GREEN AUDIT REPORT

Of Hindol College, Khajuriakata, Dhenkanal, Odisha

Submitted to:

Hindol College, Odisha

At-Khajuriakata, Po/P.S-Balimi, Dist-Dhenkanal,
Pin-759020, Odisha
Phone No: 06732254423, Fax-06732-254425
Email: hindolcollegekkata@rediffmail.com

Submitted by:

M/s. Swain & Sons Power Tech Pvt. Ltd.

Corporate office: K-8-82, Kalinga Nagar, Ghatikia
Bhubaneshwar-751029, Odisha
Phone: +91-674 -2954256
Mobile: 80935 33005
Email: info@pwrtch.com, sspt12@gmail.com
Website: www.pwrtch.com

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ACKNOWLEDGEMENT

Swain & Sons Power Tech Pvt. Ltd. (SSPTPL) places on record its sincere thanks to Principal of Hindol college for entrusting task of conducting the Green Audit of Hindol College, Khajuriakata.

SSPTPL acknowledges with gratitude the wholehearted support and encouragement given by all Hindol Collage officials while carrying out the study at Hindol College, Khajuriakata.

SSPTPL acknowledges with gratitude and sincerely thanks all the officials, staff members and students of Hindol College who have rendered their all possible co-operation and assistance to the study team during the entire period of the audit.

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Signature

Dambarudhar Kar
Sr. Manager & Sector Expert (BEE)
Swain & Sons Power Tech Pvt. Ltd.
Corporate Office: K-8-82, Kalinga Nagar, Ghatikia,
Bhubaneswar-751029, Odisha.
Phone: 0674-2954256, Mob: 8093533005, 9937159760, 8093533003
Email: sspt12@gmail.com , info@pwrtch.com
Website: www.pwrtch.com, www.powerbazar.in

AUDIT TEAM DETAILS

1. Mr. Dambarudhar Kar, Sr. Manager (Project)
2. Mr. Barada Prasana Subudhi, Consultant
3. Mr. Suraj Kumar Bhujabala , Manager (Project)
4. Mr. Prabhu Chintan Baral, Project Associate

CERTIFICATE

We certify the following

- The data collection has been carried out diligently and truthfully.
- All data measuring devices used by the auditor are in good working condition, have been calibrated and have valid certificate from the authorized approved agencies and tampering of such devices has not occurred.
- All reasonable professional skill, care and diligence had been taken in preparing the green audit report and the contents thereof are a true representation of the facts.

Signature

Dambarudhar Kar
Sr. Manager & Sector Expert (BEE)
Swain & Sons Power Tech Pvt. Ltd.
Corporate Office: K-8-82, Kalinga Nagar, Ghatikia,
Bhubaneswar-751029, Odisha.
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EXECUTIVE SUMMARY

The Hindol College is situated at Khajuriakata, Dhenkanal in Odisha state which was centrally located in the Hindol Sub-Division for setting up of a College of higher education and christened. Effulgent worth the elegance of natural flora and fauna, enriched with green resources encompassed by hills and adorned by forest streams Hindol Sub-Division was one of the princely states till 1950 and the total area is around 11.93 acres.

The Green Audit provides a comprehensive evaluation of an organization's environmental practices and sustainability performance, aiming to identify opportunities for improvement and reduce ecological impact. This audit covers key aspects such as energy consumption, waste management, water usage, carbon footprint, and resource efficiency, aligning with national and international environmental standards.

Our findings indicate several areas where the organization excels in sustainable practices, such as efficient waste disposal and energy-saving initiatives. However, there are also notable opportunities for improvement in areas like water conservation, sustainable sourcing, and employee awareness of environmental policies.

In order to identify the environmental conservation opportunities and reduce the present ecological impact, Principal, Hindol College has entrusted the work of conducting a Green Audit to Swain & Sons Power Tech Pvt. Ltd. The Green Audit of Hindol College was carried out on 17th December 2024.

1.0 INTRODUCTION

The Green Audit is a critical assessment tool designed to evaluate the environmental performance of an institution, identifying areas where sustainability practices can be improved and ecological impacts minimized. In line with its commitment to environmental stewardship, Hindol College has undertaken a comprehensive Green Audit to assess its current environmental practices and identify opportunities for greater efficiency and sustainability.

The Green Audit, conducted by Swain & Sons Power Tech Pvt. Ltd. on 17th December 2024, aims to evaluate key aspects such as energy consumption, water usage, waste management, carbon footprint, and resource utilization. The goal is to provide actionable insights that can help the college minimize its environmental footprint, reduce operational costs, and promote a culture of sustainability within the campus.

This report outlines the findings of the audit, highlighting both strengths in the college's current practices and areas where improvements can be made. Through this audit, Hindol College seeks to align itself with best practices in environmental management and contribute to the global movement towards sustainability and responsible resource use.

1.1. ABOUT THE SITE

The Hindol College is situated at Khajuriakata, Dhenkanal in Odisha state of India which was centrally located in the Hindol Sub-Division for setting up of a College of higher education and christened. Effulgent worth the elegance of natural flora and fauna, enriched with green resources encompassed by hills and adorned by forest streams Hindol Sub-Division was one of the princely states till 1950 and the total area is around 11.93 acres.

The college is getting power from the nearby 33/11 kV substation of Chainpal which is about 32 km from the college in 11 kV supply line. Hindol College, is one of reputed college of Dhenkanal, Odisha consumes on an average 8165 kWh (units) of electricity which turns out to be 97981 kW-hr per year only to maintain its volumetric activities throughout the year.

The college includes Main Building, Mini Conference Hall, Library, physics, chemistry, mathematics botany and economics departments, laboratory, IT department, Guest Room, Administrative block and Girls Hostel etc.

Their capacities become privileged adequate science education the college opened Intermediate in science in 1985 with 64 seats which was increased to 128 in 1990-91. The number of seats in arts was increased to 256 in 1992. Degree classes in arts were opened in 1988 with 128 seats and the degree science stream with 96 seats was started in 1992. Further academic expansion was obtained by opening of honours subject in history and political science in 1994. Honours subject in physics, chemistry, mathematics botany and economics were opened in 2003.

The college also provides facilities for vocational education with courses like diploma in Medical laboratory Technician and Diploma in computer science. The National social service (NSS) wing started functioning in the institution since 1990. Students of both +2 and +3 wings are part of the NSS. Different social service schemes are conducted by the NSS.

The Youth Red Cross started functioning in the college since 1995. The wing is involved various awareness programs and activities like AIDS awareness, blood donation camp etc.

The college has been privileged to open Bharat Scouts and Guides and steps are also being taken to open NCC in the College.

Now the college was joined in a new activity i.e: Green Energy Club by making wings involving students for making awareness and to grow the college towards '*Green Energy*'.

Hindol College View Area
Coordinator Point – 20.693389°, 085.303667°arrow_drop_down
MDR-19A, Dhenkanal, Odisha, India

1.2. SCOPE OF WORKS

The scope of the Green Audit for Hindol College, as conducted by Swain & Sons Power Tech Pvt. Ltd., includes a comprehensive assessment of the college's environmental performance across various domains. The primary objective is to identify opportunities for improving sustainability practices, reducing environmental impact, and enhancing resource efficiency. The key areas of focus for the audit are as follows:

A. **Energy Management**:
   - Assessing the energy consumption patterns across the college campus.
   - Identifying energy-efficient technologies and practices.
   - Recommending measures to reduce energy consumption and promote the use of renewable energy sources.

B. **Water Usage and Conservation**:
   - Evaluating current water usage practices in academic and administrative buildings.
   - Identifying opportunities for water conservation, including rainwater harvesting, efficient plumbing, and water recycling initiatives.

C. **Waste Management**:
   - Reviewing waste generation, segregation, and disposal methods.
   - Identifying areas for improvement in waste management practices, such as increasing recycling, reducing waste generation, and promoting composting.

D. **Carbon Footprint Assessment**:

- Estimating the college's carbon footprint based on energy consumption, transportation, waste generation, and other activities.
- Recommending strategies to reduce greenhouse gas emissions and promote carbon neutrality.

E. **Sustainable Building Practices**:
- Evaluating the use of eco-friendly materials and sustainable construction practices within the campus buildings.
- Providing suggestions for improving the energy efficiency of buildings, such as better insulation, ventilation, and lighting systems.

F. **Biodiversity and Green Spaces**:
- Assessing the preservation of biodiversity and green spaces within the college campus.
- Suggesting improvements in landscaping practices to enhance biodiversity and promote sustainable land use.

G. **Employee and Student Awareness**:
- Reviewing the level of environmental awareness among students and staff.
- Recommending initiatives to raise awareness and encourage sustainable practices across the college community.

H. **Compliance and Best Practices**:
- Ensuring that the college adheres to local, regional, and national environmental regulations and standards.
- Identifying best practices and benchmarking the college's environmental performance against industry standards.

The Green Audit aims to provide Hindol College with actionable recommendations that will not only enhance its sustainability practices but also reduce operational costs, contribute to environmental conservation, and foster a culture of responsibility and awareness among all stakeholders.

1.3. METHODOLOGY

The methodology for conducting the Green Audit at Hindol College involves a systematic and data-driven approach to assess the institution's environmental practices and identify opportunities for improvement. The audit process includes the following key steps:

➢ **Pre-Audit Preparation**:

- Initial meeting with college administration to define audit scope and objectives.
- Collection of relevant documents (utility bills, waste logs, water reports, etc.).

➢ **Site Survey and Inspection**:

- Walk-through of the campus to observe energy consumption, water usage, waste management, and infrastructure.
- Identification of key areas for improvement.

➢ **Water and Waste Management Assessment:**

- Review of water consumption and conservation practices.
- Evaluation of waste segregation, recycling, and disposal practices.

- **Carbon Footprint Calculation**:
  - Estimation of carbon emissions from energy consumption, transportation, and waste.
  - Recommendations for emission reduction strategies.
- **Sustainable Building Practices Evaluation**:
  - Assessment of campus buildings for sustainable design and materials.
  - Suggestions for energy-efficient retrofitting and green technologies.
- **Biodiversity and Green Spaces Evaluation**:
  - Review of green spaces and landscaping practices.
  - Recommendations to enhance biodiversity and promote sustainable landscaping.
- **Stakeholder Engagement and Awareness**:
  - Surveys and interviews with students, faculty, and staff to assess environmental awareness.
  - Suggestions for awareness programs and sustainability engagement.
- Draft soft copy of green audit report comprising of observations and recommendations with adequate financial justification, vendor support data, etc. was prepared and submitted to Hindol College for acceptance.
- Final green audit report shall be submitted after acceptance of the draft green audit report.

2.0. ABOUT ENVIRONMENT AUDIT

Green Audit can be defined as systematic identification, quantification, recording, reporting and analysis of components of environmental diversity. The 'Green Audit' aims to analyze environmental practices within and outside the college campus, which will have an impact on the eco-friendly ambience. It was initiated with the motive of inspecting the work conducted within the organizations whose exercises can cause risk to the health of inhabitants and the environment. Through Green Audit, one gets a direction as how to improve the condition of environment and there are various factors that have determined the growth by carrying out Green Audit. Auditing is an evaluating system of college in terms of internal controls for achieving desired goals. The steps of the auditing processes are most crucial include

- Planning
- Work on the ground,
- Creating the audit report and follow-on.

In addition to providing education, college is dedicated to protecting the environment by minimizing negative effect such as lowering thrash, water, energy uses etc. The main goal of the environment audit is to examine ongoing college procedures whose actions may be detrimental to the environment, health of the students and welfare of the entire work force. In order to attain environmental sustainability, improved environmental principles have come Comprehensive procedures of on-site into practice. In this connection, observation and verification are included in the planning and preparation for the environment audit.

Objectives behind the Conduct of Environment Audit:

A conducive environment is very essential for harmonious and healthy living. The most important elements of a good environment are clean air; Water and contamination free soil. People generally harm the environment to satisfy their selfish needs. This has caused a huge harm in the forms of climate change and environmental pollution. The water and air of many places of the world has become polluted to such extent that the people of those areas are struggling to survive. Indiscriminate use of synthetic chemicals in the forms of fertilizers and pesticides in modern agricultural practices has contaminated the crop products which are moving successively to different levels through food chains causing severe health hazards and bio-magnification. Environmental sustainability, therefore, is the need of the hour. If we do not take care of our environment, our future sustenance will be at stake. It is the responsibility of certain authorities or agencies to look after environment. There are many organizations who look after the issues related to environment. But without peoples' participation it is not possible to manage environmental problems. In this regard, each and every institution has a very important role to play. Energy and water use practices, waste management practices, source of water in use, source of energy in use, maintenance of campus ambience, resource all conservation attitude and above the environmental consciousness among the individuals are some aspects about which each and every institution should think, ponder and act to infuse the in order environmental responsibility within the college campus. The purpose of the audit was to ensure that the practices followed in the campus are in accordance with the Green Policy adopted by the institution. The methodology includes: preparation and filling up of questionnaire, physical inspection of the campus, observation and review of the documentation, Interviewing key persons, data analysis, measurements and recommendations.

It works on the several facets of 'Green Campus' including Water Conservation, Tree Plantation, Waste Management, Paperless Work, Alternative Energy and Mapping of Biodiversity. With this in mind, the specific objectives of the audit are to evaluate the adequacy of the management control framework of environment sustainability as well as the degree to which the departments are in compliance with the applicable regulations, policies and standards. It can make a tremendous impact on student's health and learning college operational costs and the environment. The criteria, methods and recommendations used in the audit are based on the identified risks.

3.0. ANALYSIS OF ENERGY BILL

The energy bills details and tariff categorization of Hindol College for FY 2023-24 having consumer no- 80000671372are furnished below:

ENERGY BILL - : PRINCIPAL HINDOL COLLEGE KHAJURIAKATA	
Address	KHAJURIAKATA
Connected DISCOM	TPCODL
Consumer No.	80000671372
Tariff Category	Specified Pub Purpose
Contract Demand	40.00
Supply Voltage	11.00KV
Category Type	GPS
Metering Side	HV

Energy Bill Analysis

DETAILED ANALYSIS OF ENERGY BILL OF PRINCIPAL HINDOL COLLEGE KHAJURIAKATA FOR FINANCIAL YEAR 2023-2024																			
Month	Energy Consumed in kWh	Energy Consumed in kVAh	Av. Load Factor	Actual Power Factor	MD in kW	MD in kVA	Energy Charge in Rs.	Demand Charge in Rs.	PF Penalty (+ve) / PF Incentive (-ve)	Rebate	CSC	TOD Incentive	Overdrawl Penalty	Delay Payment Surcharge	Meter Rent in Rs.	Electricity Duty in Rs.	Current Monthly Bill in Rs.	Tariff in Rs./kVAh	Tariff in Rs./kWh
Mar-23	2,067	2,070	0.28	1.00	**10.06**	10.08	**12,110**	**5,500**	**0.00**	**-176.10**	**250**	**0**	**0**	**0**	**0**	**968.76**	**18,828**	9.09	**9.11**
Apr-23	2,412	2,423	0.21	1.00	15.77	15.84	14,175	4,000	0.00	-181.75	250	0	0	0	0	1,133.96	19,559	8.07	8.11
May-23	2,002	2,010	0.19	1.00	14.34	14.40	1,176	4,000	0.00	-157.59	250	0	0	0	0	940.68	16,949	8.43	8.47
Jun-23	1,859	1,866	0.17	1.00	15.06	15.12	10,916	4,000	0.00	-149.00	250	0	0	0	0	873.29	16,039	8.60	8.63
Jul-23	2,797	2,812	0.24	0.99	15.75	15.84	16,450	4,000	0.00	-204.50	250	0	0	0	0	1,316.02	22,016	7.83	7.87
Aug-23	3,102	3,138	0.26	0.99	15.97	16.16	18,357	4,000	0.00	-223.57	250	0	0	0	0	1,468.58	24,076	7.67	7.76
Sep-23	2,890	2,927	0.22	0.99	**18.56**	18.80	17,123	4,750	0.00	-218.73	250	0	0	0	0	1,369.84	23,493	8.03	**8.13**
Oct-23	2,712	2,759	0.26	0.98	14.15	14.40	16,140	4,750	0.00	-208.90	250	0	0	0	0	1,291.21	22,431	8.13	8.27
Nov-23	1,866	1,874	0.19	1.00	13.78	13.84	10,963	4,750	0.00	-157.13	250	0	0	0	0	877.03	16,840	8.98	9.03
Dec-23	1,489	1,498	0.40	0.99	5.01	5.04	8,763	4,750	0.00	-135.13	250	0	0	0	0	701.06	14,464	9.65	9.71
Jan-24	2,004	2,010	0.48	1.00	5.58	5.60	11,759	4,750	0.00	-165.09	250	0	0	0	0	940.68	17,699	8.80	8.83
Feb-24	2,406	2,470	0.27	0.97	12.89	13.24	14,450	4,750	0.00	-192.00	250	0	0	0	0	1,155.96	20,605	8.34	8.57
Total / Av.	**27,604**	**27,859**	3.03	**0.99**	**13.08**	**13.20**	**1,52,380**	**54,000**	**0.00**	**-2,169.49**	**3,000**	**0**	**0**	**0**	**0**	**13,037.07**	**2,33,001**	**8.36**	**8.44**
Monthly Average	2,300	2,322	3.03	0.99	13.08	13.20	12,698	4,500	0.00	-180.79	250.00	0	0	0	0	1,086.42	19,417	8.36	8.44
Daily Average	77	77	3.03	0.99	13.08	13.20	423	150	0.00	-6.03	8.33	0	0	0	0	36.21	647	8.36	8.44

Observation:

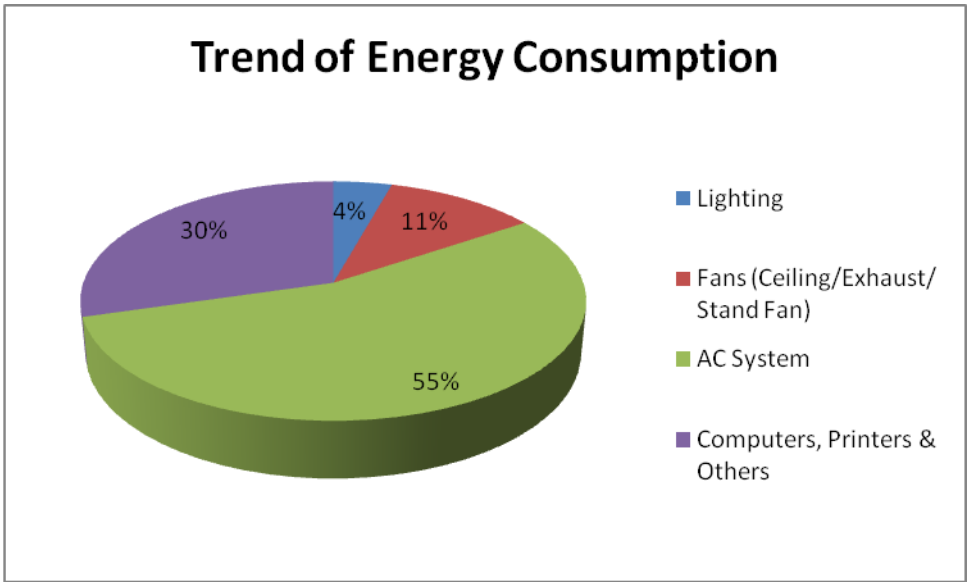
We have received the Energy Bill for the Month March 2023 to Feb 2024 and based on the above energy bill analysis, the monthly energy consumption is found to be about 2300 kWh and monthly current bill is found to be about Rs. 19416.

3.1. CONNECTED LOAD DETAILS & CORRESPONDING KW CONSUMPTION

From the inventory survey, it is estimated that there is a connected load of about **67.28** KW in Hindol College. It may be seen that the lighting load constitutes about 4.4% of the total load, and air conditioning loads share about 14.7% of the total connected load. The following table indicates the estimated connected load details (KW).

Load Centre	KW
Lighting	2.92
Fans (Ceiling/Exhaust/ Stand Fan)	7.58
AC System	36.93
Computers, Printers & Others	19.86
TOTAL	**67.28**

Connected load details & corresponding KW consumption



4.0. DATA ANALYSIS

Promotion of Green Campus: A greenery college campus is essential for the all-round growth and development of student's life. The college is surrounded by scenic, serene and sublime ambience. In addition to this, the college campus has a colorful environment that has created several green spaces. Been undertaken for the promotion of green campus in the college.

GOOGLE EARTH VIEW

PLANTATION IN COLLEGE CAMPUS

TRAINING ON GREEN AUDIT

MEMBERS OF GREEN AUDIT COMMITEE

BAUHINIA PURPUREA

FICUS BENGHALENSIS

DELONIX REGIA

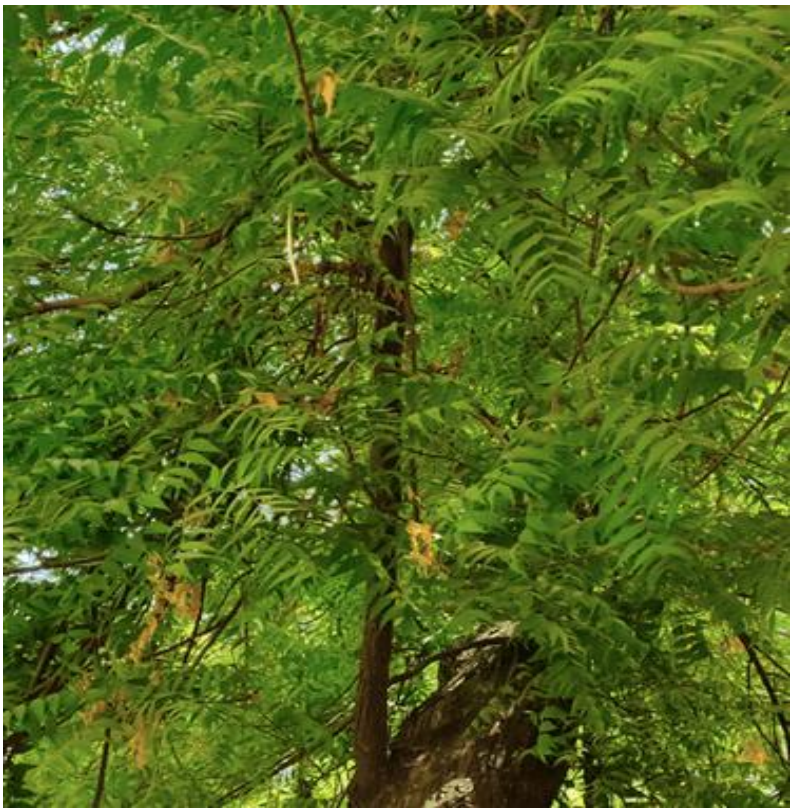
HYBANTHUS ENNEASPERMUS

CTHARANTSUS ROSEUS

SYZYGIUM JAMBOLANA

EPIPREMNUM AUREUM

OSCIMUM BACILLIUN



AZADIRACHTA INDICA

5.0. FLORA DIVERSITY IN THE COLLEGE PREMISES

Trees are planted with the objective of declining atmospheric carbon dioxide. The green floral diversity of the college campus effectively maintains the soil. Offers habitat for both diurnal as well as nocturnal animals provides cover for invertebrates and protects students from summer heat waves. Ornamental trees are planted to maintain aesthetic qualities. The following are different floral species at college campus:

List of Flora Diversity			
Sl. No.	**List of Saplings**	**Scientific Name**	**Nos.**
1	Neem	Azadirachta indicia	30
2	Jammu	Syzygium jumbos	30
3	Karanja	Pongamia pinnata	30
4	Baula	Bauhinia purpurea	20
5	Alan	Terminalia alata	20
6	Harida	Terminalia chebula	20
7	Krushnachuda	Erythrina variegata	30
8	Bahada	Ailanthus triphysa	20
9	Kadamba	Neolamarckia cadamba	5
10	Pestabadam	Prunus persica	10
11	Boula	Bauhinia racemosa	10
12	Anla	Phyllanthus emblica	10
13	Harida	Terminalia chebula	5
14	Bahada	Ailanthus triphysa	5
15	Neem	Azadirachta indica	5
16	Dabadaru	Adina cordifolia	10
17	Jamu	Syzygium cumini	10
18	Krushnachuda	Erythrina variegata	10
19	Radhachuda	Erythrina suberosa	10
20	Mango	Mangifera indica	10

6.0. ESTABLISHMENT OF SOLAR POWER PROJECT IN HINDOL COLLEGE

Concept of Net Metering:

Net metering is the concept which records net energy between export of generated energy and import of TPCODL energy for a billing month. Alternatively, the meter, having the feature of recording both the import and export values, also are generally allowed for arriving net energy for the billing period.

Principle of Net Metering:

Based on available roof area / ground area solar PV panels will be installed. The output of the panels (DC electricity) will be connected to the power conditioning unit / inverter which converts DC to AC. The inverter output will be connected to the control panel or distribution board of the building to utilize the power. The inverter synchronizes with grid and also with any backup power source to produce smooth power to power the loads with preference of consuming solar power first. If the solar power is more than the load requirement, the excess power is automatically fed to the grid. For larger capacity systems connection through step up transformer and switch yard will be used to feed the power to grid.

Advantages of Net Metering:

The grid connected roof top / ground mounted solar PV system would fulfill the partial / full power needs of large-scale buildings. The following are some of the benefits of roof top SPV systems:

- Generation of environmentally clean energy
- Consumer becomes generator for his own electricity requirements
- Reduction in electricity consumption from the grid
- Reduction in diesel consumption wherever DG backup is provided
- Feeding excess power to the grid

Background:

During audit it was found that there is sufficient space available for installation of solar roof top power Plant considering roof top and available ground area put together. The available area is fully un-shaded and can be utilized for solar roof top power Plant.

Recommendation:

Two options are recommended for establishing the solar project: utilizing the rooftop area or the ground area. Each choice offers distinct benefits and considerations, which should be evaluated to determine the most suitable and efficient approach for solar installation.

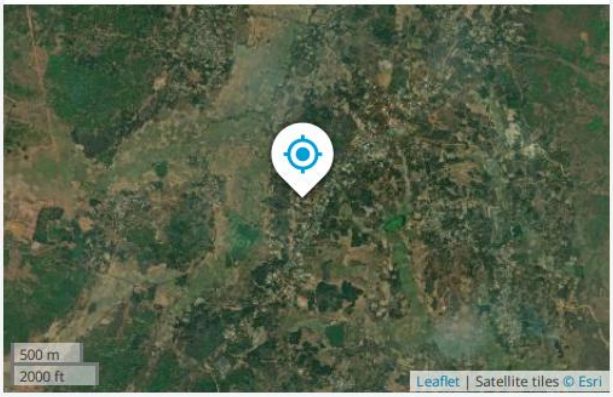
As per the solar feasibility study conducted for the three buildings of Hindol College, it was determined that approximately 106 kW of solar capacity could be installed. However, based on the contractual demand and electricity analysis, a 36.00 kWp solar system will be installed on the rooftops of the Hindol College Department Building and Blocks 1 & 2. This setup is expected to generate 59,918.40 kWh of energy annually, resulting in an annual savings of approximately Rs. 3.59 lakhs. The total investment required for the project is estimated at Rs. 25.20 lakhs, with a payback period of 7.02 years.

HARNESING SOLAR POWER
HINDOL COLLEGE
Dhenkanal
20.693389°, 085.303667°arrow_drop_down
MDR-19A, Dhenkanal, Odisha, India

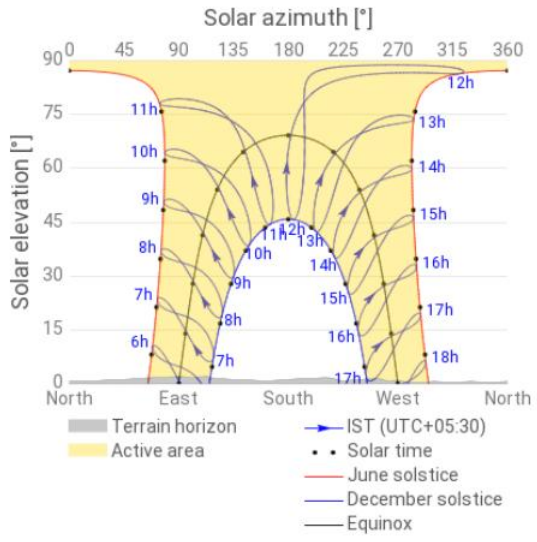
SITE INFO

Map data		Per year	
Specific photovoltaic power output	PVOUT specific	1500.5	kWh/kWp
Direct normal irradiation	DNI	1225.5	kWh/m²
Global horizontal irradiation	GHI	1799.1	kWh/m²
Diffuse horizontal irradiation	DIF	927.9	kWh/m²
Global tilted irradiation at optimum angle	GTI opta	1913.7	kWh/m²
Optimum tilt of PV modules	OPTA	23 / 180	°
Air temperature	TEMP	26.3	°C
Terrain elevation	ELE	N/A	

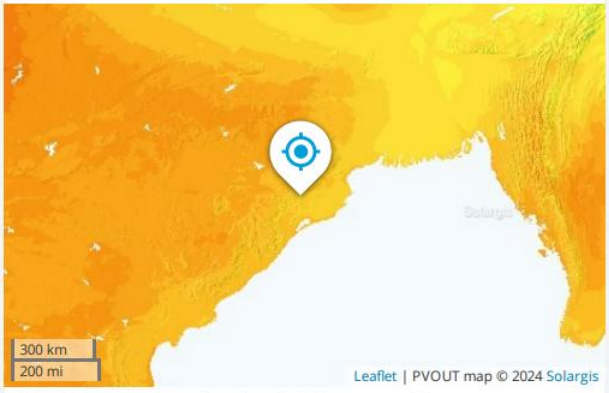
Map



Horizon and sunpath



PVOUT map



PV ELECTRICITY AND SOLAR RADIATION

Annual averages

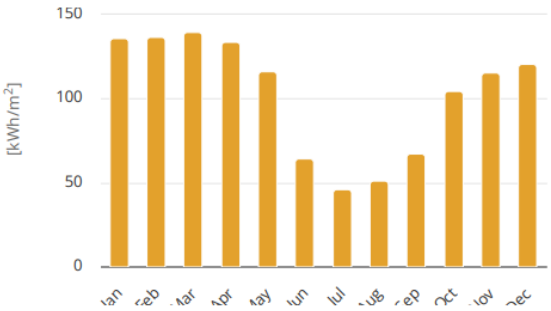
Direct normal irradiation

1233.3

kWh/m^2 per year

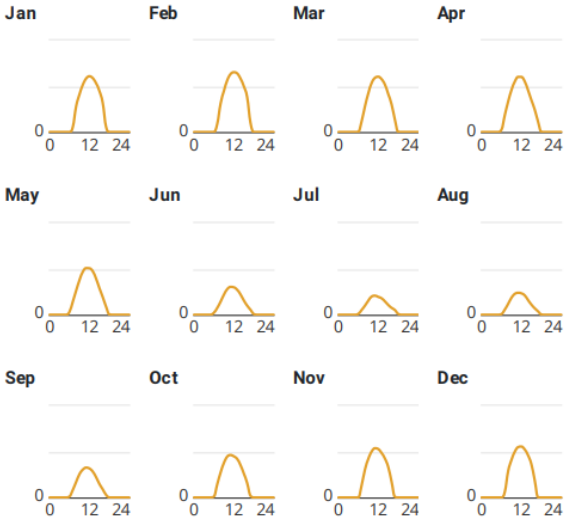
Monthly averages

Direct normal irradiation



Average hourly profiles

Direct normal irradiation [Wh/m^2]



UTC+05:30

Average hourly profiles

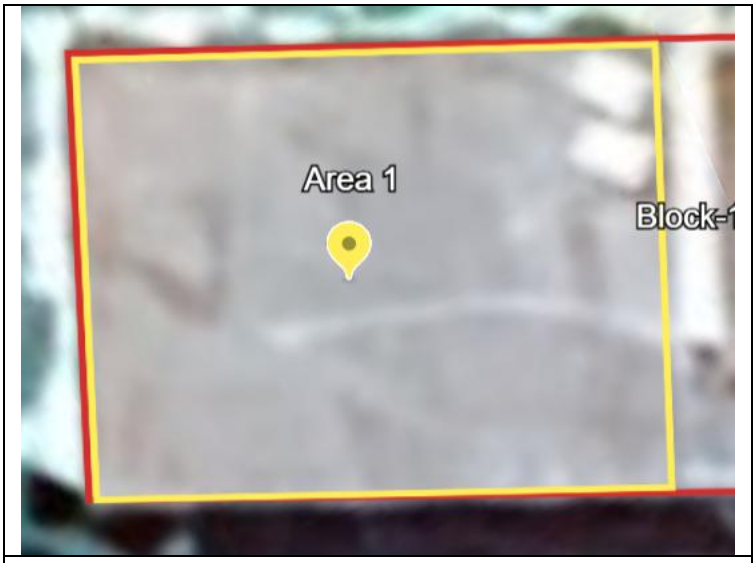
Direct normal irradiation [Wh/m^2]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0 - 1												
1 - 2												
2 - 3												
3 - 4												
4 - 5												
5 - 6												
6 - 7			3	26	33	23	10	8	11	10		
7 - 8	56	90	120	185	144	75	53	57	83	145	136	61
8 - 9	282	310	282	332	264	143	100	118	170	272	305	287
9 - 10	411	447	423	457	378	219	154	185	255	376	421	409
10 - 11	515	564	535	550	468	279	198	227	304	445	501	499
11 - 12	583	632	591	601	509	304	208	239	325	462	537	549
12 - 13	608	652	603	601	507	299	194	234	316	448	527	555
13 - 14	588	639	576	552	474	272	179	211	282	420	485	523
14 - 15	532	583	518	456	394	222	146	160	221	353	425	459
15 - 16	448	499	414	348	290	156	107	111	148	261	332	363
16 - 17	319	382	303	246	193	100	75	71	89	158	174	188
17 - 18	58	102	137	114	89	55	52	37	29	19	7	2
18 - 19			1	1	4	8	10	3				
19 - 20												
20 - 21												
21 - 22												
22 - 23												
23 - 24												
Sum	4,400	4,899	4,504	4,469	3,747	2,153	1,485	1,660	2,233	3,371	3,849	3,896

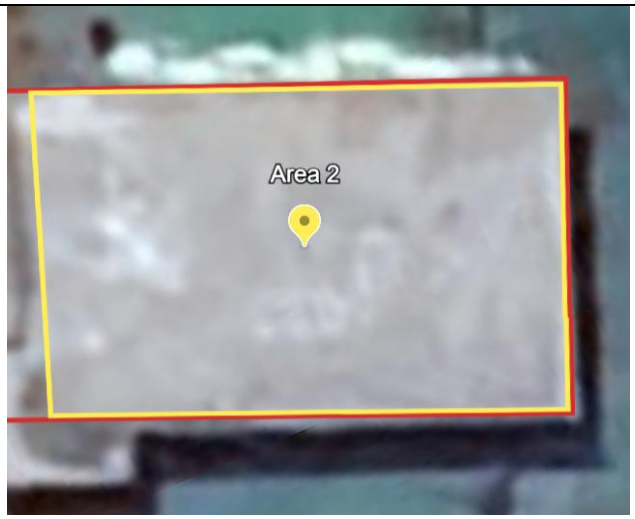
Establishment of 36 kWp Rooftop Solar Power Plant:

Establishment of Solar Power Project HINDOL COLLEGE KHAJURIAKATA FOR FINANCIAL YEAR 2023-2024		
Units Generation	**Unit**	**Net Metering**
Total Energy Consumed from TPCODL in last 12 months	kWh	27,604.20
Average Base Demand from TPSODL	kW	3.15
Connected Load/ Contract Demand as per bill	kVA	40.00
Maximum Permitted Solar Capacity	kW	**36.00**
Proposed Capacity of the Solar Power Project to be installed	kW	**21.01**
Proposed Contract to be told to consumer	kW	Not Required
Nos of SPV Modules Required 545Wp	**Nos.**	**66.06**
Final solar Capacity	**kW**	**36**
Total Area Required	Sq. Mtr	432.00
Total Area Available	Sq. Mtr	310.6
Total Project Cost Required	Rs. Lakh	**25.20**
Capacity Utilization Factor	%	19.00
Net Annual Generation (Solar)	kWh	59,918.40
Weighted Average Rate of Electricity	Rs./kWh	5.99
Annual Saving in Energy Bills due to Consumption from own solar power	Rs. Lakh	3.59
Simple Payback Period	Years	7.02

Hindol College Block-1 Building Rooftop Solar Feasibility



Block-1 Building (Area 1)

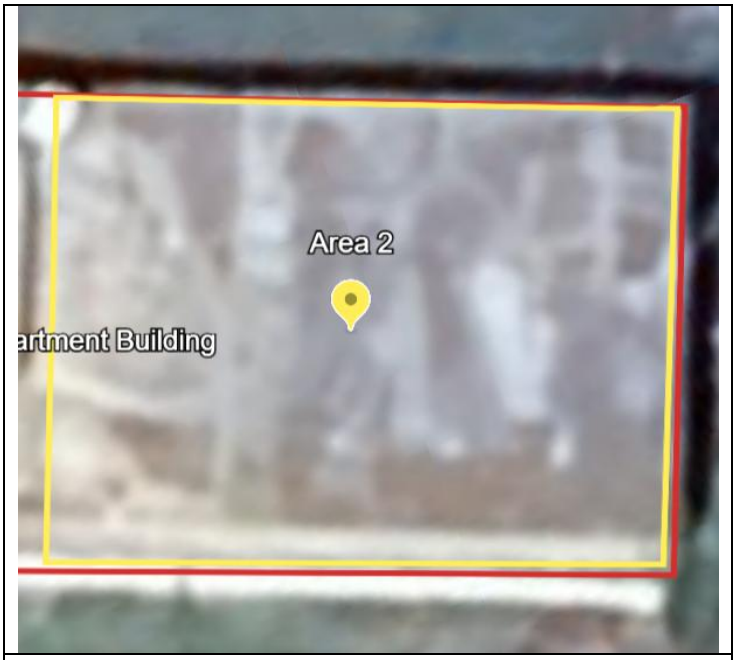


Block-1 Building (Area 2)

Hindol College Block-1 Building	
Total rooftop area	380.83 Sq Meter
Total Solar area	310.6 Sq. Meter
Total Solar Capacity	28 kWp

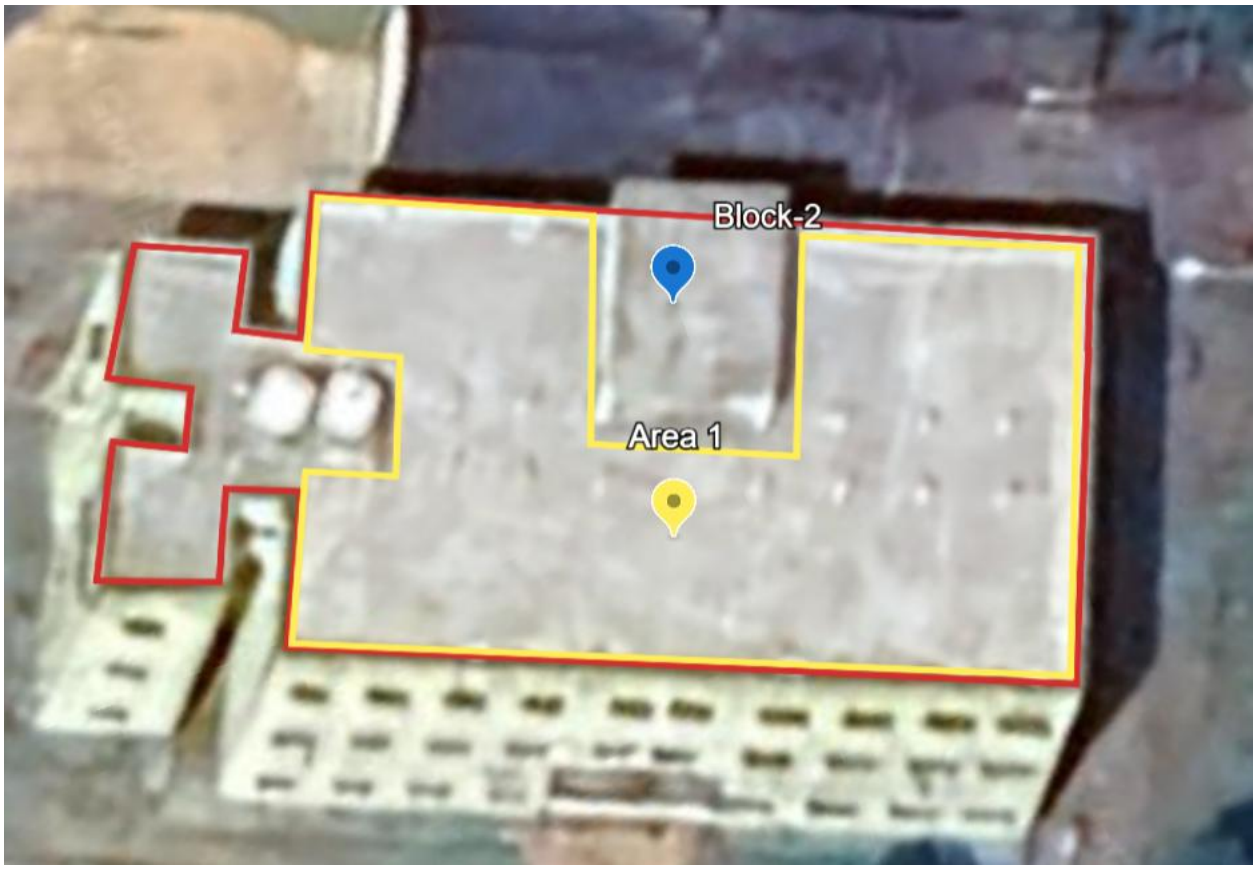
Hindol College Department Building Rooftop Solar Feasibility

Department building area-1



Department building area-1

Hindol College Department Building	
Total rooftop area	531.26 Sq Meter
Total Solar area	473.14 Sq. Meter
Total Solar Capacity	43 kWp



Hindol College Block-2 Building Rooftop Solar Feasibility

Hindol College Block-2 Building	
Total rooftop area	567.1 Sq Meter
Total Solar area	393.96 Sq. Meter
Total Solar Capacity	35 kWp

Building Name	Solar Area	Solar Capacity
Hindol College Block-1 Building	310.6 Sq. Meter	28 kWp
Hindol College Department Building	473.14 Sq. Meter	43 kWp
Hindol College Block-2 Building	393.96 Sq. Meter	35 kWp
Total Solar Capacity		**106 kWp**

STAR RATING PLAN IN ROOM AIR CONDITIONERS

New BEE Energy Efficiency Ratings (EER) for Room Air Conditioners					
STAR RATING LEVELS - Jan 1, 2014 - Dec 31, 2015					
EER (W/W)					
WINDOW AC			SPLIT AC		
Star Rating	Minimum	Maximum	Star Rating	Minimum	Maximum
1 Star ★	2.50	2.69	1 Star ★	2.70	2.89
2 Star ★★	2.70	2.89	2 Star ★★	2.90	3.09
3 Star ★★★	2.90	3.09	3 Star ★★★	3.10	3.29
4 Star ★★★★	3.10	3.29	4 Star ★★★★	3.30	3.49
5 Star ★★★★★	3.30	-	5 Star ★★★★★	3.50	-

STAR RATING PLAN IN DISTRIBUTION TRANSFORMERS

Rating	1 Star		2 Star		3 Star		4 Star		5 Star	
kVA	Max Losses at 50% (Watts)	Max Losses at 100% (Watts)	Max Losses at 50% (Watts)	Max Losses at 100% (Watts)	Max Losses at 50% (Watts)	Max Losses at 100% (Watts)	Max Losses at 50% (Watts)	Max Losses at 100% (Watts)	Max Losses at 50% (Watts)	Max Losses at 100% (Watts)
16	200	555	165	520	150	480	135	440	120	400
25	290	785	235	740	210	695	190	635	175	595
63	490	1415	430	1335	380	1250	340	1140	300	1050
100	700	2020	610	1910	520	1800	475	1650	435	1500
160	1000	2800	880	2550	770	2200	670	1950	570	1700
200	1130	3300	1010	3000	890	2700	780	2300	670	2100

STAR RATING PLAN IN PUMP SETS

Star Rating	Overall Efficiency of the Pump Set*
1 Star	>=1.00 & <1.05
2 Star	>=1.05 & <1.10
3 Star	>=1.10 & <1.15
4 Star	>=1.15 & <1.20
5 Star	>=1.20

7.0. WASTE WATER

Sewage treatment is a multi-stage process designed to treat sewage and protect natural water bodies. Municipal sewage contains various wastes. If improperly collected and improperly treated, this sewage and its related solids could hurt human health and the environment. A treatment plant's primary objectives are to clean the sewage and meet the plant's discharge standards The treatment plant personnel do this by reducing the concentrations of solids, organic matter, nutrients, pathogens and other pollutants in sewage. The plant must also help protect the receiving water body, which can only absorb a certain level of pollutants before it begins to degrade, as well as the human health and environment of its employees and neighbors. One of the challenges of sewage treatment is that the volume and physical, chemical, a limited quantity of pollutants and biological characteristics of sewage continually change. Some changes are the temporary results of seasonal, monthly, weekly or daily fluctuations in the sewage volume and composition. Other changes are long-term, being the results of alterations in local populations, social characteristics, economies, and industrial production or technology. The quality of the receiving water and the public health and well-being may depend on a treatment plant operator's ability to recognize and respond to potential problems. These responsibilities demand a thorough knowledge of existing treatment facilities and sewage treatment technology.

Sewage is 99 % water carrying domestic wastes originating in kitchen, bathing, laundry, urine and night soil. A portion of these goes into solution. The remaining goes into colloidal or suspended stages. It also contains salts used in cooking, sweat, bathing, laundry and urine. It also contains waterborne pathogenic organisms from the night soil of already infected persons. The concentrations are mentioned in Table:

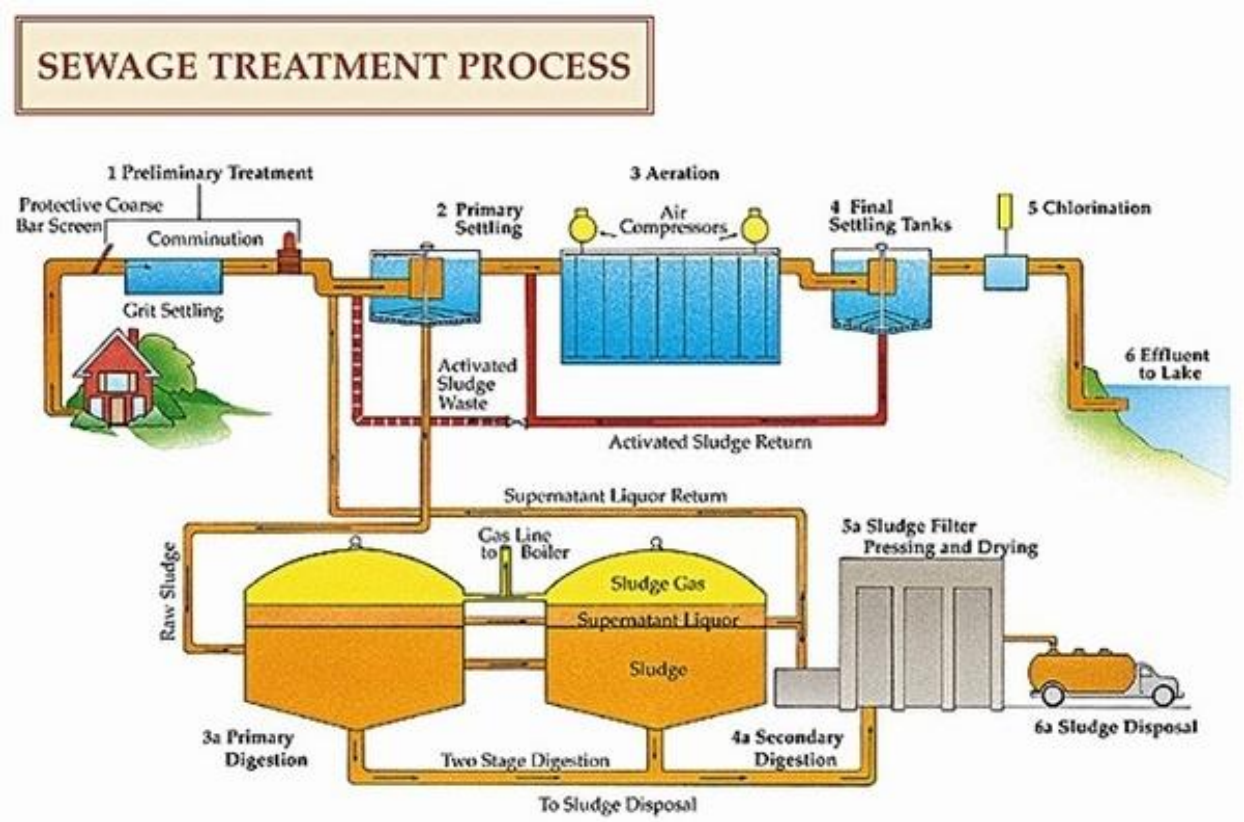
Contribution of human wastes in grams per capita per day

	Parameters				Range
1	Biochemical oxygen demand, BOD				45-54
2	Chemical oxygen demand, COD				1.6-1.9 times BOD
3	Total organic carbon, TOC				0.6-1.0 times BOD
4	Total solids, TS				170-220
5	Suspended solids, SS				70-145
6	Grit (inorganic,0.2 mm and above)				5-15
7	Grease				10-30
8	Alkalinity as calcium carbonate ($CaCO_3$)				20-30
9	Chlorides				4-8
10	Total nitrogen N				6-12
11	Organic nitrogen				~0.4 total N
12	Free ammonia				~0.6 total N
13	Nitrate				~0.0-0.5 total N
14	Total phosphorus				~0.6-4.5
15	Organic phosphorus				~0.3 total P
16	Inorganic(ortho- and poly-phosphates)				~0.7 total P
17	Potassium(as potassium oxide K_2O)				2.0-6.0
Microorganisms in 100 ml of sewage					
18	Total bacteria	10^9-10^{10}	22	Protozoan cysts	Up to 10^3
19	Coliforms	10^9-10^{10}	23	Helminthic eggs	Up to 10^3
20	Faecal streptococci	10^5-10^6	24	Virus (plaque forming units)	10^2-10^4
21	Salmonella Typhosa	10^1-10^4			

Source: Arceivala 2000

- The wastewater from toilets is usually referred to as black water and the rest of the wastewater from all other activities is referred to as grey water.
- Thus, the BOD of raw sewage has to be foreseen realistically because this dictates the cost of the STP almost pro-rata.
- The difference between total solids and suspended solids is the dissolved solids. When calculating its concentration, the dissolved solids in the freshwater used by the ULB must be added to arrive at the values in raw sewage.
- The raw sewage pH generally ranges between 6.8 to 8.0 depending on raw water quality.
- The major nitrogen compound in domestic waste is urea CO (NH2)2, which is readily hydrolyzed to ammonia (NH3) and carbon dioxide (CO2) by the enzyme unease present in sewage. Hence, NH3 constitutes the major fraction of total nitrogen in domestic sewage.
- When the treated sewage is discharged into the rivers, the ratio of the respective flows decides the concentration of these parameters in the blended river water.

7.1. SEWAGE WATER TREATMENT



From the above picture we can see that a huge amount of waste water is generating on per day basis so it is recommended to install a wastewater treatment plant inside the campus.

Steps of Waste Water Treatment Process:

a) Bar Screening

Wastewater entering the treatment plant includes items like wood, rocks, and even dead animals. Unless they are removed, they could cause problems later in the treatment process. Most of these materials are sent to a landfill.

b) Pumping

The wastewater system relies on the force of gravity to move sewage from your home to the treatment plant. So wastewater-treatment plants are located on low ground, often near a river into which treated water can be released. If the plant is built above the ground level, the wastewater has to be pumped up to the aeration tanks (item 3). From here on, gravity takes over to move the wastewater through the treatment process.

c) Aerating

One of the first steps that a water treatment facility can do is to just shake up the sewage and expose it to air. This causes some of the dissolved gases (such as hydrogen sulphide, which smells like rotten eggs) that taste and smell bad to be released from the water. Wastewater enters a series of long, parallel concrete tanks. Each tank is divided into two sections. In the first section, air is pumped through the water. As organic matter decays, it uses up oxygen. Aeration replenishes the oxygen. Bubbling oxygen through the water also keeps the organic material suspended while it forces 'grit' (coffee grounds, sand and other small, dense particles) to settle out. Grit is pumped out of the tanks and taken to landfills.

d) Removing sludge

Wastewater then enters the second section or sedimentation tanks. Here, the sludge (the organic portion of the sewage) settles out of the wastewater and is pumped out of the tanks. Some of the water is removed in a step called thickening and then the sludge is processed in large tanks called digesters.

e) Removing scum

As sludge is settling to the bottom of the sedimentation tanks, lighter materials are floating to the surface. This 'scum' includes grease, oils, plastics, and soap. Slow-moving rakes skim the scum off the surface of the wastewater. Scum is thickened and pumped to the digesters along with the sludge. Many cities also use filtration in sewage treatment. After the solids are removed, the liquid sewage is filtered through a substance, usually sand, by the action of gravity. This method gets rid of almost all bacteria, reduces turbidity and color, removes odors, reduces the amount of iron, and removes most other solid particles that remained in the water. Water is sometimes filtered through carbon particles, which removes organic particles. This method is used in some homes, too.

f) Killing bacteria

Finally, the wastewater flows into a 'chlorine contact' tank, where the chemical chlorine is added to kill bacteria, which could pose a health risk, just as is done in swimming pools. The chlorine is mostly eliminated as the bacteria are destroyed, but sometimes it must be neutralized by adding other chemicals. This protects fish and other marine organisms, which can be harmed by the smallest amounts of chlorine.

g) Wastewater Residuals

Another part of treating wastewater is dealing with the solid-waste material. These solids are kept for 20 to 30 days in large, heated and enclosed tanks called 'digesters.' Here, bacteria break down (digest) the material, reducing its volume, odors, and getting rid of organisms that can cause disease. The finished product is mainly sent to landfills, but sometimes can be used as fertilizer.

8.0. RAINWATER HARVESTING

Rainwater harvesting is collecting the run-off from a structure or other impervious surface in order to store it for later use. The rain will collect in gutters that channel the water into downspouts and then into some sort of storage vessel. Rainwater collection systems can be as simple as collecting rain in a rain barrel or as elaborate as harvesting rainwater into large cisterns to supply your entire household demand.

8.1. TYPES OF HARVESTING RAINWATER

- Surface runoff harvesting
- Rooftop rainwater harvesting

8.2. BENEFITS OF RAINWATER COLLECTION

- Rainwater is a relatively clean and absolutely free source of water
- You have total control over your water supply
- It is socially acceptable and environmentally responsible
- It promotes self-sufficiency and helps conserve water Rainwater is better for landscape plants and gardens because it is not chlorinated
- It reduces storm water runoff from college buildings.
- It uses simple technologies that are inexpensive and easy to maintain
- It can be used as a main source of water or as a backup source to wells water
- The system can be easily retrofitted to an existing structure or built during new home construction System are very flexible and can be modular in nature, allowing expansion, reconfiguration, or relocation, if necessary
- It can provide an excellent back-up source of water for emergencies.

8.3. USES OF COLLECTED RAINWATER

There are basically three areas where rainwater can be used:

- Irrigation use Indoor
- Non-potable use
- Whole house, potable use

These are some ideas for specific uses of rainwater:

- Hand water your lawn and garden
- Connect rainwater collection system to irrigation/sprinkler system
- Washing of vehicles
- Refill of fountains and fish ponds

- Replace the use of tap water with rainwater to wash driveways and sidewalks
- Use it for all indoor non-potable fixtures (flushes, toilets and clothes washer)
- Use it for all potable needs when properly filtered and disinfected

Qualitative Advantage

A compelling advantage of rain water over other water sources is that it is one of the purest sources of water available. Indeed, the quality of rain water is an overriding incentive for people to choose rain water as their primary water source, or for specific uses such as watering houseplants and gardens. Rain water quality almost always exceeds that of ground or surface water as it does not come into contact with soil and rocks where it dissolves salts and minerals and it is not exposed to many of the pollutants that often are discharged into surface waters such as rivers, and which can contaminate groundwater. However, rain water quality can be influenced by characteristics of the area where it falls, since localized industrial emissions affect its purity. Thus, rain water falling in non-industrialized areas can be superior to that in cities dominated by heavy industry or in agricultural regions where crop dusting is prevalent.

8.4. METHODS OF HARVESTING RAIN WATER

There are three methods of harvesting rain water as given below:

- Storing rainwater for direct use
- Recharging ground water aquifers, from rooftop run off
- Recharging ground water aquifers with runoff from ground area

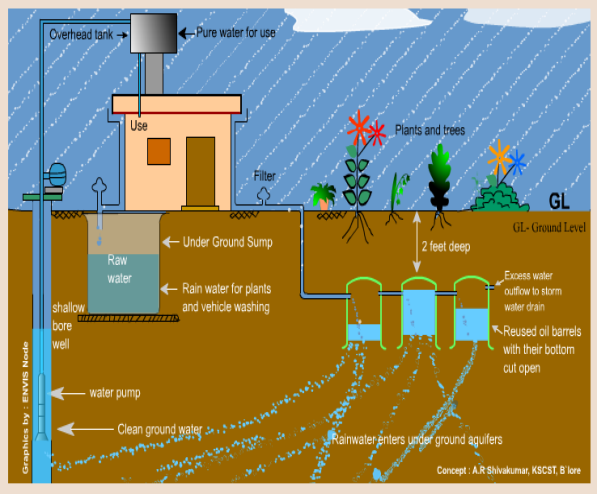


Figure 5: Ground Water Recharging from Rooftop Runoff

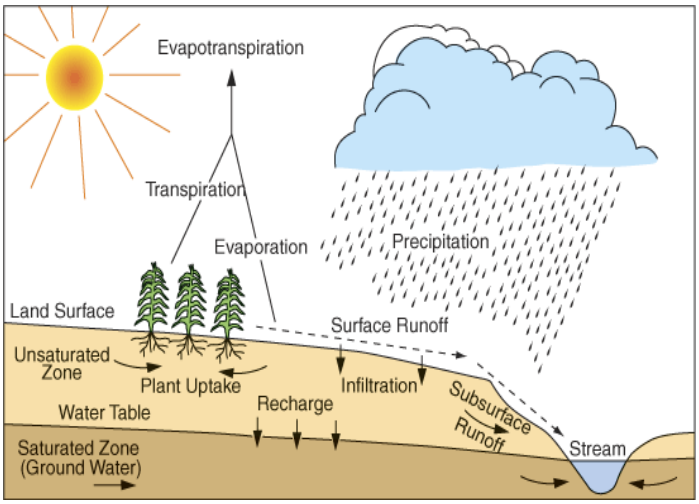


Figure 6: Ground Water Recharging with Runoff from ground Area

Components of rainwater harvesting

The rain water harvesting system consists of following basic components

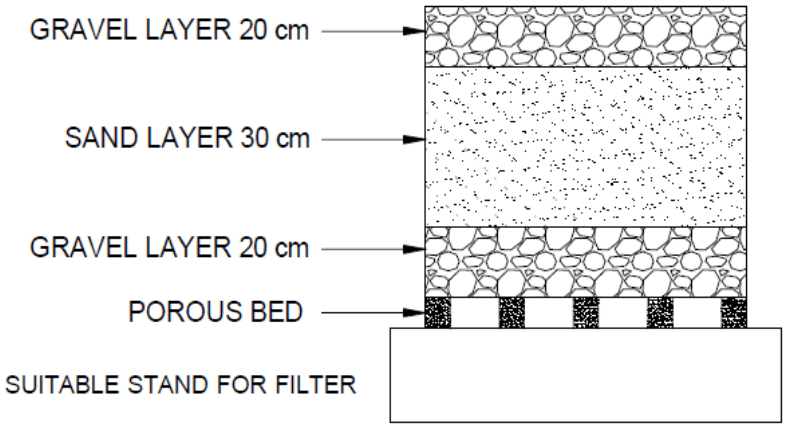
- Catchment area
- Coarse mesh / leaf screen
- Gutter
- Downspout or conduit
- First flushing device
- Filter
- Storage tank
- Recharge structure

Filter

If the collected water from roof top is to be used for human consumption directly, a filter unit is required to be diversion valve to recharge/ storage to drain installed in RWH system before storage tank. The filter is used to remove suspended pollutants from rain water collected over the roof. The filter unit is basically a chamber filled with filtering media such as fibber, coarse sand and gravel layers to remove debris and dirt from water before it enters the storage tank. The filter unit should be placed after the first flush device but before the storage tank. There are various types of filters which have been developed all over the country. The type and selection of filters is governed by the final use of harvested rainwater and economy. Depending upon the filtering media used and its arrangements, various types of filters available are described below.

Sand filter

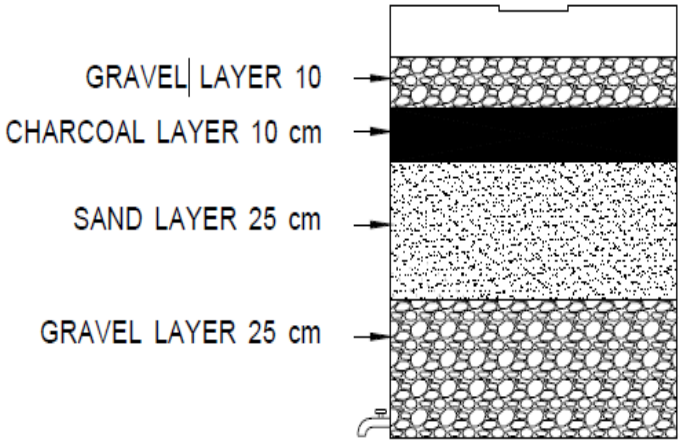
In the sand filters, the main filtering media is commonly available sand sandwiched between two layers of gravels. The filter can be constructed in a galvanized iron or Ferro cement tank. This is a simple type of filter which is easy to construct and maintain. The sand fillers are very effective in removing turbidity, colour and microorganism. In a simple sand filter that can be constructed domestically, filter media are placed as shown in Fig



Sand Filter

Charcoal water filter

This is almost similar to sand filters except that a 10-15 cm thick charcoal layer is placed above the sand layer. Charcoal layers inside the filter result in better filtration and purification of water. The commonly used charcoal water filter is shown in Fig.



Charcoal Filter

Storage tank

Whenever the rain water collected from the rooftop is used directly for various purposes, a storage tank is required. The storage tank can be cylindrical, rectangular or square in shape. The material of construction can be RCC, fibrocement, masonry, PVC or metal sheets. Depending upon the availability of space, the storage tank can be above ground, partially underground or fully underground.

The design of storage tank is dependent on many factors which are listed below:

- Number of persons in the building – The greater the number of persons, more will be the requirement of water.
- Per capita requirement – varies from household to household, based on standard of living. The requirement also varies with season. In summer the requirement is more in comparison to winter. Similarly, the per capita requirement is more in urban areas in comparison to rural areas.
- Average annual rainfall
- Rainfall pattern – It has a significant impact on the capacity of storage tanks. If the rainfall is uniformly spread

- Throughout the year, the requirement of storage capacity will be less. But if the rainfall is concentrated to a limited period in a year, the storage tanks of higher capacity will be required.
- Type and size of catchment – Depending upon the type of roofing material, the runoff coefficient varies which affect the effective yield from a catchment area. The size of the catchment also has a bearing on tank size. The more the catchment area, the larger the size of the storage tank.

The design of the storage tank can be done using following three approaches:

- Matching the capacity of the tank to the area of the roof.
- Matching the capacity of the tank to the quantity of water required by its users
- Choosing a tank size that is appropriate in terms of costs, resources and construction methods.

9.0. GREEN AUDIT ACTION PLAN FOR HINDOL COLLEGE

The Green Audit Action Plan for Hindol College aims to address the key findings and recommendations from the Green Audit, focusing on enhancing sustainability practices, reducing environmental impact, and promoting resource efficiency. The action plan is divided into specific areas of focus with detailed actions and timelines.

- **Energy Conservation**
  - Install energy-efficient lighting (LEDs) across all campus buildings.
  - Upgrade HVAC systems to energy-efficient models and incorporate smart controls.
  - Explore the feasibility of solar power installation for renewable energy generation.
  - Conduct periodic energy audits to monitor and optimize energy usage.
  - Implement energy-saving practices such as turning off unused lights and equipment.

- **Water Conservation**
  - Install water-efficient fixtures (low-flow taps, showers, and toilets) in campus buildings.
  - Set up a rainwater harvesting system to collect and store rainwater for irrigation.
  - Regularly monitor water usage and implement a water conservation awareness campaign among students and staff.
  - Fix any water leaks promptly and ensure proper maintenance of plumbing systems.

- **Waste Management**
  - Implement a comprehensive waste segregation system (biodegradable, recyclable, and non-recyclable waste).
  - Set up composting units for organic waste on campus.
  - Reduce paper usage by promoting digital communication and documentation.
  - Collaborate with local recycling centers to ensure proper disposal and recycling of waste.
  - Conduct regular waste audits to track and minimize waste generation.

- **Carbon Footprint Reduction**
  - Promote the use of electric or hybrid vehicles for campus transportation and encourage carpooling among staff and students.
  - Implement energy-efficient practices in all campus activities to reduce overall emissions.
  - Organize awareness programs to educate the campus community on reducing personal carbon footprints.
  - Monitor and track carbon emissions from all sources and set reduction targets.

- **Sustainable Building Practices**
  - Retrofit existing buildings with energy-efficient materials (insulation, double-glazed windows).
  - Use sustainable construction materials in any new infrastructure projects.
  - Implement green roofs or vertical gardens to improve insulation and air quality.
  - Optimize natural lighting in classrooms and common areas.

- **Biodiversity and Green Spaces Enhancement**
  - Plant native tree species and create green spaces that promote biodiversity.
  - Develop a campus garden for growing native plants and vegetables.
  - Reduce the use of chemical fertilizers and pesticides on campus lawns and gardens.
  - Set up a "green club" to involve students in the care and development of green spaces.

- **Stakeholder Engagement and Awareness**
  - Conduct regular workshops, seminars, and awareness campaigns on sustainability practices for students and staff.
  - Create a sustainability task force comprising faculty, staff, and students to oversee the implementation of green initiatives.
  - Develop a campus-wide communication strategy to keep all stakeholders informed about green initiatives and progress.
  - Encourage sustainable behavior through rewards, competitions, and incentives.

- **Compliance and Reporting**
  - Ensure compliance with local, regional, and national environmental regulations related to waste disposal, water usage, and energy consumption.
  - Prepare and submit an annual sustainability report detailing the college's environmental performance and improvements.
  - Regularly update environmental policies and procedures to align with changing regulations.

- **Monitoring and Continuous Improvement**
  - Establish an environmental monitoring system to track energy, water, and waste metrics.
  - Set up a feedback mechanism to gather input from students, staff, and faculty on sustainability practices.
  - Regularly review and update the Green Audit Action Plan to reflect new opportunities and challenges.
  - Organize periodic internal audits to assess the progress and impact of implemented initiatives.

10.0. CONCLUSION

The Green Audit of Hindol College has provided valuable insights into the institution's environmental practices and performance. The audit highlighted several strengths, including effective waste management practices and energy-saving measures already in place. However, it also identified key areas where improvements can be made, particularly in energy conservation, water usage, and enhancing sustainable building practices.

The recommendations outlined in this report offer a clear path toward minimizing the college's environmental impact and improving sustainability. By implementing energy-efficient systems, adopting water-saving measures, enhancing waste segregation and recycling efforts, and promoting environmental awareness among students and staff, Hindol College can significantly reduce its ecological footprint.

The college's commitment to sustainability, combined with the practical steps suggested in this action plan, will not only benefit the environment but also lead to cost savings and improve the institution's reputation as a responsible and forward-thinking educational establishment.

In conclusion, the Green Audit has provided a solid foundation for Hindol College to build upon, ensuring that it continues to evolve as a sustainable, eco-friendly institution, dedicated to fostering a culture of environmental stewardship for generations to come.

11.0. RECOMMENDATIONS

A green audit of this academic institution reveals, ways by which institute can reduce energy consumption, water use and reduction in emission of carbon dioxide in the environment. In this regard the institute tries to create awareness among students for self-motivation towards eco-friendly habits. By assessing our life style, action and assess its impact on the environment. Traditionally, we are good and efficient users of natural resources. But over the period of time excess use of resources, energy, water, chemicals are become habitual for everyone especially, in common areas. Now, it is necessary to check whether our activities are consuming more than required resources? Whether we are handling waste carefully? Green audit regulates all such practices and gives an efficient way of natural resource utilization. Some significant recommendations are laid down for Eco friendly habits in the campus are:

- Setup of a E-waste management system
- A rain water harvesting system to be setup
- Setup of a vermicompost unit
- Strict follow-up of 3R principle
- Statutory warnings for misutilization of resources
- Setup of water meter
- Installation of solar panels