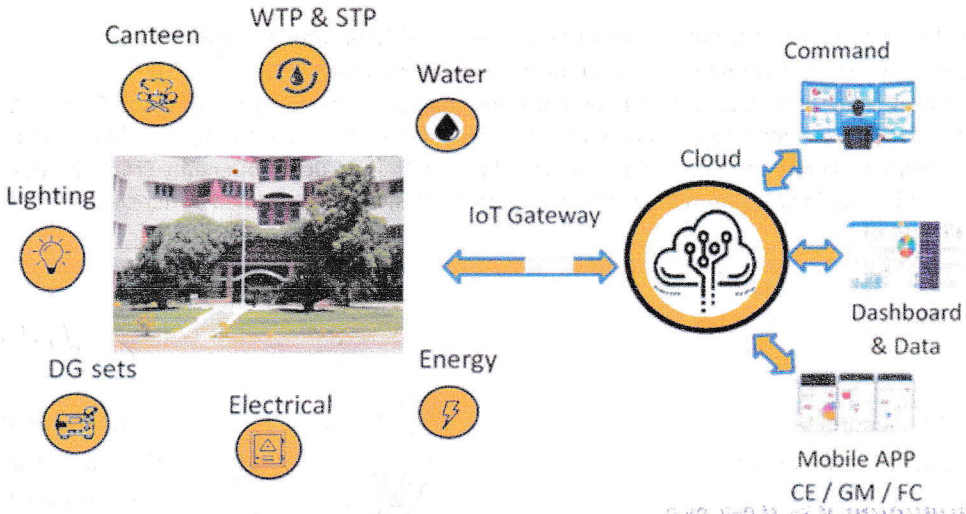
Internet of Things (IoT) based Automation Solutions:

Today the conventional method of monitoring and controlling is getting replaced/upgraded with Artificial Intelligence (AI) – Internet of Things (IoT) based automated solutions. AI-IoT automation promises "intelligent solutions," where management can run the facility wherever they are instead of physically from control room or in-situ. Intelligent automated operations are far simpler, easy to understand and operate, have accurate information all the time, eliminate inefficiencies, sustain the gains. Accordingly, AI-IoT automation is the new normal.

On a need basis, JJC could take the assistance of UVKS for detailing out IoT schemes as a separate assignment. In such a case, if desired by JJC, Proof-of-Concept (PoC) can be carried out by UVKS for meeting any priority requirements.

Benefits of AI IoT based automated solutions

- Identify the pain points and adapt mitigating solutions which would concurrently yield monetary benefits.
- Through the sensors and monitors coupled with connected load, will automate the utility equipment operation and control energy consumption based on optimum level without hindering the operation of the facility.
- Other key monitoring sensors and meters will help in the benchmarking, 365-day monitoring of major key energy areas and help management to help reduce operating cost



A typical representation of IoT based Automation System for a College Campus

8. CERTIFICATION

This part shall indicate certification for the Energy, Green and Environment stating that -

- The data collection has been carried out diligently and truthfully;
- All reasonable professional skill, care and diligence had been taken in preparing the Energy, Green and Environment audit report and the content thereof are a true representation of the facts;
- The energy audit has been carried out in accordance with the Bureau of Energy Efficiency read with the Energy Conservation Building Code (ECBC) Rules, 2017 prescribed under clause (p) of section 14 of the Act.

Signature:

Name of the Coordinator:

J.J. College of Arts and Science:

Dr.M.Arumugam,M.Sc.,M.Phil.,Ph.D.
Assistant Professor & Head
PG and Research Dept. of Botany
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Sivapuram, Pudukkottai - 622 422.
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Signature

C Soundara Rajan

Certified Energy Auditor

EA Registration: **EA 28814**

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9. CONCLUSIONS AND RECOMMENDATIONS

- On JJC share of energy bill of Rs 39 lacs, 29% savings can be achieved by implementing above schemes
- The annual savings potential is Rs 11 lakhs which can be gained by investing Rs 63 lakhs with an average payback period of 66 months (ROI 18 %)
- It is recommended to install dedicated energy meters in buildings, blocks and energy monitoring system before implementing the schemes. This is required for establishing the baseline as well as for measurement and verification of savings upon implementation of each scheme