A Synopsis of

GREEN AUDIT PROCESS

(Covering Energy, Environment, Green)

Details of the College

M/s. DHIRAJLAL GANDHI COLLEGE OF TECHNOLOGY

Opposite Salem Airport, Kamalapuram, Sikkanampatty,

Omalur, Tamil Nadu 636 309.

Period of Audit

16 DECEMBER 2019

Audit Conducted and Submitted by

RAM-KALAM CENTRE FOR ENERGY CONSULTANCY AND TRAINING

(Chennai I Coimbatore I Erode)

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M/s. DHIRAJLAL GANDHI COLLEGE OF TECHNOLOGY Opposite Salem Airport, Kamalapuram, Sikkanampatty,
Omalur, Tamil Nadu 636 309.

1. ACKNOWLEDGEMENT

ACKNOWLEDGEMENT

RAM-KALAM CENTRE FOR ENERGY CONSULTANCY AND TRAINING (RK-CECT), Coimbatore – 641 062 is thankful to the Management, Faculty and Technical team members of **M/s. DHIRAJLAL GANDHI COLLEGE OF TECHNOLOGY**, Opposite Salem airport, KamalapuramSikkanampatty, Omalur, Tamil Nadu-636 309for providing an opportunity to conduct a detailed Green Audit (Including Energy, Water and Environment) for college promises.

It is our great pleasure which must be recorded here that the management of **M/s. DHIRAJLAL GANDHI COLLEGE OF TECHNOLOGY** extended all possible support and assistance resulting in expeditious completion of the audit process. The audit team appreciates the cooperation and guidance extended during course of site visit and measurements. We are also thankful to the all those who gave us the necessary inputs and information to carry out this very vital exercise of green audit.

Finally, we offer our sincere thanks to all the members in the engineering division/ technical/non-technical and office members who were directly and indirectly involved with us during collection of data and conducting field measurements.

Management Team Members	
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Shri. MANOJKUMAR DHIRAJLAL	Vice Chairman, DGCT
Smt.ARCHANA MANOJKUMAR	Secretary, DGCT
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2. INTRODUCTION TO GREEN AUDIT PROCESS

Preamble about the Institution:

M/s. Dhirajlal Gandhi College of Technology(DGCT) is being managed by M/s. Mukesh& Associates – a leading multidisciplinary architectural and engineering consultants in India with project offices at all over PAN India. DGCT was established by a visionary management to propagate quality engineering education in the rural area and to provide placement opportunitiesin prestigious companies for their wards in various MNCs. The college is well connected in and around of Salem City. DGCT has made great stride in all dimensions of Engineering education including Academics, Placements, Sports, Entrepreneurship, Research and Innovation.

DGCT has been accredited by NAAC, Approved by AICTE, New Delhi and affliated to Anna University, Chennai. Currently the college is running with 5 under graduate programmes namely i) Civil Engineering, ii) Computer Science Engineering, iii) Electronics and Communication Engineering, iv) Electrical and Electronics Engineering and v) Mechanical Engineering along with 4 post graduate programme namely, i) ME-Structual Engineering, ii) ME-Computer Science Engineering, iii) ME-Communication System and iv) ME-CAD/CAM Engineering. The institution is also well known for several centre of Excellence. To mention a few; **Green Building, GIS/Surveying, Smart Cities, CNC programming and operations, Automation Solutions, Assembly & Animation, e-Learning, Cloud Computing, Internet of Things (IOT), Design of Embedded System, Optical communication, Renewable Energy.**

Vision Statement:

- To improve the quality of human life through multi-disciplinary programs in Engineering, Architecture and Management that are internationally recognized and world facilitate research work to incorporate social, economical and environmental development.

Mission Statement:

- To create a vibrant atmosphere that creates competent engineers, innovators, scientist, entrepreneurs, academicians and thinkers of tomorrow.
- To establish centres of excellence that provides sustainable solutions to industry and society.
- To enhance capability through various value added programs so as to meet the challenges of dynamically changing global needs.

Major Activities in the Institution:

Foreword about Green Audit Activity:

- Green audit is an inspection survey and is a major tool for analysing the present utilization of energy, water and environment condition mapping with CO_2 emission.
- The primary objective of the green audit is to reduce the amount of energy utilization, reduction of water consumption, improve the green coverage without negatively affecting the productivity or comfort level.
- The vision of the green audit with a focus on energy consumption to assess the viability to upgrade the energy efficiency measures prior to investing extensive resources in electrical and thermal energy systems.

Scope of the Audit:

- Detailed audit process in the college campus with a main focus to identify judicious usage of energy and sustainable environment.
- Identification of possible reduction of present energy consumption and thereby reduce the Carbon foot print. Also ensures to focus on Green energy generation in the college campus.
- Best practices to be followed in energy conservation, environmental management, recommended safety measures and continuous energy monitoring system.
- Providing constant awareness for both faculty and students in Energy, Environment and Ecology.

Outcomes of the Audit Process:

- Recommendations based on objective and subjective measurements with achievable **En**ergy **Con**servation (ENCON) proposals with Low cost and Cost investments.
- Minimization of present energy cost by adjusting and optimizing energy usage and reduction of energy wastage without affecting the regular activities.
- Development of rule based system for safety measures to be followed and formation of best practicing guidelines for major energy consuming system.
- Providing a pathway to become a sustainable environment inside the college campus and nurture the importance of less energy with more productivity.
- Formation of methodology for long term road map for maintaining green environment within the campus and encourage the stakeholders for continuous improvements.

Coverage in Green Audit Process:

Period of Audit:

Standards Adopted:

- IEEE – 519-2014: Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
- ISHRAE-10001:2016 – Indoor Environmental Quality Standard, Ist Version: 2016-17.
- IS-3646-Part-1 - Recommended Values of Illuminance as per National Building Code (NBC): 2005.
- BEE – Bureau of Energy Efficiency – Guidelines to conduct the Energy Audit.

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3. EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Electrical and LPG Energy Analysis:

After conducting a detailed audit in **M/s. DHIRAJLAL GANDHI COLLEGE OF TECHNOLOGY,** Omalur, Tamil Naduthe audit team has come out with**9 Energy Conservation Proposals (ENCONs)**and summary of all the ENCONs are given below:

S. No	Description	Parameters		
		Present	Proposed	Savings
1.	Annual Energy Consumption	2,18,440kWh + 4,152 kg of LPG	1,21,968 kWh + 4,069 kg of LPG	96,472 kWh + 83 kg of LPG
2.	Annual Energy Cost (For Electricity)	Rs. 22.29 Lakhs	Rs. 13.65 Lakhs	**Rs. 8.64 Lakhs**
3.	Initial Investment Required	--	**Rs. 24.62 Lakhs**	--
4.	Simple Payback Period	--	**Nearly 2.8 Years**	
5.	% Reduction of Energy Consumption	--	**44 % in Electrical + 2 % in LPG**	

Environmental Analysis (CO_2 Neutralization):

S. No	Description	Type of Fuel and their Conversion Process		
		Electricity	Diesel	LPG
1.	Total Annual Consumption	2,18,440 kWh	1,29,058 Litre	4,152 kg
2.	CO_2 Emission (Tons)	179.12	340.71	13.87
3.	Total CO_2 Emission			**533.7 Tons/Annum**
4.	No. of Matured Trees Available			508
5.	CO_2 absorption (Neutralization) due to Trees			**11.07 Tons (2.1 % ↓)**
6.	CO_2 absorption (Neutralization) due to SPV Plant			**27.7 Tons (5.2 % ↓)**
7.	CO_2 absorption (Neutralization) after implementing ENCON			**79.1 Tons (14.8 ↓)**
8.	Amount of CO_2 to be neutralized			**415.8 Tons/Annum**

Apart from the Energy Conservation and Environmental analysis, the audit team proposesnearly **10 technical recommendations** focusing on energy, water, environment, safety and best operating practices to be followed.

Audit Conduced & Complied by,

M/s. Ramkalam - Centre for Energy Consultancy & Training (RK-CECT), No. 8, VPK Garden, Velanaipatti, Coimbatore - 641 062.

S.R. Sivarasu

Dr. S.R. SIVARASU
BEE Certified Energy Auditor
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BEE Certified Energy Auditor
(EA-27299)

Table-1: Energy Conservation Proposal (ENCON) along with Annual Energy and Financial Savings

S. No	Proposed Energy Conservation Measures	% Saving& Source	Estimated Savings		Initial Investment (Rs.)	Simple Payback Period	CO_2 Reduction (Tons)	Ref. Page. No.
			Annual Energy Savings (kWh)	Monetary Savings (Rs.)				
1.	Reduction of running time of STP aerator motor during lean period of operation	4 hours/Day	7,179	63,893.0	No Cost	Immediate	5.9	13
2.	Reduction of LPG Consumption using Regular Burner Cleaning and Swapping of Active Burners.	2 % of LPG	83 kg	5,810.0	No Cost	Immediate	0.3	14
3.	Reduction of Cable Losses andPower Consumption using Load End Compensation	1 % (Electrical)	2,184	19,438.0	12,000.0	0.62 Years	1.8	15
4.	Reduction of Energy Consumption in AC Compressor using Mist Pre-Cooler	20 % (AC)	8,910	79,299.0	40,000.0	0.5 Years	7.3	16
5.	Retrofit of AIRCON Energy Saver, AC House Keeping & Optimization of AC Operation	15 % (AC)	6,690	59,541.0	50,000.0	0.84 Years	5.5	17
6.	Replacement of Existing Water Pumps into BEE Star Labelled Energy Efficient Pumps.	20 % (Pump)	6,925	61,633.0	60,000.0	0.97 Years	5.7	18
7.	Installation of Dedicated Servo Stabilizer to Reduce the Utility Incoming Voltage Variations	5 % (Electrical)	10,922	97,206.0	2,00,000.0	2.1 Years	9.0	19
8.	Replacement of Fluorescent Lamps with EE Lamps (Swap FTL to LED Lamps)	35 % (Lighting)	15,022	1,33,699.0	3,12,900.0	2.3 Years	12.3	20
9.	Replacement of Existing Convention Ceiling Fans into EC-BLDC Fans	50 % (Fan)	38,640	3,43,896.0	17,87,000.0	5.2 Years	31.7	21
Total			**96,472kWh + 83 kg of LPG**	**8,64,411.0**	**24,61,900.0**	--	**79.5**	--

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4. ENERGY CONSERVATION PROPOSALS

Energy Conservation in STP Aerator Motor	
ENCON-1	• Reduction of running time of STP aerator motor during lean period of operation
Assessment Area	• Sewage Treatment Plant (STP)
Observations	• The main purpose of blower motor is to supply oxygen (from ambient air) in order to main the BOD level. This blower motor has to run continuously (mostly 24 x7). • At present, the blower is operating for 24 h/day without having any standby motor. • For every 3 hours of running' 20 min is cut off. Hence in a day nearly 2.5 hours the blower motor is in off condition.
	• During night and early morning time as the ambient air has good amount of O_2
Recommendation (Target)	• It is recommended to turn the aerator blower motor off during 2 to 6 AM in the early morning since that time, the effluent is less and ambient atmosphere contains good amount of O_2 also.
	• Also it is better to have a standby blower motor and operate these two blower equally in a day.

Energy and Financial Saving Calculation:

Parameters	**Description**	
Proposed Area of Implementation	STP Aerator Motor Boiler system	
Input power to the motor	2.93 kW	
(Assuming 60 % of efficiency + 80 % of loading factor)		
Interlocking Turn off Time - 4 hours (preferably 2.00 AM to 6.00 AM)		
Energy Calculation	**Before**	**After**
Present Energy Consumption/day	2.93 kW x 21 h = 70.32 kWh	2.93 kW x 17 h = 49.81 kWh
Energy Savings per day	--	20.51 kWh
Annual Energy Saving	--	**7,179 kWh**
Annual Financial Savings	--	**Rs. 63,893 /-**
(Considering 350 Days/Annum)		
Initial Investment	-	**No Cost Investment**
CO2 Reduction	**--**	**5.9 Tons/Annum**

Energy Conservation in LPG Consumption	
ENCON-2	• Reduction of LPG Consumption using Regular Burner Cleaning and Swapping of Active Burners.
Assessment Area	• Cooking System in Hostel Mess
Assessment	• Cooking system in the college mess mainly uses LPG as energy carrier and utilize Gas stoves as a medium to cook the food. • Gas stoves are easy to maintain. However, when the flow of gas gets blocked, the burner heads can't burn efficiently. • The best indicator for the efficiency of LPG system is the irregular flame patterns and yellow flames. • Formation of soot in both side of the burners, cleaning methods and interval improves the efficiency and reduce the LPG consumption.
Recommendation (Target)	• The LPG commercial burners are made up of cast iron in which smoke formation is high and frequently able to crack due to aging. • It is recommended to clean the burner every week with solvent rinsed and gently clean the holes with ordinary fine cloth. Also it is highly encouraged to swap with active spare burners. The investment on spare burners are less expensive and let us make it a practice to swap the burner every week. • Also look for an alternative with Stainless Steel (SS) burners (slightly costlier compared with existing one). But the lifespan is longer and replace cost is much reduced.

Energy and Financial Saving Calculation:

Parameters	**Description**	
Swapping of new burners every week and cleaning of existing burner with natural ingredients (Ex: Dishwashing detergent, Non-abrasive scrub pad, Microfiber towels)		
Energy Calculation	**Before**	**After**
Expected Savings on LPG	**--**	**2 %**
(From overall LPG consumption; nearly 50 % consumptiongoes to burner based cooking and heating system and from that 2 % of saving is assumed)		
LPG Consumption/Annum	**4,152 kg**	**4,069 kg**
LPG Savings/Annum	--	**83 kg**
Equivalent to 4 to 5 no's of 18.5 kg cylinders and a financial savings of **Rs. 5,810 /Annum**		
Initial Investment	-	**No Cost Investment**
However purchasing of cleaning ingredients for Rs. 2,000 with a payback of 0.34 Years		
CO_2 Reduction – 0.3 kg/Annum		

Energy Conservation in Electrical Distribution System	
ENCON-3	Reduction of Cable Losses and Active Power Consumption using Load End Capacitor Compensation (PCC Level)
Assessment Area	Electrical Distribution System (Under Ground Cable Network)
Observations	• LT electrical system from power house is distributed through various PCC conveniently located all over the college campus. • Supply side power factor is being maintained by the FC connected in the main supply; whereas the load end PF is to be corrected by connecting suitable values of FC, mostly at the distribution panels.
Assessments	• In any electrical distribution network, the distribution losses may account for nearly 2 % and this can be reduced by i) Selecting proper cable size (class 1 or 2 cables) with reduced resistance and ii) Compensate the distribution losses by connecting load end capacitors at the load point and/or at DB level. • This method has the following advantages of i) reduction of kVA demand, ii) reduction of distribution losses and iii) maintaining the terminal voltage.
Recommendation (Target)	• Connect suitable value of FCs (3-Phase, 440 V,10 kVAr, Heavy Duty) at the PCC input and try to reduce the line loss.

Energy & Financial Saving Calculation:

Parameters	**Description**	
No. of DBs (Approx. Value)	04No's.(MB, First Year Block, Mech, Hostel)	
kVAr required to connected	10 kVAr (3-Phase, 400 V, Heavy Duty FC)	
Energy Calculation	**Before**	**After**
Expected % of Energy Saving	**--**	**1%**
Annual Energy Consumed	2,18,440kWh	2,16,256 kWh
Annual Energy Saving	--	**2,184 kWh**
Annual Financial Saving	--	**Rs. 19,438 /-**
Initial Investment	-	**Rs. 12,000 /-**
(Rs. 3,000/- for a 10 kVAr Heavy Duty capacitor of standard brand)		
Simple Payback	**--**	**0.62 Years**
CO_2 Reduction	**--**	**1.8 Tons/Annum**

Energy Conservation in Air Conditioning System	
ENCON-4	Performance Enhancement and Reduction of Energy Consumption in AC Compressor using Mist Pre-Cooler
Assessment Area	• Unitary Air Conditioning Systems inside the Campus
Observations	• Mist pre-cooler is one successful retrofit system to be implemented to any of the AC outdoor units. • It saves the compressor running time (and also power) by reducing the condenser temperature and there by saves the life of the compressor.
Assessments	• Mist cooling is based on the concept of evaporative cooling. Evaporative cooling is the process of removing heat from the air by using water vapour. The misting system converts ordinary water into billions of micron sized water particles by using spray nozzles.
Recommendation (Target)	• It is recommended to install the mist cooling system in higher power and continuous running AC system and ascertain the performance (especially CoP). • Implement the mist pre-cooler system and coupling of water mist with condenser reduces the compressor power up to 25%. The application of water mist condenser, inlet air pre-cooling could decrease the Specific Energy Consumption (SEC).

Energy and Financial Saving Calculation:

Parameters	**Description**	
Proposed No. of Pre-cooler fittings	5 No's	
Energy Calculation	**Before**	**After**
Power Consumption	14.86 kW	11.89 kW
(Mist cooler provides a minimum savings of 20 % from the present power consumption)		
Expected Reduction of Power	**--**	**2.97 kW**
Annul Energy Consumption	**44,580 kWh**	**35,670 kWh**
(Considering 3,000 hours per annum)		
Annual Energy Savings	**--**	**8,910 kWh**
Annual Financial Saving	--	**Rs. 79,299 /-**
Initial Investment	-	**Rs. 40,000 /-**
Simple Payback	**--**	**Nearly 0.50 Years**
CO2 Reduction	**--**	**7.3Tons/Annum**

Energy Conservation in Air Conditioning System	
ENCON-5	Retrofit of AIRCON Energy Saver, AC House Keeping and Optimization of Air Conditioning Operation
Assessment Area	Unitary Air Conditioning Systems inside the Campus
Observations	• There are about 4 No's of unitary air conditioning units are available and are located in various places inside the college.
Assessments	• The running hours of the ACs system differ from each other and purely depend on the availability of the members in the respective rooms/laboratories. • The detailed list of AC available is shown in Annexure-I: indicating their star rating, tonnage and their power capacity.
Recommendation (Target)	• Install AIRCON energy saver gadget which works on dynamic un-saturation principle in conjunction with the sensor algorithms so that the air conditioners run hours are cut by 20 to 25 %.

Energy and Financial Saving Calculation:

Parameters	**Description**	
Proposed AIRCON fittings	5 No's	
Energy Calculation	**Before**	**After**
Power Consumption	14.86 kW	12.63 kW
(AIRCON provides a minimum savings of 15 % from the present power consumption)		
Annul Energy Consumption	44,580 kWh	37,890 kWh
(Considering 3,000 hours per annum)		
Annual Energy Savings	**--**	**6,690 kWh**
Annual Financial Saving	--	**Rs. 59,541 /-**
Initial Investment	-	**Rs. 50,000 /-**
Simple Payback	**--**	**Nearly 0.84 Years**
CO2 Reduction	**--**	**5.5 Tons/Annum**

Energy Conservation in Water Pumping System				
ENCON-6	Replacement of Existing Water Pumps into BEE Star Labelled Energy Efficient Pumps.			
Assessment Area	Water Pumping System adopted in the College Area			
Observations	• 2 Nos. of monobloc water pumps are being utilized to feed the water from sump to tank for various areas. • Most of the pumps are rewinded several times which reduces the efficiency below the name plate value.			
	η Old Pumps	**Nearly 60 %**	η New Pumps	**More than 80 %**
Assessments	• BEE star labelled pumpsystem has i) High efficiency motor, ii) Lightweight materials and iii) Optimized suction-delivery system which ensures greater energy saving during their continuous operation.			
Recommendation (Target)	• Recommended to replace the older pumps into BEE star rated pumps which offers best efficiency (more than 80 %).			

Energy and Financial Saving Calculation:

Parameters	**Description**	
Total No. of Pumps	02 Nos (Mechanical Lab Back Side)	
Energy Calculation	**Before**	**After**
Power Capacity	**11.10 kW**	**8.33 kW**
(2 no's of pumps assuming the efficiency of 60 % and loading factor of 90 %)		
Annual Energy Consumed	**27,750 kWh**	**20,825 kWh**
(Star rated pumps ensurea savings of 20 %&Assuming 2,500 running hours per Annum)		
Annual Energy Saving	--	**6,925 kWh**
Annual Financial Saving	--	**Rs.61,633 /-**
Initial Investment	-	**Rs. 60,000 /-**
(Proposed price for branded pumps with the existing capacity replacement)		
Simple Payback	**--**	**Nearly 1.00 Year**
CO_2 Reduction	**--**	**5.7 Tons/Annum**

Energy Conservation in Electrical Input Voltage Control	
ENCON-7	Installation of Dedicated Servo Stabilizer to Reduce the Utility Incoming Voltage Variations
Assessment Area	• Objective measurements taken at the main EB panel of electricity incoming point located at Power House.
Observations	• The entire college is supplied with a dedicated LT supply. During the audit process, it is observed most of the time, input voltage is higher than the rated value of 400 V. • The supply voltage has wide variationsespecially the voltage may be less during date time and high during night time.
Assessments	• The voltage variations makes the Electrical/Electronic components to break down frequently due to spurious spikes and surges. Most of the equipment's are designed for a rated voltage of 380 to 415 V and hence operating beyond this level, is not safe in the long run.
Recommendation (Target)	• It is recommended to install a dedicated Servo Stabilizer of specified kVA ratings in the input side for all LT services and connect all the loads (Incoming supply - Servo Stabilizer – Load). • This step will protect the sophisticated electrical/electronic equipment's against the unwanted failure due to variations in incoming voltage and extend their life.

Energy and Financial Saving Calculation:

Parameters	**Description**	
Proposed Capacity of SS	**150 kVA**	
Energy Calculation	**Before**	**After**
Expected Annual Energy Savings	**--**	**5 %**
Annual Energy Consumed (Cumulative of above 3 services)	2,18,440kWh	2,07,518 kWh
Annual Energy Saving	**--**	**10,922 kWh**
Annual Financial Saving	--	**Rs. 97,206 /-**
Initial Investment	-	**Rs. 2,00,000/-**
(1 No. of breaded, 3-Phase, 4-wire unbalanced branded Servo Stabilizer with inbuilt SPD)		
Simple Payback	**--**	**Nearly 2.1 Years**
CO_2 Reduction	**--**	**9.0 Tons/Annum**

Energy Conservation in Lighting System		
ENCON-8	Replacement of Fluorescent Lamps with Energy Efficient Lamps (Swap FTL to LED Lamps)	
Assessment Area	Compact Fluorescent Lighting System located both in college and hostel area with magnetic/electronic choke fitting.	
Observations	College Area – Main Building (Including Class, Lab and Others)	FTL-28 W (32 W including Choke) – 615 No's (19.68 kW)
	College Area – First Year Building (Including Class, Lab and Others)	FTL-28 W (32 W including Choke) – 116 No's (3.71 kW)
	Hostel Rooms (Both BH & LH)	FTL-28 W (32 W including Choke) – 163 No's (5.22 kW)
Assessments	• The college is now replacing FTL into LED and this step must bring considerable amount of energy saving. • In general 28 W FTL consume nearly about 32 Wincluding power consumption of the Choke.	
Recommendation (Target)	• College administration has to replace the FTL to LED (20 W with choke) of branded round LED tube fitting without Blue Tinge.	

Energy and Financial Saving Calculation:

Parameters	**Description**	
Total No. of lamps Available	FTL-28 W – 894 No's	
Power rating of new lamps	LED-18 W(One to One)	
Approx. Operating Hours (Average assumed value)	4 hours/day & 350 days/Annum (Since the lamp fittings are located in and around the campus. The actual operating hours may change depends on the applications)	
Energy Calculation	**Before**	**After**
Power Consumed (Approx.)	28.61 kW	17.88 kW
Annual Energy Consumed	40,054 kWh	25,032 kWh
Annual Energy Saving	--	**15,022 kWh**
Annual Financial Saving	--	**Rs. 1,33,696 /-**
Initial Investment	-	**Rs. 3,12,900 /-**
(Considering Rs.350/Lamp fittings of branded LED Day Cool Light)		
Simple Payback	**--**	**Nearly 2.3 Years**
CO2 Reduction	**--**	**12.3Tons/Annum**

Energy Conservation in Fan System		
ENCON-9	Replacement of Existing Convention Ceiling Fans into Electronically Commutated BLDC Fans	
Assessment Area	Water Pumping System adopted in the College Area	
Observations	College Area – Main Building (Including Class, Lab and Others)	578 No's (34.68 kW)
	College Area – First Year Building (Including Class, Lab and Others)	114 No's (6.84 kW)
	Hostel Rooms (Both BH & LH)	85 No's (5.1 kW)
Assessments	• BLDC fans operate in less energy with same air delivery. Similarly these fans generates lesser noise, runs with inverter supply, remote control based speed control, Aesthetic lookand better lifespan. • Conventional fans consume 1 unit of electricity for approximately 12-13 hours of running period, whereas the BLDC fans consume the same 1 unit of electricity for nearly 28-29hours.	
Recommendation (Target)	• Recommended to replace the existing conventional fans into EC BLDC fans in a phased manner and ensure good energy saving.	

Energy and Financial Saving Calculation:

Parameters	**Description**	
Total No. of Fans available	777 No's	
	College Area: 692	Hostel Rooms: 114
Approx. Operating Hours	College : 4 h	Hostel : 8 h
Energy Calculation	**Before**	**After**
Power Consumed (Approx.)	54.39 kW	27.20 kW
Energy Consumed/Day	257.6 kWh	128.8 kWh
Annual Energy Consumed	77,280 kWh	38,640 kWh
Annual Energy Saving	--	**38,640 kWh**
Annual Financial Saving	--	**Rs.3,43,896 /-**
Initial Investment	-	Rs. 17.87 Lakhs
(Considering Rs.2,500/fan - Salvage value of Rs. 200/fan for old fan = Rs. 2,300/- per fan)		
Simple Payback	**--**	**Nearly 5.2 Years**
CO2 Reduction	**--**	**31.7 Tons/Annum**

(Note: BLDC fans consumeless power when it operates at low speeds which further saves energy)

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5. ENVIRONMENTAL ANALYSIS, CO_2 EMISSION AND CARBON NEUTRALIZATION

Assessment of Annual Energy Usage:

Table-3 shows the types of energy carriers used for their regular operation in the college campus along with application area and their source.

Table-3: Energy Carriers, Application area and their sources used for College Operation

S. No	Type of Energy Carrier	Application Area	Source of Procurement
1.	Electricity (LT)	All electrical/electronic equipment's	From TANGEDCO
2.	Solar PV System (25 kW)		Roof top captive power plant
3.	Diesel	For vehicles and DG	From authorised distributor
4.	LPG	Cooking	

Table-4 represents the annual energy consumption of all type of fuels used in the college& power generation from SPV Plant during Jan-2019 to December-2019.

Table-4: Annual Energy Consumption of all types of Fuels& SPV Power Generation

S. No.	Month	Units (kWh) Consumed	Diesel Consumption (litre)		LPG Consumption (kg)	Electricity Generation from SPV (kWh)
			Vehicles	DG		
1.	Jan-19	18,516	12,058	400	446	1,925
2.	Feb-19	20,096	13,608	0	381	1,915
3.	Mar-19	20,496	14,063	220	756	1,902
4.	Apr-19	17,944	10,683	0	354	2,056
5.	May-19	19,992	9,924	0	283	2,199
6.	Jun-19	15,356	4,341	50	159	2,160
7.	Jul-19	22,096	12,369	250	350	2,153
8.	Aug-19	18,356	10,797	250	295	2,079
9.	Sep-19	19,692	10,897	200	279	1,610
10.	Oct-19	18,556	10,241	90	313	1,589
11.	Nov-19	15,056	12,072	220	334	1,570
12.	Dec-19	12,284	6,185	140	202	1,761
Average		**18,203**	**10,603**	152	**346**	**1,910**
Total		**2,18,440**	**1,27,238**	1,820	**4,152**	**22,919**

Estimation of CO_2 Emitted by Annual Fuel Consumption:

S. No	Description		Type of Fuel and their Conversion Process		
			Electricity	Diesel	LPG
1.	Total Annual Consumption		2,18,440 kWh	1,29,058 Litre	4,152 kg
2.	CO_2 Emission (Tons)	A	179.12	340.71	13.87
Analysis-I (As per the present consumption)					
3.	Total CO_2 Emission			B	**533.7 Tons/Annum**
4.	No. of Matured Trees Available (nearly)			C	508
5.	CO_2 absorption (Neutralization) due to Trees			D	**11.07 Tons (2.1 % ↓)**
6.	CO_2 to be neutralized			E	**522.6 Tons**
Analysis-II (Including 50.3 kW SPV Plant with present consumption)					
7.	Expected Annual Energy Generated from SPV Plant			F	33,750 kWh
8.	CO_2 absorption (Neutralization) due to SPV Plant			G	**27.7 Tons (5.2 % ↓)**
9.	CO_2 to be neutralized			H	**494.9 Tons**
Analysis-III (Including SPV + Implementing Energy Conservation Measures)					
10.	Expected Reduction of Annual Electricity Consumption			I	96,472 kWh
11.	CO_2 absorption (Neutralization) after implementing ENCON			J	79.1 Tons **(14.8 ↓)**
12.	CO_2 to be neutralized (Final)			K	**415.8 Tons**

Conclusion and Recommendations:

From the above table; it is evident that activities taken forward to neutralize the CO_2 is predominant. However, nearly 78 % of CO_2 emitted to be neutralized in order to become a Net-Zero Carbon Emission buildings. The management has to plan several activities achieve the target.

- Increase the foot print of trees planted inside the college campus.
- Encourage the students to plant more trees and account them all.
- Capacity addition of solar PV plant must be initiated as this step must reduce the electricity consumption.
- Convert existing convention street lightings into solar based battery operated lightings.
- Transport sector contributes significant amount of CO_2 emission. Discuss with eminent experts (like PCRA) to reduce the transport fuel consumption.
- Identify higher fuel consuming vehicle and either rework or replace it.
- Conduct training programmes for the transport staffs at regular interval and encourage them to maintain the vehicles at good condition throughout the year.
- Encourage the students and faculties to use public transport system.
- Combine vehicles by considering patronage and coverage of distance. This must be best suitable for lean periods of college operation especially during examination and when particular year of students are not available.

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USAGE OF CHEMICALS, HANDLING AND BEST OPERATING PRACTICES

Handling and Storage of Chemicals, Salts and Acids used in the College Premises

List of Chemicals Used, Storage Method and their Application:

Table-5 shows the list of various chemicals used in the chemistry laboratory, method of storage and their application.

Table-5: List of Chemicals Used, Storage Method and Application

Chemicals/Salts/Acids Used	Method of Storage	Application
Corrosive Acids • Hydrochloric Acid • Sulphuric Acid • Nitric Acid	• Stored separately in sand • Diluted acids are stored in bench with proper labels	Volumetric Titrations
Corrosive – Bases • Ammonium Hydroxide • Sodium Hydroxide • Calcium Hydroxide	Stored separately in labelled polyethylene containers	
Flammable Liquids • Acetone • Diethyl ether • Methanol • Ethanol • Toluene • Glacial Acetic Acid	Stored separately away from sources of ignition	
General Chemicals-Non-reactive • Sodium Chloride • Sodium Bicarbonate • Calcium Carbonate • EDTA • EBT	Stored on stockroom benches or shelving preferably below eye level	
Oxidizers • Potassium Dichromate • Potassium Chromate • Potassium Permanganate	Stored in stockroom benches separately away from flammable and combustible materials.	Volumetric Titrations

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7. E-WASTE MANAGEMENT SYSTEM

Identified E-Waste in the College Campus:

E-Waste – Electrical	E-Waste – IT & Communication
• Motors and Starters • Fans • Lamps and Luminaries • Electrical Drives • Heater Coils • Broken/Fired Cables • Air Conditioning System • Power Distribution Panels • Electronic Music Instruments • Electronic GYM Equipment's • Electronic Attendance System • Analog & Digital Measuring Instruments	• Copier/Printers & Fax Machines • Power Stripes & Power Supplies • UPS/Servo Stabilizers/Inverters • Batteries • Wi-fi-Modems, Routers, Toggle • Network Cables, Switches, Hubs • Phone, Intercom & PBX • Audit & Video Equipment's/Remote Controls, Projectors • Printed Circuits Boards • Barcode/QR scanners

E-Waste Management Committee:

S. No	Name and Department	Responsibility
1.	Principal/Dean	Chairperson
2.	Member-1:	Co-ordinator (SPOC)
3.	Member-2:	Member
4.	Member-3: Electronics Department	Member
5.	Member-4: Electrical Maintenance	Member
6.	Member-5: Network Maintenance	Member
7.	Member-6: General Maintenance	Member
8.	Member-7: Administrative Member	Member

E-Waste Policy:

- All the Electrical, Electronics, IT & ITES wastes (listed above) are considered as E-Waste; either completion of their life cycle or repaired during working condition.
- Once these wastes are identified; the same must be informed to the committee through E-slip (format to be prepared).
- The committee should evaluate the same based on the details submitted before disposing the material (Rule based format to be prepared).
- Once the committee approves; then this must be weighted and taken to storage area. (Separate area must be earmarked to store E-waste with necessary facilities).
- A log book must be maintained for E-waste management (format to be prepared)
- Establish an agreement with E-waste trader (a singed MoU copy must be produced in the audit report). The committee is the responsible to communicate to the trader regarding

the amount of waste collected. (This may be fixed either based on weight of the waste or period of collection)

- Dispose the material to the vendor as per the policy and maintain the relevant documents.

Note:

- Prepare a flow chart for collection of E-waste from Generation to Disposal and paste it on appropriate places
- An electronic weighing scale (with suitable capacity) must be installed in the storage yard and should be properly calibrated.
- One emergency lamp (with UPS supply) must be installed along with suitable fire extinguisher. Ensure proper ventilation in the yard.
- Form rule for declaring the waste as E-Waste.
- Assign the singing authorities
- Identify a third party vendor to procure the E-waste from the college. Establish MoU with that party.
- Disseminate the following information at appropriate places i) E-Waste Policy, ii) Process Methodology, iii) Copy of MoU with third party vendor, iv) Contact persons mobile no. and E-mail.
- Identify certain vehicle to carry the waste from generation to storage yard.
- Provide training to the man power those are handling the waste.
- Maintain separate Delivery Challan, Billing, Weighing mechanism for handling the E-Waste.
- Update the status of E-waste (through digital circular) to all the concerned management representatives, faculty members and staff at regular interval (month wise is good).

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8. ENERGY AWARENESS ACTIVITY AND COMMITMENTS ON ENERGY CONSERVATION

Deliverable in Awareness Programme:

As a part of the green audit; an awareness programme was conducted for the faculty members and the following points are deliberated to them.

- Need for the Green Audit in College/University campus
- Components of Green Audit (Energy, Water and Environment)
- Analysis of Energy, Water and Environment in the college campus
- Assessment on energy bill(estimation for one year)
- Implementation of renewable energy sources
- Water sourcing and utilization
- Utilization of other energy sources like Diesel, LPG and any other fuels
- Identification of Energy Conservation Measures (with cost effective manner)
- Estimation on simple payback for each energy conservation measures
- Analysis of RO and Sewage Treatment Plants
- Determination of CO_2 emission and future plans for reduction
- Best operating practices, equipment life enhancement and safety

Faculty Commitments:

- Increasing the no. of pits for rain water harvesting
- IoT sensor based water consumption monitoring and conservation
- Additional installation of solar PV system and export to energy utility
- Use minimum quantity water based the requirement
- Drip irrigation to be practiced for water conservation
- Develop to monitor energy and water consumption digitally
- Disseminate the need for energy conservation to students community
- Conduct competitions for school/inter/intra college students/faculty

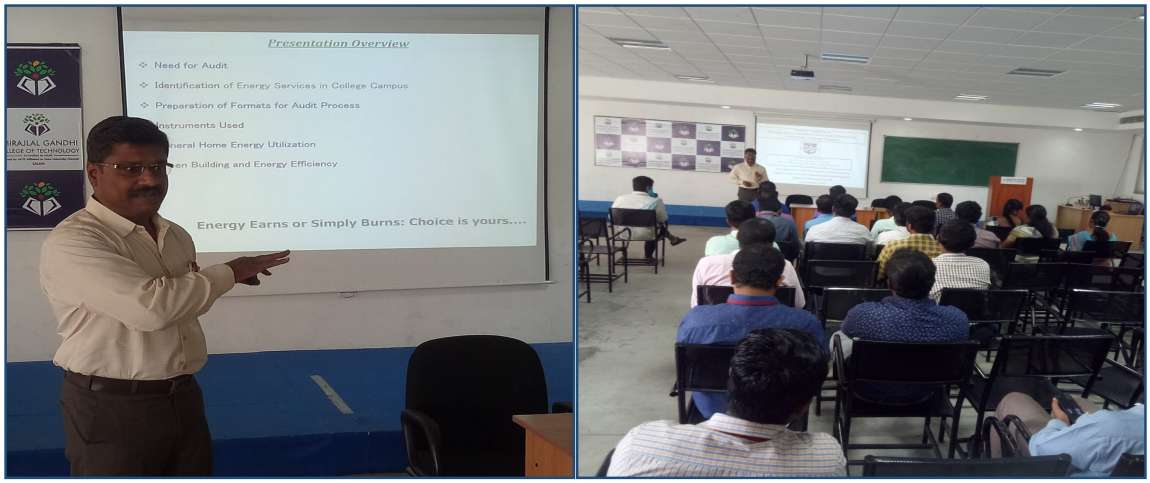

Fig.1: Sample photos on Energy Awareness Programme

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Details of the Client

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Annexure-I:

ROOF TOP SOLAR PV POWER PLANT

(Green Energy Generation)

Table-A-1: Specifications of Roof Top Solar PV Plant

Total Capacity (kWp)					**25.0 kW**				
Specifications of Individual Panel									
Panel Make/Model					I-AS (Ind-Aussie) PC-250				
P_{max}	250 W	V_{max}	29.9 V	I_{max}	8.35 A	V_{oc}	37.1 V	I_{sc}	8.92 A
Panel Location and Orientation					Main Building – North to South				
Availability of Tracking					Fixed Mounting Only				
No. of Panels per Inverter					33 No's of panel/Inverter				
Total No. of Panels					Total 100 No's				
DC Bus Voltage					650 V-DC				
Inverter Specifications									
No. of Inverters					Three No's				
Make and Model No.					Sun Tree – 10000 TL				
Power Rating					10 kVA				
Single Phase/Three Phase					Three Phase Configuration				
Output Voltage and Frequency					3/N/PE-400/230 V, 14.5 AC (max) with 50 Hz frequency				
Synchronizing Point					Connected at the mechanical SSB				
General Specifications									
DC Earthing					Done separately				
Inverter Earthing					Done separately				
Panel Mounting Angle					Nearly 15^{0C}				
Frequency of Panel Cleaning					Cleaned every month once				
Average Units Generated per Day					Between 100 – 125 Units (kWh)/day				
Year of Installation					February - 2015				

Recommendations:

- Maintain a separate record for i) Daily production of energy (export) and ii) Daily import of energy from TANGDCO. Also maintain the fault/maintenance record of entire PV plant including Panel, Array junction box, Connector, Inverter and Earthing system.
- Similarly maintain a record for panel cleaning schedule. Ensure that for each cleaning, the power generation must increase.

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Annexure-II:

LIST OF MATURED TREES IN THE COLLEGE CAMPUS

(GREEN COVERAGE)

Table-A-2: List of Matured Tree Available in the College Campus

S. No	Location	Name of the Tree	Botanical Name	Quantity
1.	Hostel (North & South)	Mahogany	Swieteniamacrophylla	200
2.	Volley Ball Ground	Pungai (Pongam tree)	Pongamiapinnata (L.) Pierre	100
3.	Hostel Road	Vembu	Azadirachtaindica	50
4.	Ist Year Block (North & South)	Pungai (Pongam tree)	Pongamiapinnata (L.) Pierre	50
5.	Main Building	Mahogany	Swieteniamacrophylla	77
6.	Canteen	Perunkondrai	Peltophorumpterocarpum	13
7.	Tennis Court	Oil Palm	Elaeisguineensis	18
Total				**508**
List of Shrubs (Bushes) & Flowing Shrubs				
8.	Main Building	Arali	Nerium oleander	17
		Sembaruthi	Hibiscus rosa-sinensis	3
		Crotons	Codiaeumvariegatum	61
		Palavagai Flowers	--	51
		Idlipoo	--	43

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Annexure-III:

SAMPLE PHOTOS ON GREEN AUDIT PROCESS

Fig. A-1: Introduction Meeting & Assessment on RO Plant

Fig. A-2: Assessment on Water Consumption & STP Plant

Fig. A-3: Assessment on Power House & Rooftop Solar PV System

GREEN AUDIT REPORT

Details of the Client

M/s. DHIRAJLAL GANDHI COLLEGE OF TECHNOLOGY

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Annexure-IV:

AUTHORISED CERTIFICATES OF AUDITOR

Reg No.: EA-27299

Certificate No.: 9645/19

NATIONAL PRODUCTIVITY COUNCIL

National Productivity Council

(National Certifying Agency)

PROVISIONAL CERTIFICATE

This is to certify that Mr./ Mrs./ Ms. **SIVARASU SULUR RATHINAVELU**

son / daughter of Mr. **P RATHINAVELU** *has passed the National certification Examination for Energy Auditors held in September 2018, conducted on behalf of the Bureau of Energy Efficiency, Ministry of Power, Government of India. He / She is qualified as* ***Certified Energy Manager*** *as well as* ***Certified Energy Auditor****.*

He / She shall be entitled to practice as Energy Auditor under the Energy Conservation Act 2001, subject to the fulfillment of qualifications for Accredited Energy Auditor and issuance of certificate of Accreditation by the Bureau of Energy Efficiency under the said Act.

This certificate is valid till the Bureau of Energy Efficiency issues an official certificate.

Digitally Signed by:K V R RAJU
Mon Apr 22 16:22:42 IST 2019
Controller of Examination, NPC AIP Chennai

Place : Chennai, India
Date : **22nd April, 2019**

Controller of Examination

TÜV NORD

ISO 14001:2015 Lead Auditor
(Environmental Management Systems)
Training course

it is hereby certified that

Dr. S. R. Sivarasu

has successfully completed the above mentioned course and examination

08th - 12th December 2017

Coimbatore, India

This report is prepared as a part of the Green Audit (Covering Energy, Water, and Environmental) Audit conducted at **M/s. DHIRAJLAL GANDHI COLLEGE OF TECHNOLOGY,** Opposite Salem airport, KamalapuramSikkanampatty, Omalur, Tamil Nadu 636 309 conducted by **M/s. RAM-KALAM CENTRE FOR ENERGY CONSULTANCY AND TRAINING,**Coimbatore-641 062, Tamilnadu, India.