Sustainable Living Inc

TRINITY COLLEGE OF ENGINEERING AND TECHNOLOGY
(Approved by AICTE & Affiliated to JNTU Hyderabad)

Trinity College of Engineering and Technology, Peddapalli

Carbon Footprint and Energy Audit

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Acknowledgment

Sustainable Living Inc

Hiran Prashanth 17 December2021
Environmental Sustainability Auditor

Carbon footprint and Energy audit at Trinity College of Engineering and Technology, Peddapalli (TCEK)

The Sustainable Living Inc acknowledges with thanks the cooperation extended to our team for completing the study at Trinity College of Engineering and Technology, Peddapalli (TCEK).

The interactions and deliberations with TCEK team were exemplary and the whole exercise was thoroughly a rewarding experience for us. We deeply appreciate the interest, enthusiasm, and commitment of TCEK team towards environmental sustainability.

We are sure that the recommendations presented in this report will be implemented and the TCEK team will further improve their environmental performance.

Kind regards,

Yours sincerely,

Hiran Prashanth
Environmental Sustainability Auditor
Sustainable Living In

About Auditor

Hiran Prashanth is a sustainability consultant based in London. He has over 15 years of experience in climate change and environmental sustainability. He was working with the Confederation of Indian Industry (CII) before moving to London to pursue a master's degree at King's College, London. He currently advises companies to reach net zero carbon emissions. He works with companies in 12 countries around the world.

Hiran Prashanth has helped more than 150 organizations around the world the achieve carbon neutrality. Apart from carbon neutrality, Hiran Prashanth has also facilitated organizations to achieve net-zero energy, water neutrality, and zero waste to landfill. He has audited more than 500 companies for their sustainability performance.

Hiran Prashanth was awarded the 'Best Sustainability Assessor' by the Honorable Minister for HRD, Mr. Prakash Javadekar. Hiran Prashanth is a CII certified carbon footprint expert and a resource efficiency expert. He has trained more than 1000 industry personnel across the world on climate change and sustainability. He is a guest a faculty at IIM Lucknow and SIBM, Pune. His credentials can be found on Hiran Prashanth | LinkedIn. Sustainable Living Inc provides services on carbon footprint, energy audit, resource management and embodied carbon.

Executive Summary

The growth of countries across the world is leading to increased consumption of natural resources. There is an urgent need to establish environmental sustainability in every activity we do. In a modern economy, environmental sustainability will play a critical role in the very existence of an organization.

An educational institution is no different. Built environment, especially an educational institution, has a considerable footprint on the environment. Impact on the environment due to energy consumption, water usage and waste generation in an educational institute is prominent. Therefore, there is an imminent need to reduce the overall environmental footprint of the institution.

As an Institution of higher learning, Trinity College of Engineering and Technology, Peddapalli (TCEK) firmly believes that there is an urgent need to address the environmental challenges and improve their environmental footprint.

True to its belief, TCEK is in the process of replacing conventional lamps with energy efficiency lamps. Sustainable Living Inc Team congratulates TCEK team for their efforts. Keeping TCEK’s work in energy efficiency, we recommend the following to be taken by the competent team at TCEK:

Work towards achieving carbon neutrality: INDC emphasizes creating an additional carbon sink of 2.5 to 3 billion tonnes of CO2 equivalent through additional forest and tree cover by 2030. TCEK's net carbon emission for the year 2020-21 is **59.50 MT CO2e**. TCEK should focus on energy efficiency, renewable energy, and carbon sequestration as tools that will enable them to offset the present carbon emissions and achieve carbon neutrality.

Installation of solar rooftop: Renewable energy plays a very important role in improving the environmental footprint of an organization. By including the share of renewable energy in TCEK energy portfolio, the overall carbon footprint of the college can be reduced. As an initial step, TCEK could look at installing 10 kWp of solar PV which can generate 20000 units per year. The renewable share will also reduce the 15 MT CO2e. Achieving carbon neutrality should be one of the major objectives of TCEK.

Installation of biogas plant: In 2020-21, TCEK had used 0.38 MT of LPG. There is an opportunity to install a biogas plant to generate biogas from sewage water. Presently, sewage water is being let out to the drain without treatment. An opportunity exists to generate biogas from the untreated sewage water and use the generated biogas to substitute LPG used in the college. By generating biogas from sewage water, about 0.93 MT of LPG can be replaced which will result in carbon savings of 2.79 MT CO2e.

Improve energy efficiency of the college: It is recommended to adopt latest energy efficient technologies for reducing energy consumption in fans, lighting, and air conditioners. We recommend the following projects to be implemented at the earliest:

- Replace conventional 70W ceiling fans with energy efficient BLDC fans of 30W
- Installation of Air conditioners energy savers
- Replace conventional lamps with LED lamps
- Installation of solar water heaters for hostel

Introduction

As educational institutions continue to expand and evolve, energy consumption remains a critical challenge. Colleges and universities are some of the largest energy consumers, as they require electricity to run various facilities, dormitories, and laboratories. Energy efficiency is essential for colleges as it helps institutions reduce energy usage, reduce greenhouse gas emissions, save money, and promote sustainability. This report will discuss the reasons why energy efficiency is essential for colleges.

Reduced Energy Costs

Energy costs represent a significant expense for colleges, and as energy prices increase, institutions are facing an increasingly challenging financial landscape. By implementing energy-efficient measures, colleges can reduce energy consumption and save money. For instance, energy-efficient lighting, heating, ventilation, and air conditioning (HVAC) systems can significantly reduce energy usage in buildings. Similarly, energy-efficient equipment such as computers, printers, and other office appliances can also contribute to energy savings. Additionally, implementing renewable energy sources, such as solar panels, can help reduce energy costs and provide a reliable source of energy.

Sustainability

Sustainability is a critical aspect that colleges must consider to reduce their carbon footprint and promote environmental conservation. By promoting energy efficiency, colleges can reduce their carbon emissions and contribute towards a sustainable future. Additionally, colleges can adopt sustainable practices such as using recycled materials and reducing waste to reduce their environmental impact. Sustainability has become a significant issue for students, and it can play a critical role in attracting prospective students to colleges.

Education and Awareness

Colleges are responsible for educating and raising awareness among their students, faculty, and staff on energy conservation and sustainability. By promoting energy efficiency, colleges can educate individuals on the importance of conserving energy, reducing carbon emissions, and promoting sustainable practices. Additionally, colleges can encourage students and faculty to adopt sustainable practices such as using public transport, reducing paper usage, and recycling waste. Colleges can also promote energy efficiency and sustainability through various academic programs such as environmental studies, sustainable development, and green energy technology.

Green Building Standards

Green building standards are critical to ensuring that buildings are designed and constructed with energy efficiency in mind. Colleges can adopt green building standards such as Leadership in Energy and Environmental Design (LEED) to ensure that their buildings are designed and constructed with sustainability in mind. These standards promote energy-efficient building designs, renewable energy usage, and sustainable practices that contribute towards reducing energy consumption and promoting environmental conservation. Green buildings are also healthier for occupants as they provide better indoor air quality, natural lighting, and thermal comfort.

Increased Resilience

Energy efficiency is critical to ensuring that colleges are resilient and prepared for emergencies. By implementing energy-efficient measures such as backup power systems, colleges can ensure that their facilities remain operational during power outages or emergencies. Additionally, renewable energy sources such as solar panels can provide a reliable source of energy, reducing the dependence on the grid. This can be critical in times of natural disasters or other emergencies.

Improved Indoor Air Quality

Indoor air quality is critical to the health and well-being of individuals, especially in colleges where students, faculty, and staff spend most of their time indoors. Energy-efficient HVAC systems can improve indoor air quality by filtering out pollutants and providing adequate ventilation. Additionally, energy-efficient lighting can reduce glare, eyestrain, and headaches, improving the comfort and well-being of individuals.

Community Engagement

Colleges are an integral part of their communities, and by promoting energy efficiency, they can engage with their communities and raise awareness on the importance of conserving energy and promoting sustainability. Additionally, colleges can collaborate with local businesses and organizations to promote sustainable practices and reduce the carbon footprint of their communities.

Carbon Footprint and Energy Audit

Trinity College of Engineering and Technology, Peddapalli (TCEK) and Sustainable Living Inc are working together to identify opportunities for improvement in energy efficiency and carbon reduction. This report highlights all the potential proposals for improvement through the audit and analysis of the data provided by TCEK for lighting, air conditioning, ceiling fans, and biogas potential.

The report also details the carbon emissions from college operations. For carbon emissions, scope 1 and scope 2 emissions are calculated from the data submitted by TCEK. The report emphasizes the GHG emission reduction potential possible through a reduction in power consumption.

Submission of Documents

Carbon footprint and energy audit at TCEK was carried out with the help of data submitted by TCEK team. TCEK team was responsible for collecting all the necessary data and submitting the relevant documents to Sustainable Living Inc for the study.

Carbon Footprint and Energy Audit

Data submitted and collected was used to calculate the carbon footprint of the campus and assess energy consumption and finally provide necessary recommendations for environmental improvement.

Note

Carbon footprint and energy audit are based on the data provided by TCEK team and discussions the Sustainable Living Inc team had with TCEK team. The scope of the study does not include the exclusive verification of various regulatory requirements related to environmental sustainability.

Sustainable Living Inc has the right to recall the study if it finds (a) major violation in meeting the environmental regulatory requirements by the location and (b) occurrence of major accidents, leading to significant damage to ecology and environment.

OPPORTUNITIES FOR IMPROVEMENT

As a part of the overall environmental improvement study at TCEK, carbon footprint calculations were also carried out. The objective of calculating the carbon footprint of the campus is find the present level of emissions from campus operation and what initiatives that the TCEK can take to offset the emissions. By offsetting the emissions, the college can become carbon neutral in the future by adopting energy efficient processes, increase in renewable energy share and tree plantation.

Carbon footprint calculations:

To help delineate direct and indirect emission sources, improve transparency, and provide utility for different types of organizations and different types of climate policies and business goals, three “scopes” (scope 1, scope 2, and scope 3) are defined for GHG accounting and reporting purposes.

For calculating carbon footprint of the campus, Scope 1 & Scope 2 emissions are being considered. Since day scholars use college provided transportation and hostelers stay in campus, Scope 1 and Scope 2 are the highest contributor to overall emissions. For this reason, Scope 3 is not being calculated.

Scope 1: Direct GHG Emissions

Direct GHG emissions occur from sources that are owned or controlled by the company, for example, emissions from combustion in owned or controlled DG sets, canteen, vehicles, etc.; emissions from chemical production in owned or controlled process equipment. Direct CO_2 emissions from the combustion of biomass shall not be included in scope 1 but reported separately.

<u>TCEK Scope 1 emissions for 2020-21:</u>

Sources of Scope 1 emissions in TCEK:

1) LPG used for canteen

2) Diesel used for generator

3) Diesel for transportation

S No	Fuel Type	Description	Activity Data	Units	CO_2 eq. Emissions (tons)
1	LPG	Canteen	0.38	MT	1.13
2	Diesel	Transportation	15.00	KL	39.60
3	Diesel	Generator	0.50	KL	3.17

Total Scope 1 emissions of TCEK : 43.90 Tons (for year 2020-21)

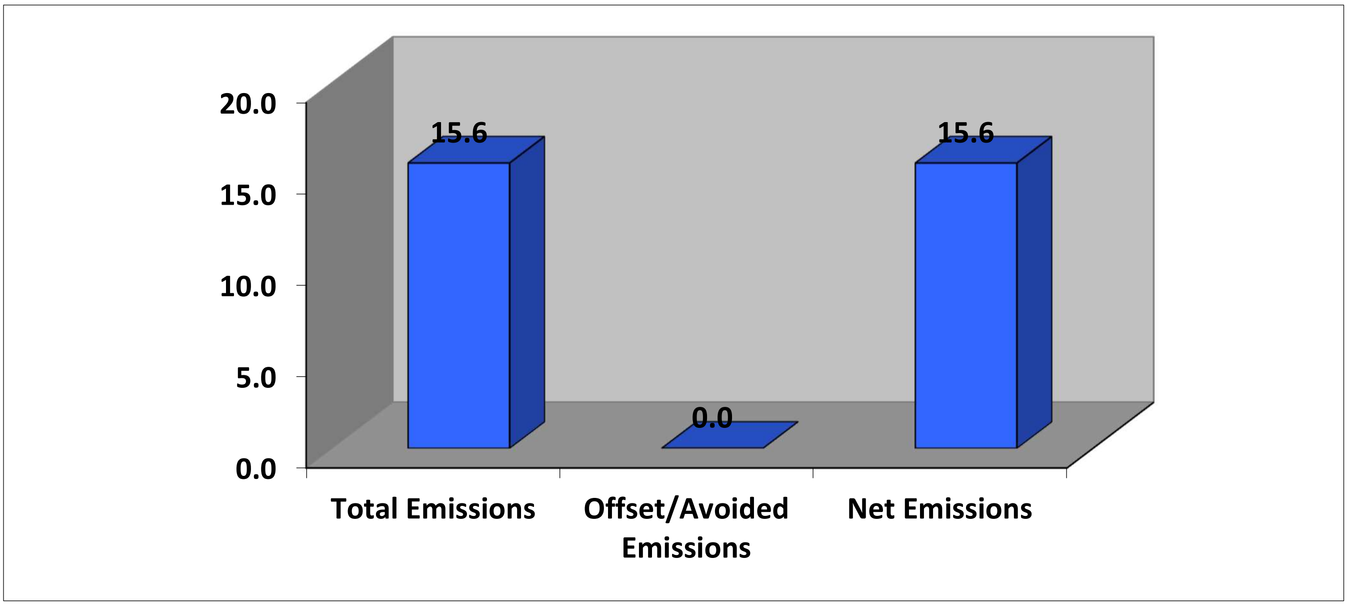
Scope 2: Electricity Indirect GHG Emissions

Scope 2 accounts for GHG emissions from the generation of purchased electricity consumed by a company. Purchased electricity is defined as electricity that is purchased or otherwise brought into the organizational boundary of the company. Scope 2 emissions physically occur at the facility where electricity is generated.

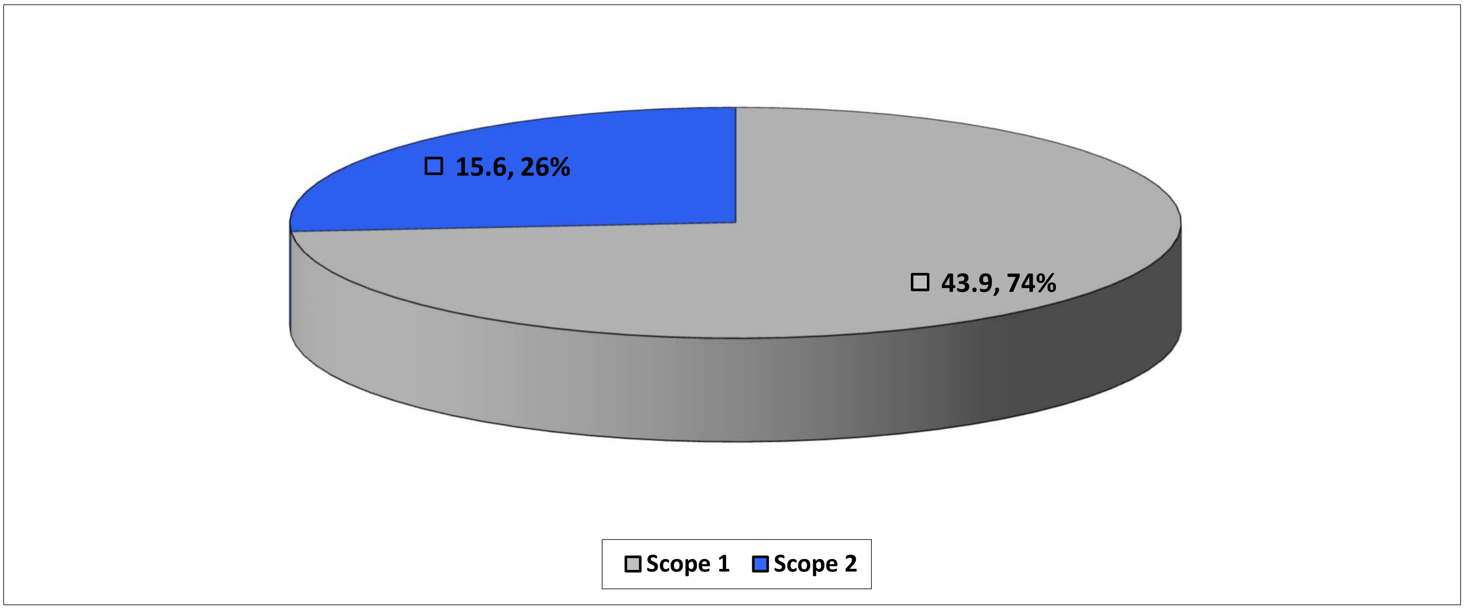
TCEK Scope 2 emissions for 2020-21:

Electricity purchased from grid	:	22,000
Solar energy produced	:	0

Scope 2 Breakup



GHG Emission Summary of TCEK



Scope 1	43.90	**MT CO2 eq.**
Scope 2	15.60	**MT CO2 eq.**
Total	59.50	**MT CO2 eq.**

Develop a roadmap to increase contribution of renewable energy in the overall energy consumption

To have a continued focus on increasing renewable energy utilization to 100% which will also lead to reduction in GHG emissions, it is suggested to develop a detailed roadmap on RE utilization. The road map should broadly feature the following aspects -

- Renewable energy potential of TCEK and the maximum offset that can be achieved at TCEK
- Percentage substitution with renewable energy that TCEK wants to achieve in a specified time frame
- Key tasks that needs to be executed to achieve the renewable energy target
- Specific financial break up for each of the projects highlighting the amount required, available and the utilization status as on date
- A regular review mechanism to ensure progress along the lines of the roadmap should be framed
- The roadmap should also highlight important milestones/key tasks, anticipated bottle necks & proposed

Renewable energy roadmap should be used as a base to frame GHG emissions reduction target

It is suggested to use the developed renewable energy roadmap to correlate the GHG reduction that each of the renewable energy project will achieve. This approach will provide a base to set targets for reduction in GHG emissions. The action plan for renewable energy will shoulder the action plan for GHG emissions reduction and work towards achieving carbon neutrality.

Explore the option of other onsite and offsite renewable energy projects

The renewable energy field has been witnessing many private investors due its increased market demand and attractive policies in many states. There are Renewable Energy Independent Power Producers (RE IPPs) who have installed RE based power plants like wind, small hydro and solar PV. GOC can consider having a long-term power purchase agreement with these RE IPPs in purchasing fixed quantity of power for a period of 5 to 10 years.

Evolve a system to monitor the implementation of various GHG mitigation opportunities

TCEK has an action plan to reduce its GHG emissions. TCEK should also evolve a system to monitor the implementation of various GHG mitigation opportunities. It is recommended to use a Gantt chart to mark out the action plan for the activities and track its implementation. Gantt chart will serve as an excellent way to instantly monitor and comprehend all different tasks in one place which would ease tracking of implementation.

Install 10 kWp of Solar PV in TCEK campus

Renewable energy is one of the important steps to be taken up by the college to reduce their overall carbon footprint.

A renewable energy capacity of 10 kW of solar panel may be installed can generate **20,000** units of electricity per year. Additionally, 25 kWp of solar rooftop can offset **15 MT CO2e** per annum.

RESCO model for solar rooftop installation:

A Renewable Energy Service Company (RESCO) is an ESCO Energy service company which provides energy to the consumers from renewable energy sources. RESCO or BOOT model is about pay as you consume the electricity.

- Solar Power Plant is owned by the RESCO or Energy Company
- Customer must sign a Power purchase Agreement (PPA) with actual investor at mutually agreed tariff and tenure
- Customer only pays for electricity consumed
- RESCO developer is responsible for its annual operations & maintenance (O&M)
- The RESCO gets the benefit by selling the surplus power generated to the DISCOM

Install biogas plant at TCEK Institutions

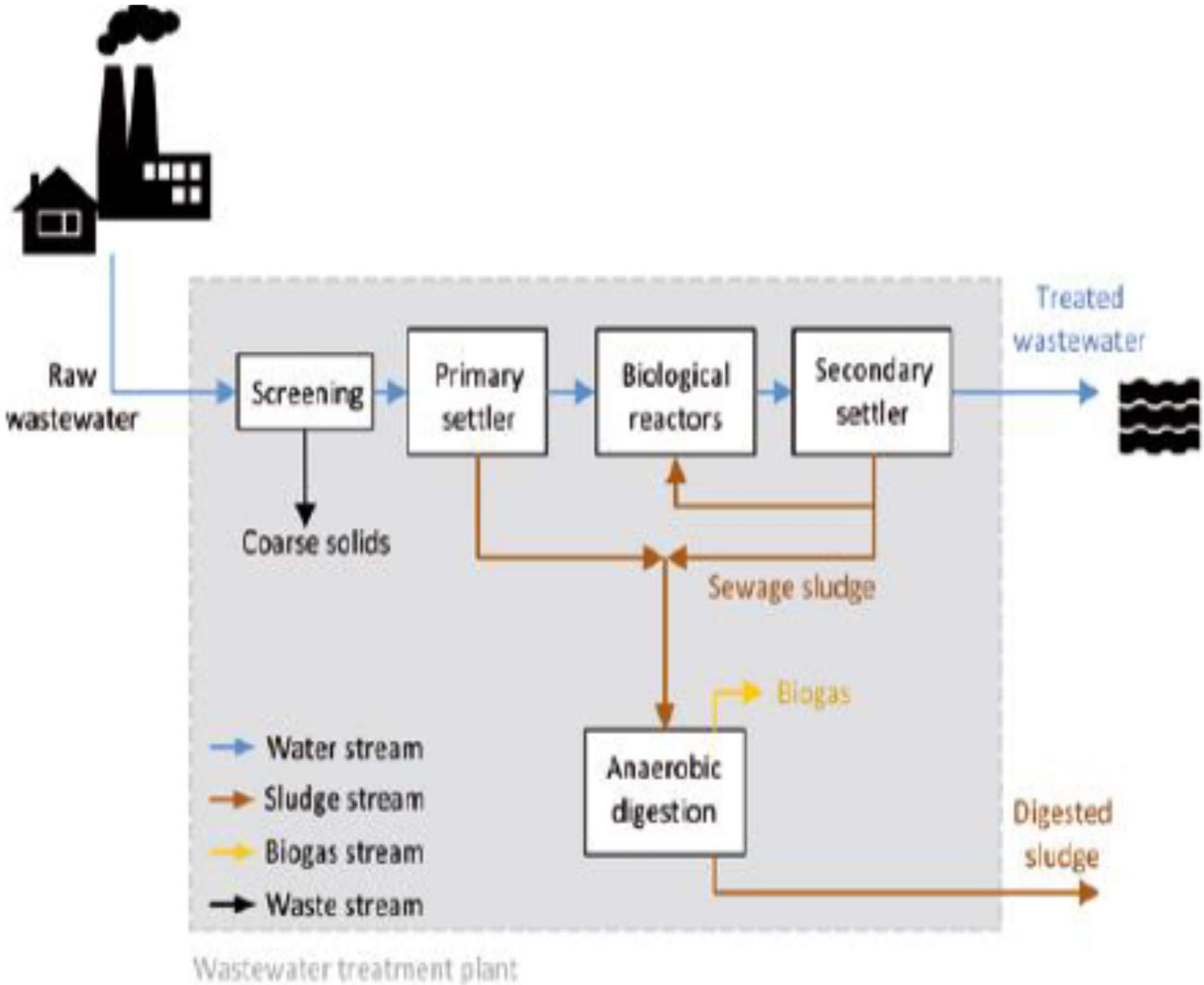
Presently, sewage water is treated in a sewage treatment plant and the treated water is used for gardening purpose. An opportunity exists to generate biogas from the untreated sewage water before it reaches the sewage treatment plant and use the generated biogas to substitute LPG used in the college.

TCEK used 0.48 MT of LPG. By generating biogas from sewage water, about 0.93 MT of LPG can be replaced which will result in carbon savings of 2.79 MT CO_2e.

Biogas Production Potential of Wastewater

The sewage water is a useful waster as 1% of it in any quantity is a sludge which when subjected to anaerobic digestion will produce biogas. Wastewater is the effluent from household, commercial establishments and institutions, hospitals, industries and so on. Sewage water source contains large amount of organic material which can be efficiently recovered in as sludge which and when subjected to anaerobic digestion, the sludge produces methane gas (biogas).

Biogas is a mixture of gases containing 50-75% Methane, and 25-50%Carbon dioxide while 0-10% Nitrogen, 0-3% Hydrogen disulphide and 0-2% Hydrogen may be present as impurities which is produced by anaerobic digestion of organic material i.e. a sequential enzymatic breakdown of biodegradable organic material (Biomass) in the absence of oxygen. The process is usually carried out in a digester tank known as biodigester. Biogas is an important energy source used as cooking gas, to generate electricity, etc. thus producing biogas from wastewater is an efficient and sustainable waste management and renewable energy technique. One of the major environmental problems of the world today is waste management and wastewater constitutes a huge environmental problem to the society thus the need for wastewater treatment to recover and also recycle the recovered water for usage.



The physical process: this is the mechanical treatment of the water that involves removal of debris from the raw wastewater right from the point it enters the plant. The screening and primary settling of debris. Wastewater enters the treatment plant through the inlet chamber from where it is channeled to the coarse screen that removes solid waste.

The biological process: this involve the biotreatment of the sewage in the bioreactors. It is the heart of the treatment plant where a biological process takes place. The bioreactors of a treatment plant are usually large tanks consisting of several mammoth rotors and submersible mixers. While the rotor introduces atmospheric oxygen into the sewage, the submersible mixers keep the biomass in suspension thus several reactions takes place in the bioreactors.

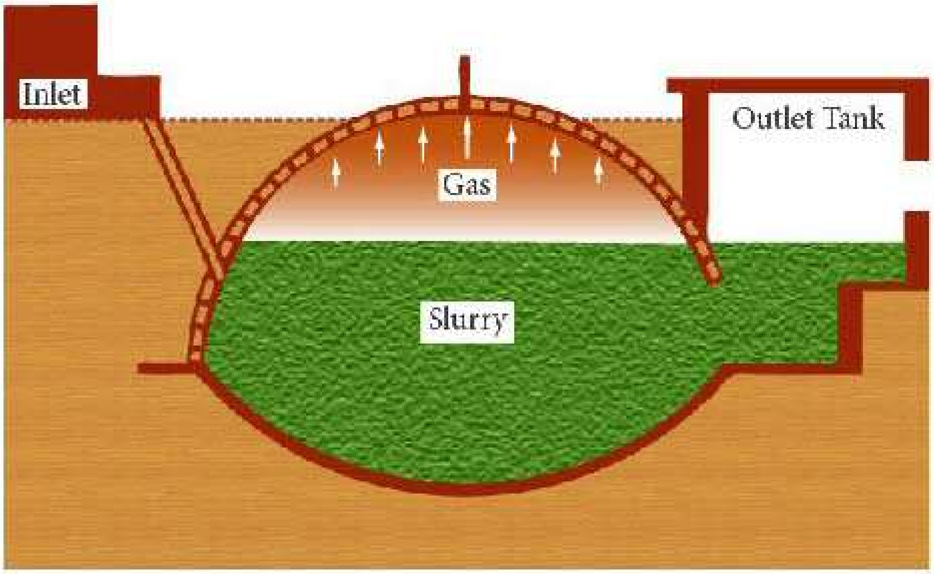
From the bioreactor, the sewage enters the sedimentation tank. Here the biological process ends and sludge is separated from water such that the clean water is passed to the disinfection tank for disinfection and onward discharge for use while the sludge is removed by the returned activation sludge (RAS) pump that removes and sends part to the anaerobic digestion chamber while some are return to the anaerobic bioreactor for reactivation.

Production of biogas is an anaerobic digestion whereby microorganisms break down biodegradable material in the absence of oxygen to produce methane/carbon dioxide used to generate electricity and heat. Sludge from the treatment plant (primary and activated sludge) is the main feedstock (biodegradable organic matter) in the biogas production plant of a wastewater treatment plant and the biogas production process involves series of steps. The combine sludge resulting from primary and secondary water treatment is gathered, sieved and thickened to a dry solids content of up to 7% before entering the digesters. Optionally, the sludge can be pretreated by disintegration technologies with the aim to improve the gas yield. In the anaerobic digestion process, the sludge is pumped into the anaerobic continuously stirred tank reactors where digestion takes place.

In the process, microorganisms break down part of the organic matter that is contained in the sludge and produce biogas, which is composed of methane, carbon dioxide and trace gases. The raw biogas produced is dried and hydrogen sulphide and other trace substances removed and burned in burners after treatment. The digested sludge is dewatered, and the water reintroduce into the treatment plant while the remaining undigested matter used for organic fertilizer.

Calculations:

Sewage water available per day	:	5 KL (Least value considered for calculation)
Sludge in 10KL of sewage water	:	1% (100 kg)
From 6kg of organic waste	:	1 kg of biogas can be produced
Therefore, from 50 kg	:	8.33 kg of biogas can be produced
Kg of biogas	:	0.45kg of LPG
Per day equivalent LPG production	:	3.25 kg per day
Annual LPG production for 250 days	:	937.50 kg
Annual emission reduction potential	:	2.79 T CO_2



ENERGY EFFICIENCY

Annual energy consumption of TCEK Institutions is 22,000 units. There are major blocks in the campus which consumes energy for their operation. Major energy consumers are:

1. Fans
2. Air conditioners
3. Water heating in hostels

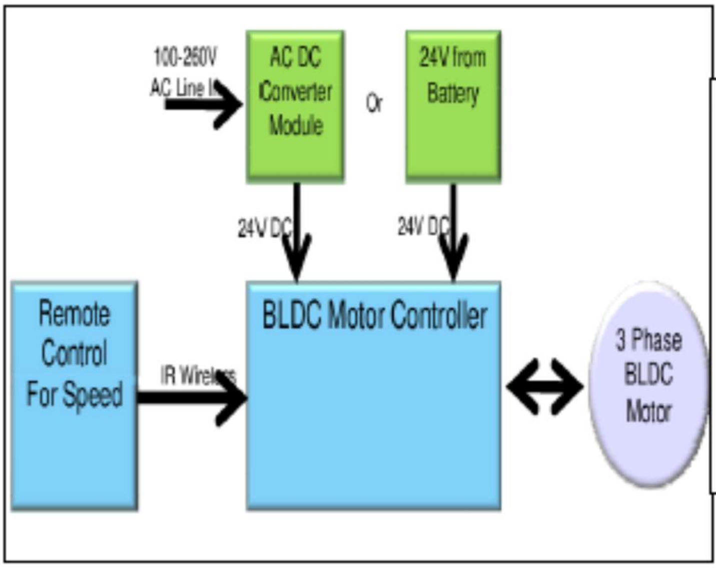
Replace Conventional Ceiling Fans with Energy Efficient BLDC Fans

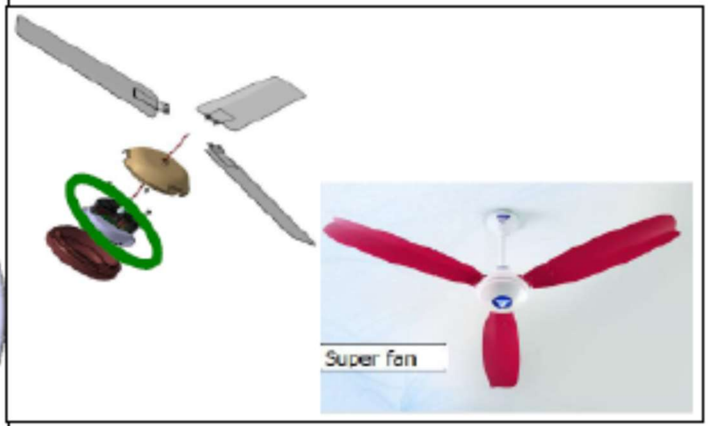
During the Energy Audit at TCEK, a detailed study was carried out to identify the potential for replacing the existing ceiling fans with BLDC super fans. There are 300 fans operating in TCEK Institutions.

Instead of conventional ceiling fans, latest technology BLDC fans which consume only 30W can be installed in the newly constructed building. A brushless DC (BLDC) motor is a synchronous electric motor powered by direct-current (DC) electricity and having an electronic commutation system, rather than a mechanical commutator and brushes. A BLDC motor has an external armature called the stator, and an internal armature called the rotor.

The rotor can usually be a permanent magnet. Typical BLDC motor-based ceiling fan has much better efficiency and excellent constant RPM control as it operates out of fixed DC voltage. The proposed BLDC motor and the control electronics operate out of 24V DC through an SMPS having input AC which can vary from 90V to 270V. The operational block diagram of a BLDC motor is as follows:

Calculations:





With the replacement of existing ceiling fans with Super Fans the energy consumption is likely to reduce by 55% per fixture. Considering 100 fans being replaced with super-efficient BLDC fans, 3.50 kW can be saved. Considering the average operating hours to be 2000 and unit cost as Rs. 7.50, the calculations are as follows:

Total no. of fans in college	:	300
Energy consumption per fan	:	70 W
Total energy consumption of fans	:	70W X 100 fans
	:	7 kW
Super-efficient BLDC fans energy consumption	:	30 W
Savings from 70W to 30 W	:	55%
Total savings in fans energy consumption	:	55% of 7kW
	:	3.5 kW
Savings per year	:	3.5 kW X 2000 hrs X Rs. 7.50 / unit
	:	Rs. 0.75 Lakhs
Investment	:	Rs. 2, 50, 000
	:	52 months
Annual emission reduction potential	:	6.00 T CO2

Install solar water heater for hostel hot water requirements

Heaters are being used for the hot water requirements of the hostel Electrical heaters are one of the highest energy consumers in the hostel with each heater consuming 800W of energy.

Replacing the electrical heaters with solar water heaters is the best solution for eliminating the power consumption of the heaters.

The following explanation of solar water heaters is taken from www.bijlibachao.com.

A solar water heater is a system that utilizes solar energy (or the energy from sunlight) to heat water. It has a system that is installed on a terrace or open space where it can get sunlight and the energy from the sun is then used to heat water and store it in an insulated tank. The system is not connected to electricity supply and thus does not have an on-off switch, but it uses the sunlight throughout the day to heat the water and store it in the storage tank. Most of the solar water heater on a sunny day can provide heater water at about 68° ±5° C temperature. Water from the storage tank can then be used for any application as desired. One can feed this heated water to the electric geyser so that when sunlight is not enough, it uses electric energy to heat the water to the desired set temperature. This is also called Hybrid Water Heater.


Solar Water Heaters Types and Benefits

Flat Plate Collectors (FPC) System	Evacuated Tube Collectors (ETC) System
Long lasting as they are metallic. But are expensive	Fragile but cheaper.
Can work in colder regions with sub zero temperature but will need an anti freeze solution.	Very good for colder regions where the temperature is sub zero.
In places with salty water a heat exchanger is required with FPC system.	Require regular cleaning where the water is salty.

Benefits of a 100 lts Solar Water Heater in India.

	Northern Region	Eastern Region	Southern Region	Western Region
Expected no. of days of use of hot water per year	200 days	200 days	300 days	250 days
Expected yearly electricity saving on full use of solar hot water (units of electricity)	1000	1000	1500	1250

Bijli Bachao!
...because saving electricity saves money

For this report, a 100-liter capacity solar water heater is considered. A 100-liter, EPC solar water require requires 20 square feet of space. The energy saving from the system is calculated a follow:

Heat required (kcal) = M (Mass of water) x Cp (Specific heat of water) x delta T (Difference in starting temperature and desired temperature)

kW saving = M (Mass of water) x Cp (Specific heat of water) x delta T (Difference in starting temperature and desired temperature) X 0.0012 (conversion from kcal to kW)

= 100 kg X 1 X (50 Deg C – 25 Deg C) X 0.0012

= 3 kW

Therefore, for heating 100 litres of water, the energy saving would be 3 kW.

Cost of 500-liter EPC solar water will be Rs. 60,000.

For a 500-litre solar water heater the energy saving will be 15 kW.

Cost saving for 250 days of operation will be Rs. 28,000.

Pay back will be in 25 months.

Replace Conventional Lamps with LED Lamps

As per the data submitted, the total number of all the lighting fixtures installed are 300 tube lights.

Under failure replacement policy, at least 130 lamps can be changed in the first year.

Types of fixtures	36 W Tube
No of fixtures	130
No of hours in Operation	2000

The campus should be keen in harnessing the day lighting available thereby reducing the use of artificial lighting. Based on the occupancy, monitoring should be ensured to reduce excessive consumption of energy.

Major savings in energy through lighting fixtures can be achieved by replacing all the above existing fixtures with LED's meeting the required LUX levels. The LED's being less energy consuming while maintaining the equivalent lux is the more sustainable option. The replacement of lighting fixtures should be done as per failure replacement policy i.e. change the old fixture with LED when it fails

Advantages of LED

- Lower energy consumption: The energy consumption of LEDs is low when compared to the other conventional sources for the same amount of Lumen output.

Performance comparison of different type lights

Type of Lamp	Lumen/ Watt	CRI	Life hours
HPSV lamps	90-120	Bad (22-25)	15,000-20,000
Metal Halide lamps	65-00	Good (65-90)	18,000
LED lamps	100-150	Very Good (> 80)	10,000 – 12,000

- **High S/P ratio**: LEDs have higher scotopic/photopic ratio (S/P ratio). The eye has two primary light sensing cells called rods and cones – cones function in day light and process visual information whereas rods function in night light. The cone dominated vision is called photopic and the rod dominated vision is called scotopic. The S/P ratio indicates the measure of light that excites rods compared to the light that excites cones. In office environments, illumination is more effective if the S/P ratio is high as it is under scotopic region. LEDs hence are ideally suited for these applications as they have a high S/P ratio.
- **Longer life-time**: LEDs have longer life time of around 1,00,000 hours. This is equivalent to 11years of continuous operation or 22 years of 50% operation.
- **Faster switching**: LED lights reach its brightness instantly upon switching and can frequently be switched on/off without reducing the operational life Expectancy.
- **Greater durability and reliability**: As LEDs are solid-state devices and uses semi-conductor material; they are sturdier than conventional sources that use filaments or glass. LEDs can also withstand shock, extreme temperatures and vibration as they don't have fragile materials as components.
- **Good Colour Rendering Index (CRI)**: The color rendering index, i.e., measure of a light sources' ability to show objects as perceived under sunlight is high for LEDs. The CRI of natural sunlight is 100 and LEDs offer CRI of 80 and above.
- LED offers more focused light and reduced glare. Moreover, it does not contain pollutants like mercury. LED technology is highly compatible for solar lighting as low-voltage power supply is enough for LED illumination.

Calculations are as follows:

Existing Lighting Fixtures	**36 W Tube**
Existing power consumption (kW)	4.50 kW (130 lamps)
Proposed LED Wattage (W)	15
LED power consumption (kW)	1.95 kW
Energy saving (kW)	2.55 kW
Operating hours	2000

Annual monetary savings : Rs 38,250/-

Investment needed : Rs 90,000/-

Payback period : 2.50 Years

Annual Emission reduction potential : 4.18 MT of CO2

Conclusion

TCEK has initiated few energy efficiency activities in their campus. While Sustainable Living Inc appreciates the plant team for their efforts, we would like to emphasize that opportunity exists further reduce the energy consumption. Installation of renewable energy is to be given major focus. RESCO model can be adopted to install renewable energy without upfront capital investment. We in Sustainable Living Inc are sure that all the recommendations mentioned in the report will be implemented by TCEK team and the overall environmental performance of the campus will be improved.

List of Vendors

Equipment	Supplier Name	Contact Person	Mail Address	Contact Number
AC Energy Saver	Gloabtel Convergence Ltd	Mr Chirag Morakhia	chirag@gloabtel.com	9324176440
AC Energy Saver	Magnatron International	Mr Kishore Mansata	indiaenergysaver@gmail.com	9748727966
BLDC Ceiling Fans	Atomberg Technologies Pvt Ltd	Ms Roshni Noronha	roshninoronha@atomberg.com	9987366655
BLDC Ceiling Fans	Versa Drives	Mr Sathish	sathish@versadrives.com	94885 94382
LED	Havells India Ltd	Mr. Sunil Sikka	sunil.sikka@havells.com	0120-4771000
LED	Kwality Photonics Pvt. Ltd.	Mr. K. Vijay Kumar Gupta	kwality@kwalityindia.com	+ 91 40 2712 3555
LED	OSRAM Lighting Pvt. Ltd.	Mr Nitin Saxena	N.saxena@osram.com	+91 124 626 1300
LED	Reckon Green Innovations Pvt Ltd	Mr Krishna Ravi	krishna@reckongreen.com	9985333559