
# GREEN AUDIT
# REPORT 2021-22
## of

## VIJAYGARH JYOTISH RAY COLLEGE

## Members of the Green Audit Committee of Vijaygarh Jyotish Ray College

1. Dr. Rajyasri Neogy Principal
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3. Dr. Shilajit Barua Dept. of Microbiology
4. Soma Majumder Dept. of Physiology
5. Dr. Pinaki Ranjan Chakraborty Dept. of Zoology
6. Dr. Dasarath Mal Dept. of Chemistry
7. Dr. Arnab Banerjee Dept. of Journalism & Mass Communication

## Members of the Green Audit Team of Nandi Resources Generation Technology Pvt. Ltd.

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## Green Energy Audit key steps:

- Planning completed 3rd August, 2022
- Field work completed 8th August, 2022
- Draft report completed and sent for management response 13th August, 2022
- Management response received 24th August, 2022
- Final report completed 29th August, 2022
- Report presented to the Management 30th August, 2022

## Certificate by Energy Auditor

This is to certify that Green Audit of Vijaygarh Jyotish Ray College in Kolkata, West Bengal for the period 2021-22 was assigned to us. During this period following activities have been audited by us:

- Electrical Distribution System
- Lighting System
- Heating, Ventilation, and Air Conditioning System
- Water Pumping System
- Motor Load Survey
- Rain Water Harvesting
- Potential of harnessing Renewable Energy sources
- Wastes Recycling
- E-wastes Management

Nandi Resources Generation Technology Pvt. Ltd.
Paritosh Nandi
Director

Dr. Paritosh Nandi
Director

## Certificate by Principal

Our Green Audit Committee along with Certified Energy Auditor from Nandi Resources Generation Technology Pvt. Ltd. appointed by us has done a commendable work in framing out a green policy in our college. We strive to comply with Energy Conservation Act 2001 and other relevant standards, such as ISO 14001, Green Audit Framework etc.

I hereby accept all the recommendations and observations mentioned in the Green Audit Report and undertake to implement the same.

Rajyasri Neogy

Principal
Vijaygarh Jyotish Ray College
Kolkata-700 032

Dr. Rajyasri Neogy

**Principal**
**Vijaygarh Jyotish Ray College**
8/2, Bejoygarh, Jadavpur
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# PRELUDE

Green Audit team of Vijaygarh Jyotish Ray College conducted a green audit of the college in August 2022 in consultation with Kolkata based Nandi Resources Generation Technology Private Limited. The company is promoted by Certified Energy Auditors by Ministry Power, Government of India. The objective of the Green Audit is to ensure that the carbon and water foot prints are optimised in line with the environmental sustainability as mandated by National Accreditation Council. The objectives of the audit were 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. In order to assess on the carbon footprint issue, a detailed energy audit was conducted to determine how and where energy is used and to identify methods for energy savings. There is now a universal recognition of the fact that new technologies and much greater use of some that already exist provide the most hopeful prospects for the future. The opportunities lie in the use of existing renewable energy technologies, greater efforts at energy efficiency and the dissemination of these technologies and options. Considerations of efficiency, accountability, transparency and ethics are important in both the public and private sector. However, it is arguable that they are more so in the public sector and government, as their primary purpose is to promote the public good. Public assets of the whole society, including natural and social goods, are entrusted to the state and, therefore, the need to protect them in the long term is more pressing than for businesses which have a more limited responsibility to their shareholders. Governments are responsible for the outcomes for society in general, as well as their own direct policy or organisational impacts on them. For these reasons, existing sustainability reporting frameworks for the private sector are not adequate to the needs of the public sector or national government. There are certainly lessons to be learnt, but these are not one-way. Sustainability reporting in any sector should also draw on the planning, monitoring and reporting frameworks in the private sector to understand where and how elements of sustainability are already addressed, perhaps under a different name and, hence, where the gaps may be. Measurement Sustainability planning, action and reporting have grown greatly in recent years. Environmental sustainability has received the most attention as there is growing evidence of an urgent need for change in this area. But there is also general consensus that environmental sustainability cannot be achieved except in tandem with social and economic change. The measurement of environmental sustainability in isolation, then, does not seem sufficient. Greater attention needs to be paid to understanding how other elements of sustainability could also be measured, in order to ensure they also receive action and attention. This measurement could be, but does not necessarily need to be, in financial terms.

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# 1. Introduction

In 1950 Vijaygarh Jyotish Ray College came into existence as part of a larger historical reality known as Bengal Partition. Continuous with the struggle carried on by the victims of partition elsewhere, the college sprang up with the sole effort put in by those uprooted from the erstwhile East Bengal. In order to understand the historical struggle, its philosophy and the goals that compelled the birth and the subsequent growth of the college, the background and its location may be briefly outlined.

## 1.1 About the college

Vijaygarh Jyotish Ray College is located in the Jadavpur area bordered by Saktigarh, Pallisree, Sree Colony, Golf Green and Vikramgarh. It covers an area of approximately two square miles and living within the colony today are approximately 15,000 inhabitants. The land was originally owned by the United States Army and by a private Zamindar. Although the settlement of this land by first refugees in 1946 appears to be in line with the classic pattern of Jabardakhal, there was actually much behind-the-scene negotiations with the government on the part of veteran freedom fighter Santosh kumar Dutta who had a land deed to occupy the land. There were secret instructions to the police not to disturb those squatters, but there were frequent police raids and the constant presence of plainclothes policeman. The Zamindar, however, had not given his tacit approval to the settlement, and there were constant confrontations with his hired hoodlums. Despite these bloody raids,the squatters felt that by fending off the onslaught of invaders, they had won a significant battle. In recognition of this pride, they named the colony Vijaygarh which means "Victory Fort".

Today the colony of Vijaygarh is divided into 11 wards, each with its colony committee. The committees are elected by every adult member of the community, and they are responsible for overseeing land disputes and for mobilizing refugees around political issues. Within Vijaygarh, there is one college, one hospital and maternity home, four schools, one large park and a very active bazaar, all built by the refugees themselves. In June, 1950 the first colony committee consisting of Santosh Kumar Dutta, Bhupendra Lal Nag, Prof. Samar Chowdhury and Prof.

Sukumar Chakraborty set its sight upon the military barrack as the possible site for the college. In 1950, 21 August, Eastern Command that owned the site finally agreed to hand it over to the committee for the college to be built. The college was finally founded in 1950, 2 November. The first Governing Body with Prof. Prasanta Kumar Bose at the helm included such illustrious academicians as Dr. Triguna Sen, Dhirendranath Raychowdhury, Nagendranath Pal, Sukumar Gupta, Dr. Makhanlal Raychowdhury.

The next important step for the college was to secure the approval of Calcutta University for which a sum of Rs. 25 thousand had to be deposited in Reserve Bank. Attempts were made to mobilize the required fund. A good samaritan named Uttama Sundari Devi came forward with twenty thousand rupees. The college was named after her son-in-law Jyotish Chandra Ray.

With this in view the college has progressed in the last 65 years. The three-storied building in which the college is housed has in front an open space with trees planted with a view to giving a sense of proximity to nature. Students coming from the neighbouring and far-off places find it easier to integrate into the academic space which is however free of exclusive academics. Thirteen subjects in Honours are taught at present but the emphasis in recent years has been on new and non-conventional subjects. Some very vocational and professional courses are being considered for the students. Whatever future direction the college intends to take rests on the same educational philosophy avowed some 65 years back.

Our ultimate goal is to take part in nation-building. To us building of nation means making the students realise that they are full of possibilities. We want to infuse the spirit of service and sacrifice into young minds so that they become useful instrument of the society. In line with our service to the nation the college has distinct Vision Mission in its futuristic objective.

**VISION :**

- To empower students from all section of the society through holistic education centering around academic and extra-academic engagement
- To instill moral values, discipline and broader humanistic commitment in our students
- To nurture and exchange the legacy of the college – its commitment to education and society

**MISSION :**

- To impart quality education to students from backward classes and first generation learners from economically challenged backgrounds, thereby encouraging inclusive growth
- To provide an ambiance that promotes students' moral strength and professional competence, contributing to a healthy and prosperous society.
- To optimise the available infrastructure for the sustained development of the college
- To supplement and enrich the existing curriculum by means that look beyond the established one.
- To encourage a culture of participation for all the stakeholders that finally results in a collective team spirit.

### 1.2 Objective of Green Audit

Energy Audit is aimed at obtaining a detailed idea about the various end use energy consumption activities and identifying, enumerating and evaluating the possible energy savings opportunities.The green audit practically involves use of renewable sources, conservation of the energy, rain water harvesting program, and efforts of carbon neutrality, plantation of trees, E-waste management and hazardous waste management. The target of Green Audit is to achieve savings in the electrical energy consumption to the extent of 20%. For the college this Green Audit assumes all the more significance due to the fact that its combined electricity bill was Rs. 2.81 lakh during the year 2022( January-December). The Green Audit was also aimed at giving the students a feel of the practical problems and difficulties in carrying out audit activities and the long-term benefits as well.

The objective of the Green Audit is quite holistically mentioned in the Mission statement of the college which clearly states that To nurture and exchange the legacy of the college – its commitment to education and society.

### 1.3 Green Building: A global development

Green Building is a structure that is efficient in resources throughout its life cycle which are designed to lessen down the overall impact of the built environment on the natral environment and human health. They are also known as high performance building or sustainable building. Green Building's main objective:-

- Energy Efficiency
- Structure Efficiency
- Water Efficiency
- Material Efficiency
- Waste and Reduction

Shortly a Green Building is that which uses less water, conserve natural resources, produces less water, uses eco-friendly ways, optimization of energy efficiency and by doing all these providing healthier space for living for the occupants in comparison with conventional building.

GBC or Green Building Council is an umbrella organization for all the developing, existing and growing GBCs around the world. GBC is a non-governmental, non-profit, national organization that is a part of global network recognized by the World Green Building Council. GBC's goal is to form buildings, towns and cities which are sensitive to environment, economically feasible, culturally just and socially just. Green buildings around the- at least 19 nations has established GBCs, 7 recognized as growing members and many more is in the process of development. The 19 established councils are below.

- Argentina Green Building Council
- Green Building Council of Australia
- Green Building Council Brazil
- Peru Green Building Council
- Canada Green Building Council
- Dutch Green Building Council
- Emirates Green Building Council
- France Green Building Council
- German Sustainable Building Council
- Korea Green Building Council
- Mexico Green Building Council
- New Zealand Green Building Council
- Pakistan Green Building Council
- Green Building Council of South Africa
- Sweden Green Building Council
- Taiwan Green Building Council
- Romania Green Building Council

- Indian Green Building Council
- Italy Green Building Council
- Japan Green Building Consortium
- United Kingdom Green Building Council
- U.S. Green Building Council
- Vietnam Green Building Council

### 1.4 Vijaygarh Jyotish Ray College Energy Scenario

The energy consumption on campus is mainly in the form of electricity, apart from the use of LPG as cooking fuel in the college canteen. The college campus has a cumulative connected electrical load of 108 kVA as on July 2022 and one of the meter is NET Meter for the solar system. The electricity meter details along with contract demand and connected load for the year 2022 is given in Fig.1.

| Consumer ID. | Meter No. | Connected Load (kVA) |
|---|---|---|
| 85000028895 | | 58.8 |
| 85000058188 | | 29.4 |
| 05000102171 | | 19.8 |

Fig 1: Campus Meter details with demand and connected load

- The college has one 82.5 kVA DG set for emergency usage and it consumes approximately 60 litre of diesel annually for its normal O&M activity and emergency period.

### 1.5 Specific Energy Consumption (SEC)

The Specific Energy Consumption (SEC) is defined as the energy consumption per unit of product output. The specific energy consumption considering students, faculty and staff members were calculated which forms the college SEC and was taken as reference for comparison. The SEC was calculated to be annual energy cost /person for the year 2022 in the

academic area @ Rs. 92.00 per person per annum. It is necessary to mention that the college is approximately generating 30000 unit of solar power which is being adjusted against its total consumption in the period.

### 1.6 Segmentation

This energy audit report has segmented the energy consumption patterns both by building/ offices and by end use activities (lighting, cooling and pumping etc.). The details are provided in the subsequent chapters.

## 2. Energy Audit

### 2.1 Energy Audit Methodology

The methodology adopted for this audit was

- Visual inspection and data collection
- Observations on the general condition of the facility and equipment and quantification
- Identification / verification of energy consumption and other parameters by measurements
- Detailed calculations and analyses
- Validation
- Potential energy saving opportunities
- Recommendation

#### 2.1.1 Data Collection

For suggesting any corrective measures to reduce power consumption, it is first necessary to know the power consumption pattern in detail. For this, the exhaustive data collection exercise was performed at all the departments, controller of section and other supporting entities such as library, computer lab etc.

Following steps were taken for data collection:

- The audit team went to each department, laboratories, library etc.
- Information about the general electrical appliances was collected from its manual or nameplate sticker.
- Load hour calculation was done by interview of the Head of the Departments and the very experienced staff who have been working for decade or so.
- The power consumption of appliances was measured using power analyzer when there is nothing visible from the nameplate.
- Light intensity was measured using Lux meter at the college classrooms, computer lab, library and the other departmental laboratories.
- External electrical insulation was measured with Infrared Thermometer.
- Air-conditioners and their insulation was checked with visual inspection.
- Quality of power is measured with Power Analyser.

The details of the instruments used are given in **Annexure B**

### 2.2 Primary Data Building-Wise

| Room Name or No. | Floor | Instrument Name | Nos | Rating (W) | Total Load (kW) | Uses time (hr) | kWh |
|---|---|---|---|---|---|---|---|
| Room No 120 | Gr. Floor | Tube Light | 19 | 40 | 0.76 | 3 | 2.28 |
| | | LED Tube Light | 19 | 20 | 0.38 | 3 | 1.14 |
| Chemistry Lab | | Exhaust Fan | 4 | 75 | 0.3 | 3 | 0.9 |
| | | LED Desktop | 3 | 40 | 0.12 | 3 | 0.36 |
| | | LED Light | 2 | 9 | 0.018 | 3 | 0.054 |
| | | Fridge | 3 | 100 | 0.3 | 10 | 3 |
| | | Ph Meter | 2 | 10 | 0.02 | 1.85 | 0.037 |
| | | Conductivity | 2 | 7.2 | 0.0144 | 1.11 | 0.01598 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | meter | | | | | 4 |
| | | Polarimeter | 1 | 300 | 0.3 | 0.9 | 0.27 |
| | | Spectrophotometer | 1 | 15 | 0.015 | 1 | 0.015 |
| | | Potentiometer | 2 | 1 | 0.002 | 1 | 0.002 |
| | | Digital BP Apparatus | 1 | 250 | 0.25 | 1 | 0.25 |
| | | Calorimeter | 3 | 10 | 0.03 | 1 | 0.03 |
| | | Weight Machine | 2 | 7 | 14 | 0.5 | 7 |
| | | Table Fan | 2 | 65 | 0.13 | 3 | 0.39 |
| Scholarship Room | Gr | Tube Light | 1 | 40 | 0.04 | 2.5 | 0.1 |
| | | Ceiling Fan | 2 | 60 | 0.12 | 2.5 | 0.3 |
| | | LED Tube Light | 3 | 15 | 0.045 | 2.5 | 0.1125 |
| Corridor | | Tube Light | 8 | 40 | 0.32 | 3 | 0.96 |
| | | Ceiling Fan | 2 | 60 | 0.12 | 3 | 0.36 |
| | | Water Filter | 2 | 15 | 0.03 | 3 | 0.09 |
| | | Halogen | 7 | 150 | 1.05 | 11 | 11.55 |
| | | LED Tube Light | 11 | 20 | 0.22 | 4 | 0.88 |
| Day Office | Gr | Tube Light | 7 | 40 | 0.28 | 3 | |
| | | Ceiling Fan | 6 | 60 | 0.36 | 3 | 1.08 |
| | | Air Conditioner | 1 | 1600 | 1.6 | 1 | 1.6 |
| | | LED Desktop | 5 | 40 | 0.2 | 3 | 0.6 |
| | | LED Tube Light | 6 | 20 | 0.12 | 4 | 0.48 |
| | | Table Fan | 1 | 65 | 0.065 | 1 | 0.065 |
| | | Server | 1 | 80 | 0.08 | 11 | 0.88 |
| Union Office | Gr | Tube Light | 2 | 40 | 0.08 | 3 | 0.24 |
| | | Ceiling Fan | 1 | 60 | 0.06 | 3 | 0.18 |
| | | LED Tube Light | 1 | 20 | 0.02 | 3 | 0.06 |
| Male Washroom 117 | Gr | Tube Light | 2 | 40 | 0.08 | 8 | 0.64 |
| | | Exhaust Fan | 1 | 125 | 0.125 | 8 | 1 |
| | | LED Tube Light | 1 | 20 | 0.02 | 11 | 0.22 |
| | Gr | Xerox Machine | 1 | 250 | 0.25 | 0.15 | 0.0375 |
| | | LED Desktop | 2 | 40 | 0.08 | 9 | 0.72 |
| Room No | | Ceiling Fan | 7 | 60 | 0.42 | 2 | 0.84 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 116 | | | | | | | |
| | | LED Tube Light | 1 | 20 | 0.02 | 2 | 0.04 |
| | | Laptop | 5 | 65 | 0.325 | 1 | 0.325 |
| | | LED Lamp | 1 | 10 | 0.01 | 2 | 0.02 |
| | | Printer | 1 | 45 | 0.045 | 0.15 | 0.00675 |
| | | Water Filter | 1 | 20 | 0.02 | 12 | 0.24 |
| | | | | | | | |
| | | Monitor | 1 | 40 | 0.04 | 1 | 0.04 |
| | | Microwave Oven | 1 | 1500 | 1.5 | 0.15 | 0.225 |
| | | | | | | | |
| Room No 115 | | Tube Light | 2 | 40 | 0.08 | 2.5 | 0.2 |
| | Grnd | Ceiling Fan | 3 | 60 | 0.18 | 2.5 | 0.45 |
| | | LED Tube Light | 3 | 15 | 0.045 | 2.5 | 0.1125 |
| | | Table Fan | 2 | 65 | 0.13 | 2.5 | 0.325 |
| | | | | | | | |
| Room 114 | | Tube Light | 5 | 40 | 0.2 | 5 | 1 |
| | | LED Tube Light | 2 | 20 | 0.04 | 3 | 0.12 |
| | | LED Desktop | 1 | 40 | 0.04 | 3 | 0.12 |
| | | Printer | 1 | 40 | 0.04 | 0.05 | 0.002 |
| | | | | | | | |
| Room 113 | Gr | Tube Light | 7 | 40 | 0.28 | 2.5 | 0.7 |
| | | Ceiling Fan | 5 | 60 | 0.3 | 2.5 | 0.75 |
| | | LED Tube Light | 1 | 15 | 0.015 | 2.5 | 1 |
| | | | | | | | |
| Room 105 | | Tube Light | 1 | 40 | 0.04 | 3 | 0.12 |
| | | Ceiling Fan | 5 | 60 | 0.3 | 2.5 | 0.75 |
| | | LED Tube Light | 1 | 20 | 0.02 | 3 | 1 |
| | | | | | | | |
| Room 112 | | Ceiling LED Light | 5 | 20 | 0.1 | 3 | 0.3 |
| | | Air Conditioner | 1 | 1800 | 1.8 | 0.75 | 1.35 |
| | | LED Tube Light | 6 | 20 | 0.12 | 3 | 1 |
| | | | | | | | |
| Room 111 | | Ceiling LED Light | 5 | 20 | 0.1 | 3 | 0.3 |
| | | Air Conditioner | 1 | 1800 | 1.8 | 2.75 | 4.95 |
| | | Projector | 1 | 80 | 0.08 | 3 | 0.24 |
| | | Ceiling Fan | 5 | 65 | 0.325 | 3 | 0.975 |
| | | LED Desktop | 25 | 40 | 1 | 4 | 4 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Room 110 | | Tube Light | 5 | 40 | 0.2 | 3 | 0.6 |
| | | Ceiling Fan | 5 | 60 | 0.3 | 2.5 | 0.75 |
| | | LED Tube Light | 5 | 20 | 0.1 | 3 | 1 |
| Room 109 | | Ceiling LED Light | 4 | 20 | 0.08 | 3 | 0.24 |
| | | Fridge | 4 | 125 | 0.5 | 12 | 6 |
| | | Projector | 1 | 80 | 0.08 | 3 | 0.24 |
| | | Printer | 1 | 40 | 0.04 | 0.75 | 0.03 |
| | | Tube Light | 2 | 40 | 0.08 | 3 | 0.24 |
| | | LED Tube Light | 5 | 20 | 0.1 | 3 | 0.3 |
| | | Centrifuge | 1 | 220 | 0.22 | 1 | 0.22 |
| | | Microwave Oven | 1 | 1500 | 1.5 | 0.15 | 0.225 |
| Room 108 | | Bulb | 2 | 60 | 0.12 | 2.3 | 0.276 |
| | | Tube Light | 6 | 40 | 0.24 | 3 | 0.72 |
| | | Ceiling Fan | 2 | 60 | 0.12 | 2.5 | 0.3 |
| | | LED Tube Light | 5 | 20 | 0.1 | 3 | 1 |
| | | Exhaust Fan | 2 | 100 | 0.2 | 3 | 1 |
| Room 107 | | Tube Light | 6 | 40 | 0.24 | 3 | 0.72 |
| | | Ceiling Fan | 3 | 60 | 0.18 | 2.5 | 0.45 |
| | | LED Tube Light | 2 | 20 | 0.04 | 3 | 1 |
| | | Projector | 1 | 80 | 0.08 | 3 | 1 |
| Room 104 | | Tube Light | 5 | 40 | 0.2 | 3 | 0.6 |
| | | Ceiling Fan | 6 | 60 | 0.36 | 2.5 | 0.9 |
| | | LED Tube Light | 2 | 20 | 0.04 | 3 | 0.12 |
| | | Table Fan | 1 | 65 | 0.065 | 1.3 | 0.0845 |
| | | LED Lamp | 11 | 9 | 0.099 | 2 | 0.198 |
| | | Aquarium | 1 | 4.5 | 0.0045 | 24 | 0.108 |
| | | Fridge | 1 | 125 | 0.125 | 12 | 1.5 |
| | | Centrifuge | 1 | 220 | 0.22 | 0.15 | 0.033 |
| Room No 102, 106, 103,Female Wash room and NCC Room | Ground | Tube Light | 6 | 40 | 0.24 | 3 | 0.72 |
| | | Ceiling Fan | 9 | 60 | 0.54 | 2.5 | 1.35 |
| | | LED Tube Light | 11 | 20 | 0.22 | 3 | 0.66 |
| | | Table Fan | 2 | 65 | 0.13 | 1.3 | 0.169 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | LED Lamp | 17 | 9 | 0.153 | 3 | 0.459 |
| | | Autoclave | 1 | 4.5 | 0.0045 | 24 | 0.108 |
| | | Microwave Oven | 1 | 1100 | 1.1 | 0.752 | 0.8272 |
| | | Centrifuge | 1 | 220 | 0.22 | 0.15 | 0.033 |
| VS-2 | 2nd Floor | Ceiling Fan | 5 | 60 | 0.3 | 2 | 0.6 |
| | | Table Fan | 2 | 65 | 0.13 | 2 | 0.26 |
| | | CFL Light | 24 | 18 | 0.432 | 2 | 0.864 |
| VS1 | 2nd Floor | Ceiling Fan | 4 | 60 | 0.24 | 2 | 0.48 |
| | | CFL Light | 24 | 18 | 0.432 | 2 | 0.864 |
| Physiology Lab | 2nd Floor | Table Fan | 1 | 65 | 0.065 | 0.8 | 0.052 |
| | | Ceiling Fan | 2 | 60 | 0.12 | 1 | 0.12 |
| | | CFL Light | 5 | 18 | 0.09 | 2.4 | 0.216 |
| | | Tube Light | 5 | 40 | 0.2 | 1 | 0.2 |
| | | Fridge | 1 | 125 | 0.125 | 12 | 1.5 |
| | | LED Desktop | 1 | 40 | 0.04 | 0.025 | 0.001 |
| Deptt. of Economics Corridor | 2nd Floor | Tube Light | 4 | 40 | 0.16 | 2.65 | 0.424 |
| | | LED Tube Light | 6 | 20 | 0.12 | 2.75 | 0.33 |
| | | Table Fan | 1 | 65 | 0.065 | 0.3 | 0.0195 |
| | | Water Filter | 1 | 20 | 0.02 | 2 | 0.04 |
| | | Ceiling Fan | 1 | 60 | 0.06 | 3 | 0.18 |
| | | Server | 1 | 80 | 0.08 | 4 | 0.32 |
| Room 316 Virtual Calss Room | 2nd Floor | CFL Light | 18 | 20 | 0.36 | 2.75 | 0.99 |
| | | Table Fan | 2 | 65 | 0.13 | 3 | 0.39 |
| | | Air Conditioner | 2 | 1800 | 3.6 | 0.1 | 0.36 |
| | | Projector | 1 | 80 | 0.08 | 3 | 0.24 |
| | | Mic and Speaker | 1 | 55 | 0.055 | 2.45 | 0.13475 |
| | | Server | 1 | 80 | 0.08 | 3 | 0.24 |
| Room 315 | 2nd | LED Tube Light | 2 | 20 | 0.04 | 3 | 0.12 |
| | | LED Desktop | 1 | 40 | 0.04 | 0.08 | 0.0032 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Air Conditioner | 1 | 1600 | 1.6 | 0.08 | 0.128 |
| | | Ceiling Fan | 1 | 60 | 0.06 | 3 | 0.18 |
| | | Monitor | 1 | 85 | 0.085 | 4 | 0.34 |
| | | Tube Light | 1 | 40 | 0.04 | 3 | 0.12 |
| Room 314 | 2nd | LED Tube Light | 1 | 20 | 0.02 | 1.1 | 0.022 |
| | | LED Bulb | 2 | 9 | 0.018 | 1.1 | 0.0198 |
| | | CFL Light | 4 | 20 | 0.08 | 1.1 | 0.088 |
| | | Ceiling Fan | 2 | 60 | 0.12 | 2 | 0.24 |
| | | Tube Light | 4 | 40 | 0.16 | 1.1 | 0.176 |
| | | LED Desktop | 4 | 40 | 0.16 | 0.1 | 0.016 |
| | | Air Conditioner | 2 | 1600 | 3.2 | 0.1 | 0.32 |
| | | Xerox Machine | 1 | 250 | 0.25 | 0.08 | 0.02 |
| | | Projector | 1 | 80 | 0.08 | 3 | 0.24 |
| | | Mic and Speaker | 1 | 55 | 0.055 | 2.45 | 0.13475 |
| | | Server | 1 | 80 | 0.08 | 3 | 0.24 |
| Room 309 | 2nd Floor | Ceiling Fan | 5 | 60 | 0.3 | 3 | 0.9 |
| | | Tube Light | 3 | 40 | 0.12 | 3 | 0.36 |
| | | LED Tube Light | 3 | 20 | 0.06 | 3 | 0.18 |
| Room 308 | 2nd Floor | | | | | | |
| | | Ceiling Fan | 5 | 60 | 0.3 | 3 | 0.9 |
| | | Tube Light | 4 | 40 | 0.16 | 3 | 0.48 |
| | | LED Tube Light | 1 | 20 | 0.02 | 3 | 0.06 |
| Room 307 | 2nd Floor | Ceiling Fan | 12 | 60 | 0.72 | 2 | 1.44 |
| | | Tube Light | 13 | 40 | 0.52 | 2 | 1.04 |
| | | LED Tube Light | 1 | 20 | 0.02 | 2 | 0.04 |
| Room 306 Male Wash room | 2nd | Tube Light | 1 | 40 | 0.04 | 2 | 0.08 |
| | | LED Tube Light | 1 | 20 | 0.02 | 2 | 0.04 |
| Room 302 Deptt. of | 2nd | LED Tube Light | 4 | 20 | 0.08 | 2.1 | 0.168 |
| | | Exhaust Fan | 4 | 100 | 0.4 | 3 | 1.2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Physics | | | | | | | |
| | | Table Fan | 4 | 65 | 0.26 | 1.1 | 0.286 |
| | | Ceiling Fan | 16 | 60 | 0.96 | 2 | 1.92 |
| | | Tube Light | 20 | 40 | 0.8 | 1.1 | 0.88 |
| | | LED Desktop | 1 | 40 | 0.04 | 0.1 | 0.004 |
| | | Printer | 1 | 40 | 0.04 | 0.08 | 0.0032 |
| | | Fridge | 1 | 125 | 0.125 | 12 | 1.5 |
| | | Band Gap | 1 | 580 | 0.58 | 0.1 | 0.058 |
| | | Focal Length of Concave Lense | 1 | 70 | 0.07 | 0.1 | 0.007 |
| | | Heater | 3 | 220 | 0.66 | 0.2 | 0.132 |
| | | Power Source | 2 | 30 | 0.06 | 1 | 0.06 |
| | | Lamp | 1 | 10 | 0.01 | 1 | 0.01 |
| | | Lamp | 1 | 2 | 0.002 | 1 | 0.002 |
| | | Light Source | 1 | 70 | 0.07 | 0.5 | 0.035 |
| | | Magnetic Susceptibility | 1 | 500 | 0.5 | 0.5 | 0.25 |
| | | Weight Balance | 2 | 2 | 0.004 | 0.05 | 0.0002 |
| | | Galvanometer | 4 | 5 | 0.02 | 0.1 | 0.002 |
| Room 312 | 2nd Floor | Ceiling Fan | 5 | 60 | 0.3 | 2 | 0.6 |
| | | Tube Light | 3 | 40 | 0.12 | 2 | 0.24 |
| | | LED Tube Light | 2 | 20 | 0.04 | 2 | 0.08 |
| Room 313 | 2nd Floor | CFL Light | 22 | 18 | 0.396 | 2 | 0.792 |
| | | Ceiling Fan | 1 | 60 | 0.06 | 2 | 0.12 |
| | | Tube Light | 6 | 40 | 0.24 | 2 | 0.48 |
| | | LED Tube Light | 1 | 20 | 0.02 | 2 | 0.04 |
| | | LED Desktop | 1 | 40 | 0.04 | 2 | 0.08 |
| | | Laptop | 1 | 45 | 0.045 | 2 | 0.09 |
| | | Air Conditioner | 2 | 1500 | 3 | 0.9 | 2.7 |
| | | Fridge | 3 | 125 | 0.375 | 9 | 3.375 |
| | | Laminar Air Flow | 3 | 250 | 0.75 | 2 | 1.5 |
| | | BOD Incubator | 3 | 300 | 0.9 | 0.1 | 0.09 |
| | | Water Bath | 1 | 500 | 0.5 | 1.5 | 0.75 |
| | | Autoclave | 1 | 250 | 0.25 | 1 | 0.25 |
| | | Microwave | 1 | 1250 | 1.25 | 0.1 | 0.125 |
| | | Hot Air Oven | 2 | 500 | 1 | 1 | 1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Centrifuge | 1 | 110 | 0.11 | 0.5 | 0.055 |
| | | Thermal Cycling PCR | 1 | | | | |
| Room 313 | 2nd Floor | Tube Light | 5 | 40 | 0.2 | 1 | 0.2 |
| | | Ceiling Fan | 5 | 60 | 0.3 | 1 | 0.3 |
| | | Projector | 1 | 80 | 0.08 | 1 | 0.080 |
| NSS-2 | | Tube Light | 1 | 40 | 0.04 | 1 | 0.04 |
| | | LED Tube Light | 2 | 20 | 0.04 | 1 | 0.04 |
| | | Table Fan | 1 | 60 | 0.06 | 2 | 0.12 |
| | | Exhaust Fan | 2 | 125 | 0.25 | 3.5 | 0.875 |
| Room No 202 | 1st | LED Ceiling Light | 4 | 12 | 0.048 | 3.25 | 0.156 |
| | | LED Bulb | 3 | 20 | 0.06 | 3.25 | 0.195 |
| | | Tube Light | 8 | 40 | 0.32 | 3.75 | |
| | | LED Tube Light | 12 | 20 | 0.24 | 3.75 | 0.9 |
| | | Ceiling Fan | 16 | 60 | 0.96 | 3 | 16 |
| | | Exhaust Fan | 3 | 55 | 0.165 | 3 | 0.495 |
| | | LED Desktop | 7 | 40 | 0.28 | 5 | 1.4 |
| | | Printer | 3 | 250 | 0.75 | 0.1 | 0.075 |
| | | Xerox Machine | 1 | 250 | 0.25 | 0.1 | 0.025 |
| | | CCTV | 1 | 35 | 0.035 | 24 | 0.84 |
| | | Water Filter | 1 | 25 | 0.025 | 24 | 0.6 |
| Room No 206 | 1st | Tube Light | 3 | 40 | 0.12 | 2.85 | 0.342 |
| | | LED Tube Light | 4 | 20 | 0.08 | 2.85 | 0.228 |
| | | Ceiling Fan | 6 | 60 | 0.36 | 2.25 | 16 |
| | | Air Conditioner | 2 | 1500 | 3 | 0.15 | 0.45 |
| | | Water Filter | 1 | 40 | 0.04 | 4 | 0.16 |
| Room No 207 | 1st | Tube Light | 6 | 40 | 0.24 | 2.85 | 0.684 |
| | | LED Tube Light | 7 | 20 | 0.14 | 2.85 | 0.399 |
| | | Ceiling Fan | 8 | 60 | 0.48 | 2.25 | 1.08 |
| | | Speakers | 4 | 40 | 0.16 | 0.15 | 0.024 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Room No 208 | 1st | Tube Light | 4 | 40 | 0.16 | 2.85 | 0.456 |
| | | LED Tube Light | 3 | 20 | 0.06 | 2.85 | 0.171 |
| | | Ceiling Fan | 5 | 60 | 0.3 | 2.25 | 0.675 |
| | 1st | Tube Light | 4 | 40 | 0.16 | 2.85 | 0.456 |
| Room 209 | | LED Tube Light | 2 | 20 | 0.04 | 2.85 | 0.114 |
| | | Ceiling Fan | 5 | 60 | 0.3 | 2.25 | 0.675 |
| Room 210 | 1st | Tube Light | 5 | 40 | 0.2 | 2.85 | 0.57 |
| | | LED Tube Light | 2 | 20 | 0.04 | 2.85 | 0.114 |
| | | Ceiling Fan | 5 | 60 | 0.3 | 2.25 | 0.675 |
| Room 211 | 1st | Tube Light | 4 | 40 | 0.16 | 2.85 | 0.456 |
| | | LED Tube Light | 2 | 20 | 0.04 | 2.85 | 0.114 |
| | | Ceiling Fan | 5 | 60 | 0.3 | 2.25 | 0.675 |
| Room No 212 | 1st | Tube Light | 3 | 40 | 0.12 | 2.85 | 0.342 |
| | | LED Tube Light | 3 | 20 | 0.06 | 2.85 | 0.171 |
| | | Ceiling Fan | 5 | 60 | 0.3 | 2.25 | 0.675 |
| Room No 213 | 1st | Tube Light | 4 | 40 | 0.16 | 2.85 | 0.456 |
| | | LED Tube Light | 2 | 20 | 0.04 | 2.85 | 0.114 |
| | | Ceiling Fan | 5 | 60 | 0.3 | 2.25 | 0.675 |
| | | Projector | 1 | 80 | 0.08 | 1 | 0.08 |
| Room No 215 | 1st | Tube Light | 2 | 40 | 0.08 | 2.85 | 0.228 |
| | | LED Tube Light | 2 | 20 | 0.04 | 2.85 | 0.114 |
| | | LED Desktop | 2 | 40 | 0.08 | 2.25 | 0.18 |
| | | Air Conditioner | 1 | 1500 | 1.5 | 0.21 | 0.315 |
| | | Printer | 1 | 250 | 0.25 | 0.52 | 0.13 |
| Room No 216 | 1st | Tube Light | 11 | 40 | 0.44 | 2.85 | 1.254 |
| | | LED Tube Light | 4 | 20 | 0.08 | 2.85 | 0.228 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Ceiling Fan | 5 | 40 | 0.2 | 2.25 | 0.45 |
| | | Table Fan | 5 | 60 | 0.3 | 1.1 | 0.33 |
| | | Hot Air Oven | 1 | 500 | 0.5 | 0.5 | 0.25 |
| | | Incubator | 1 | 800 | 0.8 | 1 | 0.8 |
| | | Shaker | 1 | 1000 | 1 | 0.5 | 0.5 |
| | | Laminar Flow | 1 | 250 | 0.25 | 2 | 0.5 |
| | | Autoclave | 1 | 250 | 0.25 | 2 | 0.5 |
| | | Projector | 1 | 80 | 0.08 | 3.5 | 0.28 |
| Room No 214 | 1st | LED Tube Light | 6 | 20 | 0.12 | 2.85 | 0.342 |
| | | Table Fan | 4 | 65 | 0.26 | 2.85 | 0.741 |
| | | LED Desktop | 22 | 40 | 0.88 | 2.25 | 1.98 |
| | | Air Conditioner | 1 | 1500 | 1.5 | 0.1 | 0.15 |
| | | Printer | 1 | 250 | 0.25 | 0.2 | 0.05 |
| | | Xerox Machine | 1 | 250 | 0.25 | 0.09 | 0.0225 |
| | | Ceiling Spotlight | 4 | 20 | 0.08 | 2.85 | 0.228 |
| | | Laptop | 1 | 45 | 0.045 | 2 | 0.09 |
| Research Lab | 1st | LED Tube Light | 12 | 20 | 0.24 | 2.85 | 0.684 |
| | | Table Fan | 4 | 65 | 0.26 | 2.85 | 0.741 |
| | | LED Desktop | 2 | 40 | 0.08 | 2.25 | 0.18 |
| | | Air Conditioner | 2 | 1500 | 3 | 0.71 | 2.13 |
| | | Printer | 2 | 250 | 0.5 | 0.2 | 0.1 |
| | | Xerox Machine | 1 | 250 | 0.25 | 0.09 | 0.0225 |
| | | Ceiling Spotlight | 4 | 20 | 0.08 | 2.85 | 0.228 |
| | | Laptop | 1 | 45 | 0.045 | 2 | 0.09 |
| | | Tube Light | 38 | 40 | 1.52 | 2.25 | 3.42 |
| | | Exhaust Fan | 7 | 125 | 0.875 | 2.25 | 1.96875 |
| | | Fridge | 3 | 100 | 0.3 | 9 | 2.7 |
| | | Incubator | 1 | 300 | 0.3 | 2 | 0.6 |
| | | Hot Air Oven | 1 | 250 | 0.25 | 2 | 0.5 |
| | | Laminar Air Flow | 1 | 500 | 0.5 | 2 | 1 |
| Room No 203 | 1st | Ceiling Fan | 5 | 40 | 0.2 | 2 | 0.4 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Tube Light | 4 | 40 | 0.16 | 2 | 0.32 |
| | | LED Tube Light | 2 | 20 | 0.04 | 2 | 0.08 |
| ROOM 1 | 3RD | Ceiling Fan | 4 | 40 | 0.16 | 2 | 0.32 |
| | | LED Tube Light | 7 | 20 | 0.14 | 2 | 0.28 |
| ROOM 2 | 3RD | Ceiling Fan | 4 | 40 | 0.16 | 2 | 0.32 |
| | | LED Tube Light | 7 | 20 | 0.14 | 2 | 0.28 |
| ROOM 3 | 3RD | Ceiling Fan | 4 | 40 | 0.16 | 2 | 0.32 |
| | | LED Tube Light | 7 | 20 | 0.14 | 2 | 0.28 |
| Corridor | 3rd | LED Tube Light | 3 | 20 | | | |
| Rabindra Hall | 2nd | LED Tube Light | 21 | 20 | 0.42 | 2.85 | |
| | | Ceiling Fan | 14 | 40 | 0.56 | 2.85 | 1.596 |
| | | Air Conditioner | 4 | 1500 | 6 | 0.09 | 0.54 |
| | | Ceiling Spotlight | 9 | 20 | 0.18 | 2.85 | 0.513 |
| | | Projector | 1 | 80 | 0.08 | 2 | 0.16 |
| Left Side Room | 2nd | Tube Light | 1 | 2 | 0.002 | 0.07 | 0.00014 |
| | | Ceiling Fan | 1 | 40 | 0.04 | 0.055 | 0.0022 |
| | | Table Fan | 2 | 60 | 0.12 | 0.055 | 0.0066 |
| Right Side Room | 2nd | Tube Light | 2 | 40 | 0.08 | 2.85 | |
| | | Ceiling Fan | 1 | 40 | 0.04 | 2.85 | 0.114 |
| | | Air Conditioner | 4 | 1500 | 6 | 0.09 | 0.54 |
| | | Ceiling Spotlight | 9 | 20 | 0.18 | 2.85 | 0.513 |
| | | Projector | 1 | 80 | 0.08 | 2 | 0.16 |

## 3. Quantification by End Use

The loads were segregated based on the end use as lighting and fans, air conditioning, computers, printers, Lighting LED based and conventional Tube Lights, instruments in the laboratories. Quantification, types and necessary measurements were carried out. The details are given here.

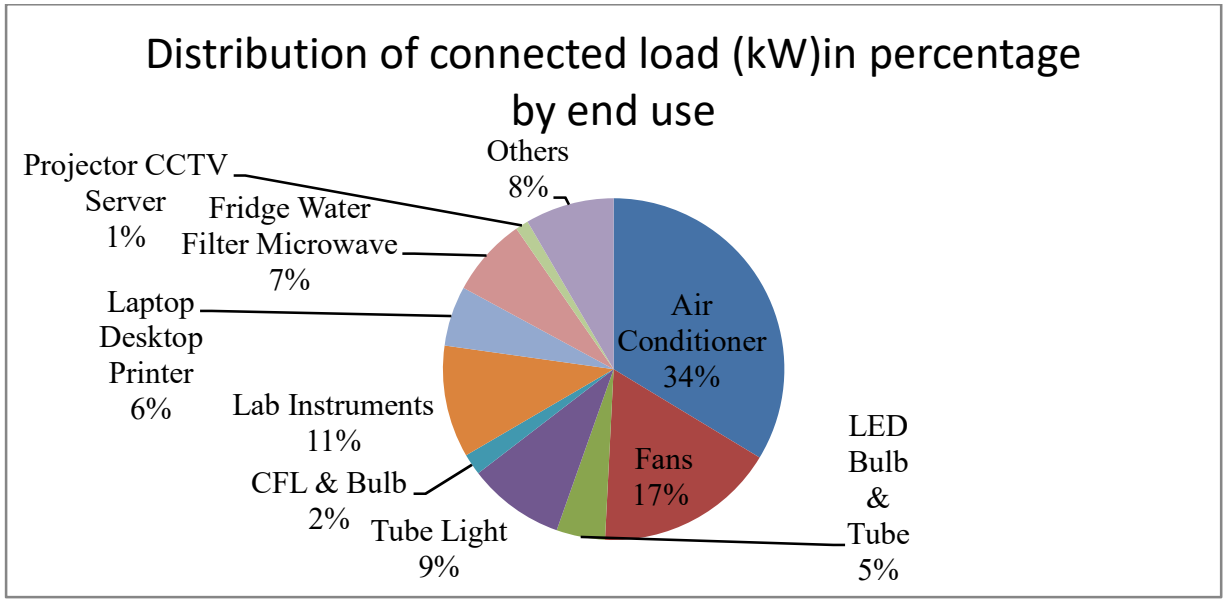


Fig. 3.1 Distribution of connected load in percentage by end use in Vijaygarh Jyotish Ray College

Connected Load is also given in the Fig 3.2

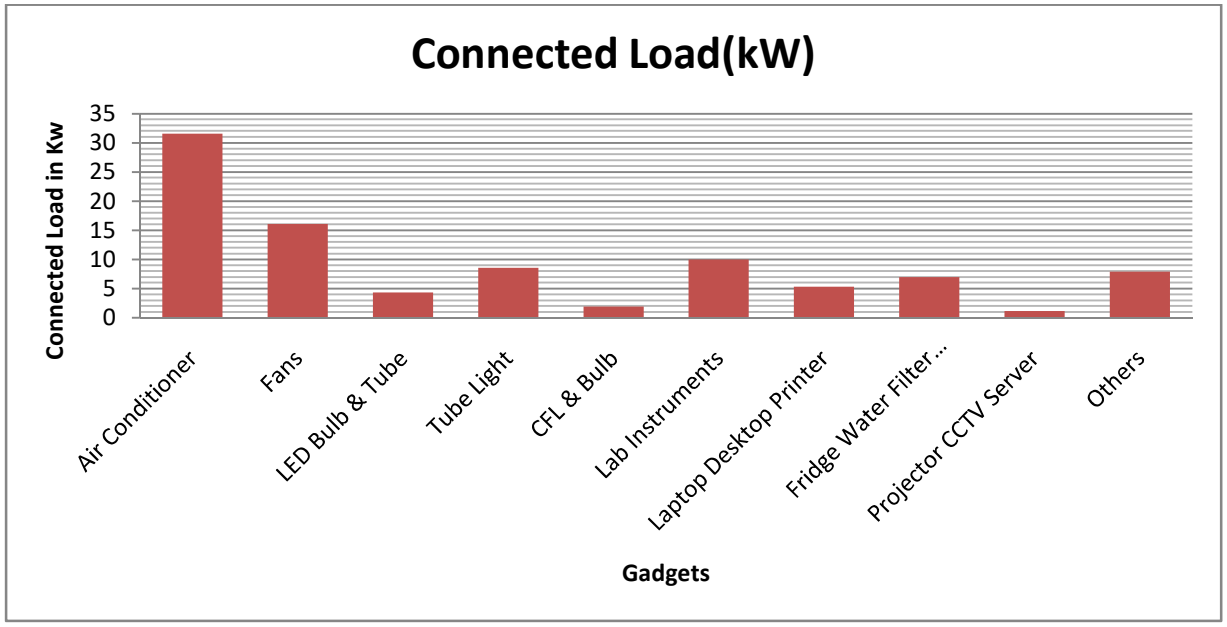


Fig 3.2: Conncted Load (kW) in Vijaygarh Jyotish Ray College

## 4. Benchmarking

Energy benchmarking involves the development of quantitative and qualitative indicators through the collection and analysis of energy-related data and energy management practices. Benchmarking in simplistic terms is the process of comparing the performance of a given process with that of the best possible process and to try to improve the standard of the process to improve quality of the system, product, services etc. It allows organizations to develop plans on how to adopt such best practices, usually with the aim of increasing some aspect of performance. Benchmarking may be a one-off event, but is often treated as a continuous process in which organizations continually seek to challenge their practices. Benchmarking is a method which should be used on a continual basis as best practices are always evolving. Benchmarking of energy consumption is a powerful tool for performance assessment and logical evolution of avenues for improvement. Historical data, well documented, helps to bring out energy consumption and cost trends month-wise / daily. Trend analysis of energy consumption, cost, relevant production features, specific energy consumption, help to understand effects of capacity utilization on energy use efficiency and costs on a broader scale. The basis for benchmarking the

energy consumption at Vijaygarh Jyotish Ray College is energy consumed per person (includes teaching staff and students). The benchmarking parameters are hereunder

- Departmental energy performance
- Consumed per sq.m of area and
- Per capita consumption

### 4.1 Building Energy Performance

The details of the daily energy consumption in three floors are as shown here in Fig. 4.1.

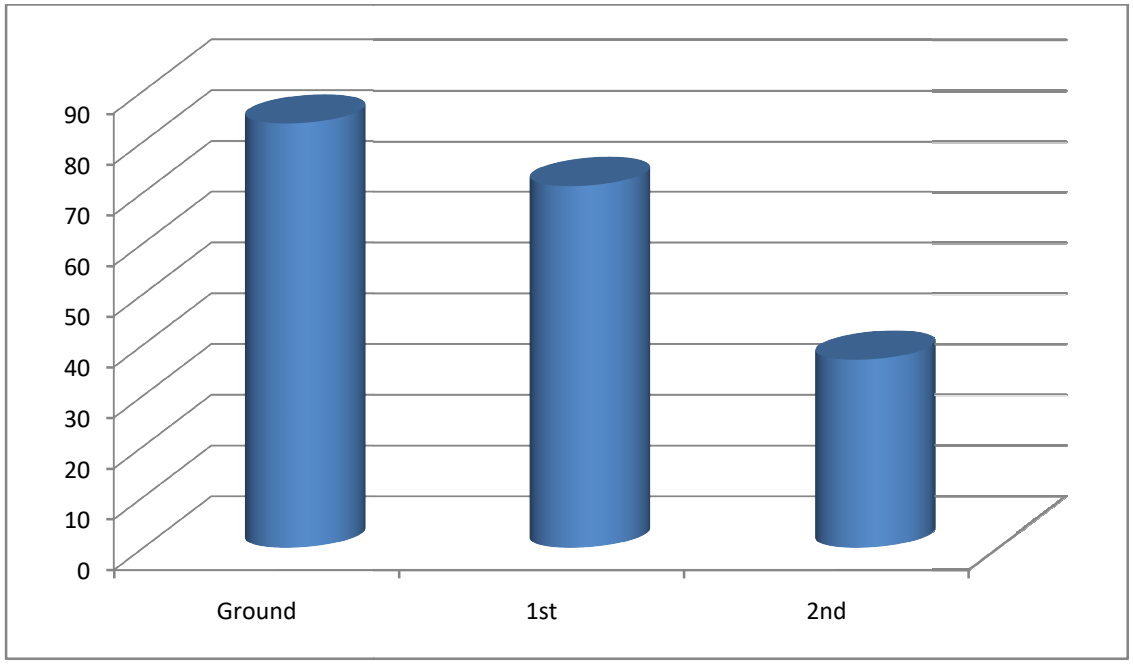


Fig 4.1.1 Floor-wise daily average energy consumption in (kWh) in July, 2022

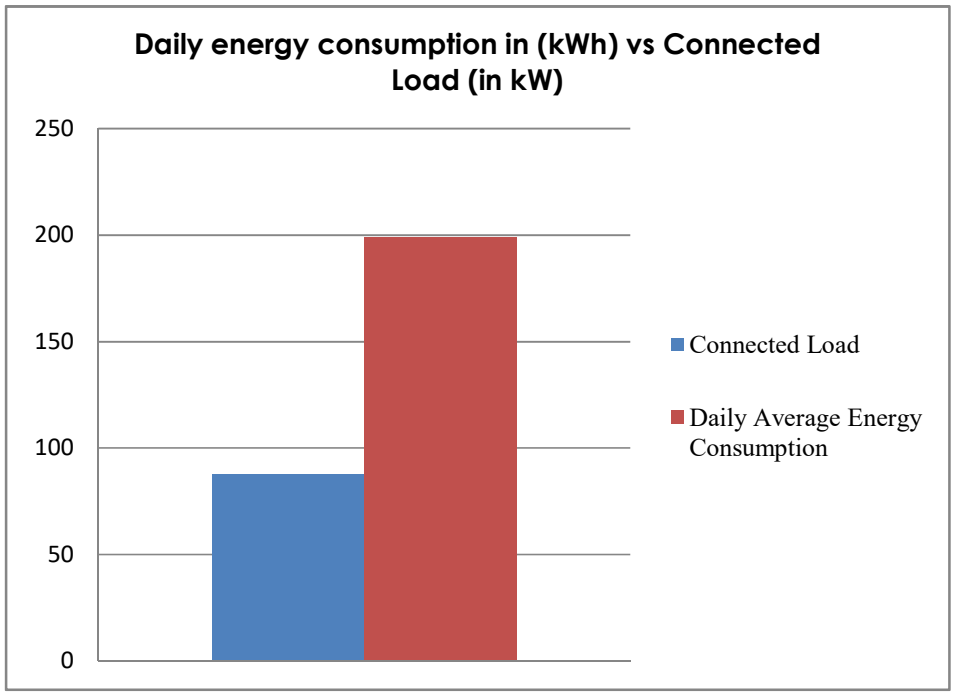


Fig 4.1.2 Daily energy consumption in (kWh) Vs Connected Load (in kW) upto July, 2022

### 4.2 Equipment Wise Consumption

Electrical gadgets wise per day consumption has been given in Fig 4.2

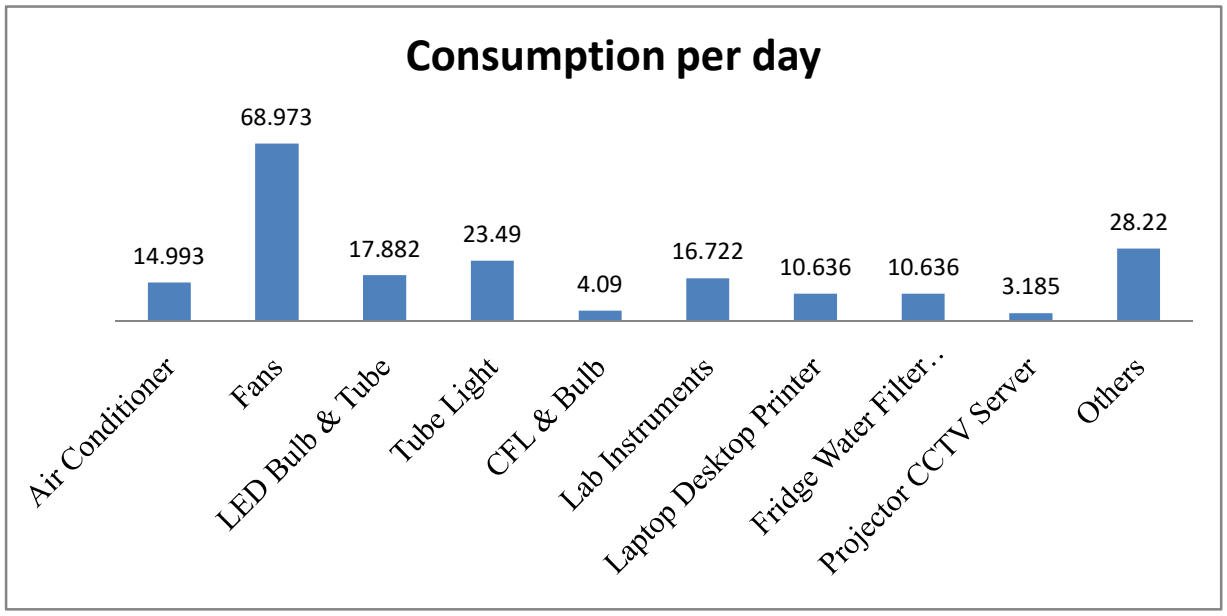


Fig 4.2.1: Daily average consumption (kWh)

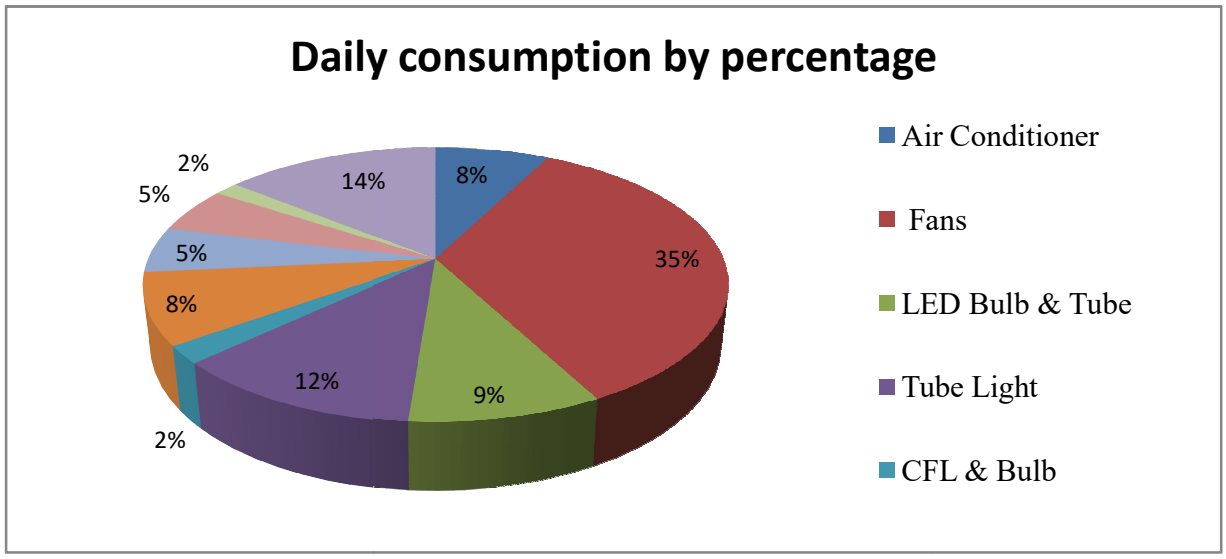


Fig 4.2.2: Daily average percentage consumption (kWh)

### 4.3 Unit Area Energy Consumption

The energy consumption per sq. ft

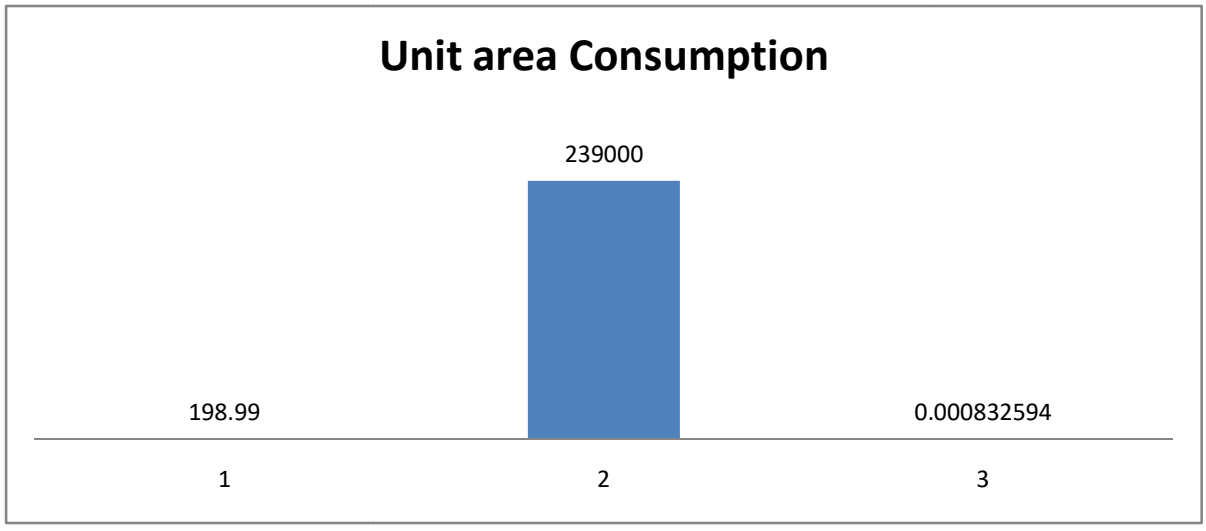


Fig. 4.3 Building area unit consumtion in sq. ft as in 3

### 4.4 Yearly energy consumption

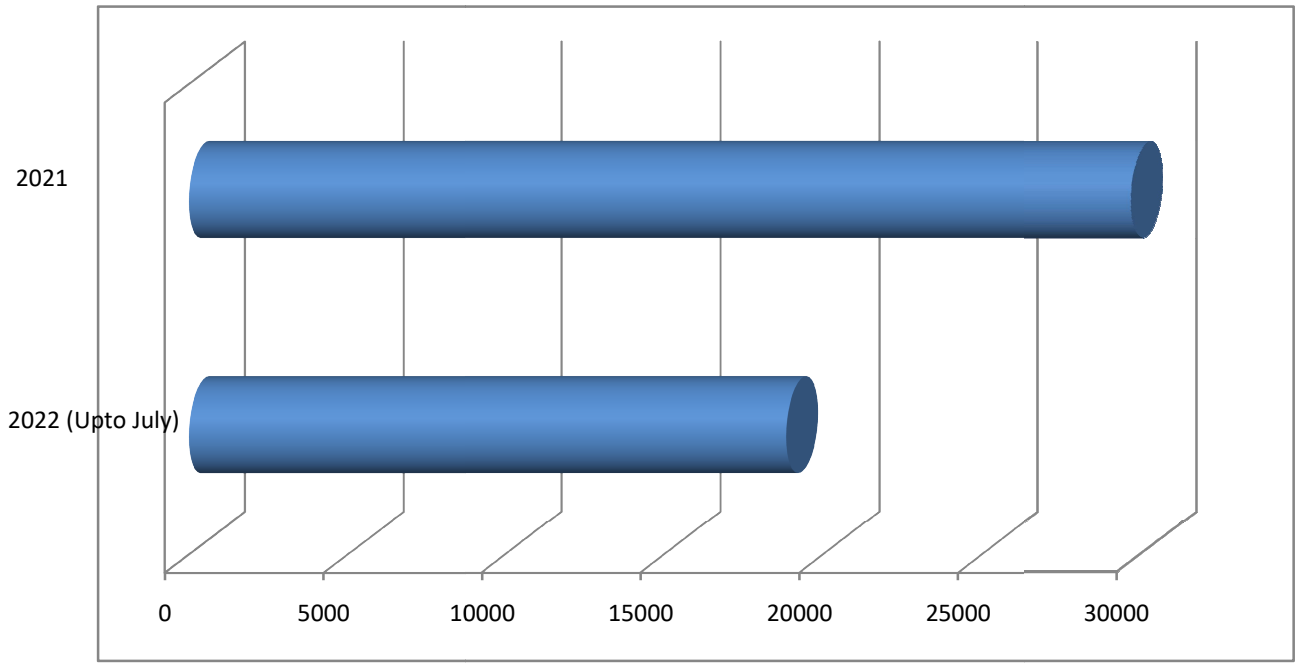


Fig 4.4 Electricity Consumption in 2021 and 2022 (upto July)

### 4.5 ECBC Standards and Comparison

As per the Energy Conservation Building Code (ECBC) – 2007, published by the Bureau of Energy Efficiency (BEE), Govt. of India, recommended levels of lighting power density are as given below in Table 4.1.

| Space/ application | Lighting power density in W/sq.m. |
|---|---|
| General 200 | Reading Room 200 |
| Reading tables 200 | Bathrooms 50 |
| Computer Workspace 300 | Interior Parking Area 20 |
| Music Rooms 200 | Sports halls 200 |
| Corridors, passageways &Stairs 50 | Canteens ,Cafeterias ,Dining Rooms and |
| Mess Rooms | 150 |
| Food Preparation and Cooking 300 | |
| General 200 | Reading Room 200 |
| Reading tables 200 | Bathrooms 50 |

| | |
|---|---|
| Computer Workspace 300 | Interior Parking Area 20 |
| Music Rooms 200 | Sports halls 200 |

Table 4.5: ECBC recommended levels for lighting power density

### 4.6 Illumination Level

Measured Lux Level as in the Table 4.1

| Place | Lux level (lx) |
|---|---|
| Class Room | 160 |
| Office | 180 |
| Laboratory | 160 |
| Common area | 130 |

## 5. Recommendation

Based on the power consumption data analysis, few steps have been proposed for improving energy efficiently in the main building and new building. Given below are few important recommendations for better energy efficiency.

### 5.1 Replacing Conventional Ballast FTLs with Electronic Ballast FTLs

5.1.1 Cost Analysis of Replacement (Calculation for 100 Conventional Ballast FTL is done here)

- Conventional Ballast FTL=100
- Average consumption of power of Conventional Ballast FTL=52W
- Average consumption of power of Electronic Ballast FTL=40W
- Power can be saved per FTL= (52-40)W= 12W
- Total power can be saved= 100*12W=1200W= 1.2kW
- Average FTL use per year =280*7hours=1960 hours
- Total energy can be saved per year=1.2kW * 1960 hours= 2352kWh
- Saving in Rs. Per year=2352 kWh * 8= Rs.18816
- Average cost of replacing each FTL= Rs. 150

- Total cost of the replacement of 100 Conventional Ballasts FTLs= 100 * 150= 15000
- Capital cost recovery time needed= 15000/18816 = 0.797 years.

Hence time needed for the capital cost recovery is 0.797 years for replacing 100 Conventional Ballast FTLs with Electronic Ballast FTLs of the campus.

### 5.2 Installing Motion Sensors in Corridors

Corridors and toilets have large potential of saving energy by use of automation tools. Motion sensors can be used there to automatically switch on the light when there is any movement and switch off the light when there is no movement. This can greatly reduce the total load in corridors and toilets.

#### 5.2.1 Cost Analysis Motion Sensors in Corridors

- Average number of tube lights in a corridor=10
- Average power consumption of the tube lights= 40W
- Average number of motion sensor required= 10
- Average reduction in usage of tube lights per day by motion sensor=4hours
- Total energy can be saved in a corridor per year=(10*40W*4hours*280days) / 1000= 448 kWh
- Saving in Rs per year=448*10=Rs. 4480
- Average cost of installation per motion sensors= Rs. 250
- Total cost of installing motion sensors in a corridor= 10 *250= Rs. 2500
- Capital cost Recovery time= 2500/4480= 0.5 years.

Hence the time needed for the capital cost recovery is 0.5 years for installing motion sensors in corridors

### 5.3 Replacing Old ACs with New Star Rated ACs

**5.3.1** Cost of Replacement of the ACs (Calculation for 100 Old Window ACs)

- Old Window ACs of 1.5 tons =5
- Average consumption of power of the old window ACs= 2000W
- Average consumption of power of a new 5 star rated AC with 1.5 ton capacity= 1500W
- Power can be saved per AC= (2000-1500)W=500W
- Power consumption can be saved per AC=500W
- Total power saving= 5*500=2500= 2.5 kW
- Average use of AC per year=280*4= 1120 hours
- Total Energy saved per year= 2.5kW*1120hrs=2,800kWh
- Saving in Rs per year=2,800*10= Rs.28,000
- Average cost of replacing each old window ACs with new 5 star rated split ACs both of capacity 1.5 tons= Rs. 26000
- Total cost of replacing all AC= 5*38000= Rs. 1,90,000
- Capital cost recovery time needed= 1,90,000/26,000= 7.3 years.

Therefore time needed for the capital cost recovery is 7.3 years for replacing 5 old windows ACs of 1.5 tons with 5 new 5 star rated new split ACs of 1.5 tons of the campus. The split AC's are costlier than the window AC's but their energy efficiency in terms of consumption is higher.

### 5.3.2 Better Practices for ACs

**Proper Insulation** – Good quality insulation must be maintained in the air conditioned rooms by keeping all doors and windows closed properly so as to prevent cool air go out and hot air come in.

**Curtains** – Always keep curtains on windows to prevent direct sunlight inside the room to avoid heating of cooled air. This reduces AC load significantly.

**Maintenance** – Proper maintenance and cleaning of ACs is required at regular intervals to make it work at highest efficiency. Any dirt in filter may reduce efficiency of ACs very significantly.

**Operating** – The ACs should be switched on 15 minutes before actual use and should be switched off before leaving the room

### 5.4. Energy saving by using Super-Efficient (BLDC) Fans

A Super-Efficient (BLDC) Fan consumes 30 watts whereas a conventional fanconsumes 80 watts.

- Hence energy savings per fan per hour = 50 Wh
- Total Energy savings by Super-Efficient Fans = 50W XOperating hours
- (Per day Per fan) = 50W X 6.5Hrs = 325 Wh = 0.325 KWh (Per day Per fan)
- Cost saving per day per fan = 0.325 KWh X Rs. 10 = Rs. 3.25/-
- Cost saving per day for 200 fans =Rs. 3.25/-X 200= Rs. 650/- (Per day)
- Total annual cost saving by using Super-Efficient Fans = Rs. 650/- X Total no.
- of operating days =Rs. 650- X 180 days =Rs. 1,17,000/-
- Cost of buying 200 Super-Efficient (BLDC) Fans = Rs. 3000/- X 200= Rs.6,00,000/-

Hence the time needed for the capital cost recovery is 5.12 years for BLDC fan.

Recommended to buy super-efficient ceiling fans instead of ordinary fan whenever there is requirement for new purchase. Also note that always use proper capacitor for ordinary fan and change the capacitor a necessary.

### 5.5. Energy Saving By Replacing Old Tubelights With Led lights

A 40 watt old tube light can be replaced with a LED tube light which has apower rating of 20 watt.

- Energy saving per light per hour = 20 watt
- Energy saving per light per day= 20 watt X 6.5hrs = 130 Wh=0.13 kWh
- Total annual energy saving per light = 0.13kWh X 280 days= 36.4 kWh
- Total annual energy cost saving per light = 36.4 kWh X Rs. 10 = Rs. 364/-
- Total annual energy cost saving by replacing all the old tubelights = Rs. 364/- X 500 =

Rs. 1,82,000/-

- Cost for buying 500 LED tube lights = Rs. 250/- X 500 = Rs. 1,20,000/-
- Payback period = (Rs. 1,20,000/-)/ (Rs. 1,82,000/-) = 8 months

Payback period is much shorter than the lifespan of LED tubelights (Lifespan ofa LED tubelight is usually 20000 hrs+; which is around 8.4 years consideringoperating hour is 6.5 hours a day). Hence it is recommended to replace all the existing tubelights with LED light.

### 5.6 Electric wiring:

Power loss in old electric wirings is more than current electrical wiring and also old electrical wirings are not secured. It is recommended to maintain electric wiring with licensed electricians. Some of electric wires are laid with the help of iron angle from the main building to the new building. A further consultation with the licensed electrician is required in regard to the safety of the system. It is recommended to use proper cable try to laying the cable or wire with proper earthing arrangement.

It is also recommended that installation of modern electrical distribution board (ACDB) with proper load distribution in generator room and other floors wherever required.

### 5.7 Civil work.

Maintenance and check of roofs/ceilings by professionals are recommended for the buildings.

### 5.8 Mosquitors and pest control

Regularly use pest control solution to keep college campus free from any pests and harm.

### 5.9 Painting

Paint wall with appropropiate colour for light refection where needed.

## 6. Maximum Utilization of Renewable Energy Resources

National Assessment and Accrediation Council (NAAC)'s Vision is "To make quality the defining element of higher education in India through a combination of self and external quality evaluation, promotion and sustenance initiatives." Under NAAC criteria, Criterion VII, INNOVATIONS AND BEST PRACTICES, the key aspects are as follows-

- Environment Consciousness.
- Innovations
- Best Practices.

Under Environmental Consciousness focuses are given on topics like-

- Energy Conservations
- Rain Water Harvesting
- Maximum Use of Renewable Energy sources
- Wastes Recycling
- Efforts for carbon neutrality
- Check dam constructions
- Solid wastes, Hazardous wastes, and E-wastes Managements
- Plantations and gardening
- Efforts for Carbon neutrality
- Minimum uses of paper, plastics

**6.1 Renewable Resources**

India has a huge potential in generating solar energy using the unutilized space on the rooftops of any buildings. Solar power generated from any individual's household, industrial building, commercial buildings and institutional buildings or in any other types of buildings can substitute a huge amount of power demand from non-renewable power sources and can be partly used to fulfil the energy demand of the inhabitants of the building and in case of surplus can be fed into the grid. Till date, 26 states have notified their regulation to provide with Net Metering/ Gross Metering facilities to support the installations of solar rooftops. In recent times it is possible to generate solar power of about Rs. 5.50/kWh from the rooftop solar system, which is much

cheaper than the electricity generation from a diesel generator sets. It is also cheaper than the cost at which most DISCOMS which would avail power to the domestic, industrial and commercial consumers. The new Technologies and initiatives will help India rise as a major country using their roof space for rooftop solar energy system on a huge scale. Nearly 60 million tonnes of CO2 per year will be reduced due to 40 GW of power, with the India's commitment toward its contribution in mitigating the global effect of climate change.The National Solar Mission was launched on the 11th January, 2010 by the Prime Minister. The Mission has set the ambitious target of deploying 20,000 MW of grid connected solar power by 2022 is aimed at reducing the cost of solar power generation in the country through (i) long term policy; (ii) large scale deployment goals; (iii) aggressive R&D; and (iv) domestic production of critical raw materials, components and products, as a result to achieve grid tariff parity by 2022. Mission will create an enabling policy framework to achieve this objective and make India a global leader in solar energy.Further, Government has revised the target of Grid Connected Solar Power Projects from 20,000 MW by the year 2021-22 to 100,000 MW by the year 2021-22 under the National Solar Mission and it was approved by Cabinet on 17th June 2015.

### 6.2 Solar Cell

Solar cells represent the fundamental power conversion unit of a photovoltaic system. For practical operation, solar cells are usually assembled into modules. Its operation is based on the ability of semiconductors to convert sunlight directly into electricity by exploiting the photovoltaic effect. In the conversion process, the incident energy of light creates mobile charged particles in the semiconductor, which are then separated by the device structure and produce electricity.

Depending upon the type of absorbing material used, manufacturing technique / process adopted, and type of junction formed etc., the solar cell technologies can be broadly classified as following:

- Wafer based crystalline silicon solar cells
- Thin-film solar cells, which includes, Copper Indium Gallium Diselenide (CIGS), Cadmium Telluride, Amorphous silicon (a-Si) etc.
- Concentrating Photovoltaic (CPV) and

- Emerging technologies such as thin-film silicon, dye sensitized solar cells; polymer organic solar cells etc.

| Material | Thick-ness | Efficiency (%) | Colour | Features |
|---|---|---|---|---|
| Mono-crystalline Si solar cells | 0.3 mm | 15 – 18 | Dark blue, black with AR coating, grey without Anti Reflective(AR) coating | Lengthy production procedure, wafer sawing necessary. Best researched solar cell material – highest power/area ratio. |
| Poly-crystalline Si solar cells | 0.3 mm | 13 – 15 | Blue with AR coating, silver-grey without AR coating | Wafer sawing necessary. Most important production procedure at least for the next ten years. |
| Poly-crystalline transparent Si solar cells | 0.3 mm | 10 % | Blue with AR coating, silver-grey without AR coating | Lower efficiency than mono-crystalline solar cells. Attractive solar cells for different BIPV applications. |
| EFG (Edge Defined Film fed Growth) | 0.28 mm | 14 | Blue, with AR coating | Limited use of this production procedure Very fast crystal growth, no wafer sawing necessary |
| Poly-crystalline ribbon Si solar cells | 0.3 mm | 12 | Blue, with AR coating, silver-grey without AR coating | Limited use of this production procedure, no wafer sawing necessary. Decrease in production costs expected in the future. |
| Apex (polycrystaline | 0.03 to 0.1 mm + | 9.5 | Blue, with AR coating, silver- | Production procedure used only by one producer, no |

| Material | Thick-ness | Efficiency (%) | Colour | Features |
|---|---|---|---|---|
| Si) solar cells | ceramic substrate | | grey without AR coating | wafer sawing, production in form of band possible. Significant decrease in production costs expected in the future. |
| Mono-crystaline dendritic web Si solar cells | 0.13 mm incl contacts | 13 | Blue, with AR coating | Limited use of this production procedure, no wafer sawing, production in form of band possible. |
| Amorphous silicon | 0.0001 mm + 1 to 3 mm substrate | 5 – 8 | Red-blue, Black | Lower efficiency, shorter life span. No sawing necessary, possible production in the form of band. |
| Cadmium Telluride (CdTe) | 0.008 mm + 3 mm glass substrate | 6 – 9 (module) | Dark green, Black | Poisonous raw materials, significant decrease in production costs expected in the future. |
| Copper-Indium-Selenide (CIS) | 0.003 mm + 3 mm glass substrate | 7.5 – 9.5 (module) | Black | Limited Indium supply in nature. Significant decrease in production costs possible in the future. |
| Hybrid silicon (HIT) solar cell | 0.02 mm | 18 | Dark blue, black | Limited use of this production procedure, higher efficiency, better temperature coefficient and lower thickness. |

Table 6.2: Comparison of different Solar Cell Technologies

### 6.3 Solar PV System

A PV system essentially consists of modules (array of solar cells generating the electricity) and a balance of system (BoS) including the cabling, battery, charge controller and DC/AC inverter and other auxiliaries/support system. Most of the systems are in flat-plate variety having fixed orientation while some of the system uses sun-tracking (single or double axis) concentrators in order to achieve high radiation on smaller areas for higher efficiency. The storage system (batteries) is not required in grid connected SPV systems.

A Solar PV module is the smallest PV unit that can be used to generate electricity. Although individual PV cells produce only small amount of electricity, PV modules are manufactured with varying electrical outputs ranging from a few watts to more than 100 watts of direct current (DC) electricity. The modules can be connected into PV arrays for powering a wide variety of electrical equipment. A typical schematic of grid-connected PV system is given in Figure 6.

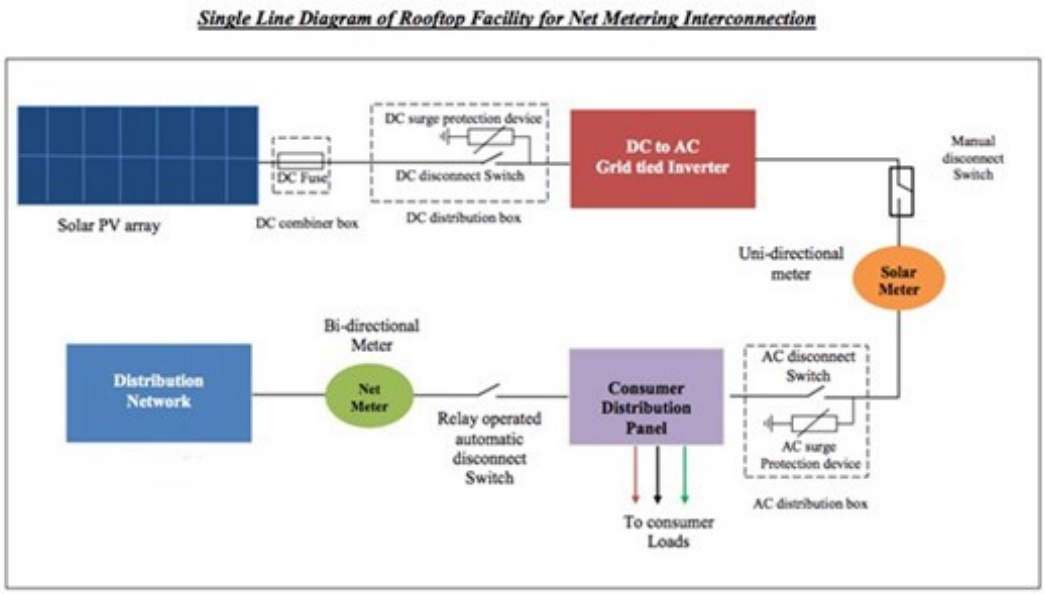


Fig 6.3: Single Line diagram with Net metering facility

### 6.4 Current Solar Capacity

Currently the college has an installed capacity of 20 kW grid connected solar PV plant which is generating approximately 30000 unit of electricity. However there is a planning of additional rooftop solar plant but the work needs regulatory approval.

### 6.5 Further scope of Solar Capacity Utilization

The college has adequate shade-free rooftop space for utilization of solar energy. A detailed available rooftop area is hereunder.

| Building Name | Shade less Area | Approx Install capacity |
|---|---|---|
| VJRC Building Rooftop | 7000 | 70 kW |
| | | |

Harnessable rooftop solar potential is approximately total 70 kWp from the rooftop of the buildings.

A 70 kW of solar PV plant will generate approximately 105,000 units of electricity per year. If the roofs are fully utilised in regard to rooftop installation then the college will be completely energy independent.

## 7. Disposal and Reclying of Waste

### 7.1 Waste Management

The waste is segregated at source by providing separate dust bins for Biodegradable and Plastic waste. Segregation of chemical waste generated in chemistry, zoology lab and other laboratories. Solid and liquid waste from the college are also decomposed here.

| Waste Category | Method of disposal |
|---|---|
| Solid waste from canteen | Organic Manure |
| Plastic Waste | Through Authorised recycler |
| Solid Waste from Lab | Composting |
| | Organic manure |

### 7.2 Waste to Compost ( WTC) Machine

Presently there is no waste compost machine in the campus.
However, there is a vermi-compost facility available in the backside of the college campus.

#### 7.2.1 WTC Procedure

I. The machine has Input door, Output door, Blades for Mixing, So process is noiseless and odorless.

II. Humidity sensor which sense the moisture in the wet waste, Heater, Saw dust with Micro-Organism, Air Ventilation, pipe which directly connect to the sewage system.

III. First step is to put organic waste in the Machine from waste input door then close the door.

IV. Blades start mixing all the waste in the machine at 2 RPM (Rotation per Minute) Clock wise and Anti-Clock Wise.

V. Humidity Sensor in the machine, as it is known that organic waste content 70-80% water.

VI. Once waste is sensed by the humidity sensor Heater will automatically turns On & Water gets evaporate, here we achieve 70-80% volume reduction and steam goes out through pipe which is directly connect to sewage system. e Air Ventilation is provided for Micro Organism to be in live condition.

VII. After that rest of materials are l decomposed by bacteria and hereby 80-95% volume reduction is achieved.

VIII. Per day you will get 10% compost, but no need to remove on a daily basis once in a 7-8 days when compost reaches to Maximum Indicator Line of Machine.

IX. Once byproduct came out from the machine we sent it to Laboratory to check the compost.

X. Microorganisms operate best under neutral to acidic conditions, with pH's in the range of 5.5 to 8. During the initial stages of decomposition, organic acids are formed. The acidic conditions are favourable for growth of fungi and breakdown of lignin and cellulose. As composting proceeds, the organic acids become neutralized, and mature compost generally has a pH between 6 and 8.

XI. Zero Maintenance

### 7.3 E-Waste Management

Over the last two decades, the amount of consumer and business electronic equipment has increased continuously. At the same time, rapid changes in information and communication technologies, the concomitant increasing versatility of most electronic devices together with the downward trend in prices have led to a drastically reduced lifespan for most electronic equipment. Almost every used electronic items are considered as e-waste such as discarded cellphones, cameras, CD players, TVs, radios, drillers, fax machines, photocopiers, printers, toners, ink cartridges, batteries, rechargeable batteries, digital calculators and clocks, CRT monitors, electric solders, computer mother boards, key board, industrial and house hold electronic machinery such as oven, fridge, sewing& washing machines, fan, air-conditioner, grinder, iron, heater, military and laboratory electronic equipment's, etc. The rapid growth of technology, rise in per capita income of people in developing nation, up gradation of technical innovations and a high rate of obsolescence in the electronics industry have led to one of the fastest growing waste streams in the world which consist of end of life electronic waste products. Electronic waste or e-waste is one of the fastest growing waste streams around the world, growing at a rate of 3–5% per annum or approximately three times faster than normal municipal solid waste. Managing electronic waste (or e-waste) is one of the most rapidly growing pollution problems worldwide. New technologies are rapidly superseding millions of analogue appliances leading to their disposal in prescribed landfills despite potentially their adverse impacts on the environment. The consistent advent of new designs, ''smart'' functions and technology during the last 20 years is causing the rapid obsolescence of many electronic items. The lifespan of many electronic goods has been substantially shortened due to advancements in electronics, attractive consumer designs and marketing and compatibility issues. The college has following electronic equipments.

| Instrument | Number (Approx) |
|---|---|
| Computer | 87 |
| Printer | 11 |
| Xerox Machine | 3 |
| CCTV Camera | 3 |
| Projector | 9 |

In line with the institutional e-waste management best practices the college follows the policy on the e-waste. The e-waste and defective item from computer lab and other places are stored properly. The institution has decided to contact approved e- waste management and disposal facility in order to dispose e-waste in scientific manner. An agreement for solid waste management has been given in ***Annexure I***

## 8. Water Footprint

Water footprints help individuals, businesses and countries because they reveal water use patterns, from the individual level all the way to the national level. They shine a light on the water used in all the processes involved in manufacturing and producing our goods and services. A water footprint also accounts for the amount of water contaminated during manufacturing and production because that water is made unusable and is, essentially, taken out of the system.

The water footprint gives everyone - from individuals to business managers to public officials - a solid frame of reference that helps us all be more efficient and sustainable with our water use and appreciate the role of water in our lives. A water footprint is measured in terms of the volume of water consumed, evaporated and polluted.

**Blue Water Footprint :** The amount of surface water and groundwater required (evaporated or used directly) to make a product.

**Green Water Footprint :** The amount of rainwater required (evaporated or used directly) to make a product.

**Grey Water Footprint :** The amount of freshwater required to mix and dilute pollutants enough to maintain water quality according to certain standards (like the ones established in the US Clean Water Act) as a result of making a product.

The college has total 5 overhead tanks and 4 (3+1 one reserved for emergency) pumps which run in an average of 2 hrs a day.

The water pumps details-

| Water Pump Capacity | Types | Number of pump | Instantaneous current draw | Water suction from |
|---|---|---|---|---|
| 1.5 HP | 3 phase | 2 | 2.93 A per phase | Ground level water |

| | | | |
|---|---|---|---|
| | Centrifugal Pumps | per pump | reaserver. Water supply from local govt. body (Kolkata Municipal Corporation) |
| 1 HP | Single Phase | | Reservoir to OHT |
| 0.5HP | Single Phase | | Reservoir to OHT |

2 (two) water pumps are used daily and 1 (one) water pump reserved for emergency purpose. It is recommended to use one water pump alternately.

### 9. Rain Water Harvesting

Water harvesting means capturing rain water, where it falls and capture the runoff from catchment and streams etc. Generally, water harvesting is direct rainwater collection. This collected water could be stored for later use and recharged into the ground water again. There is an advance phase of installation with a plinth area of 150 sq ft in the college. Rain water from catchment roof to be passed through granules followed by dugwells to recharge to the layers of the earth.

## 10. Carbon Neutrality

Students and staff members are made aware of pollution caused by use of vehicles and bicycles. Most of the students in the college use bicycle for commuting and most of the staff members reside nearby. They either avail public transport, bicycle or rickshaw. Besides, residences of some of the staff are in the vicinity of the college and they commute by walking. A maximum of 3 to 4 staff members out of all, use private car for coming. In the college campus almost 60% of students are using bicycles, 20% of student using local transport and 10% of student using private conventional vehicles. The college has cycle-stand capacity of 400 cycles. The carbon consumption awareness programme improves carbon emission at individual as well as social

level. It also helps the college authorities to avoid air and noise pollution in the campus due to vehicles or any activity in it.

**11. Environment Awareness Programme**

a. Air Pollution its causes, effects & installation of various devices that reduces the air pollution.
b. Water Pollution its causes, effects & various methods to prevent the it.
c. Sound Pollution its causes, effects & installed equipments that reduces it.
d. Noise Pollution its effects on surroundings.

A comprehensive list of environment awareness programme conducted by the college has been given in ***Annexure II***

## 12. Plantation and Gardening

Activities organised in the campus to upkeep the greenery profile in the campus

### 12.1 Plantation of Diversified species

To create- green cover, eco-friendly atmosphere, pure oxygen at the college campus, plantation program is organized every year with involving all students, principal, and all departments faculty members. To keep the greeneries in the campus, the college regularly maintain the gardens which are looked after by paid staff under the guidance of garden committee members.

The following bird species are observed inside the college campus.

| SL. NO | LOCAL NAME | ENGLISH NAME | SCIENTIFIC NAME |
|---|---|---|---|
| 1 | Haryal | Yellow leged green pigeon | *Treron phoenicoptera* |
| 2 | Tile ghughu | Spotted dove | *Streptopelia chinensis* |
| 3 | Papiya | Common hawk cuckoo | *Cuculus varius* |
| 4 | Kokil | Koel | *Eudynamys scolopacea* |
| 5 | Nilgala | Bluethroated barbet | *Megalaima asiatica* |
| 6 | Chil | Pariah Kite | *Milvus migraus* |
| 7 | Tia | Rose ringed parakeet | *Psittacula krameri* |
| 8 | Lakkhi Pencha | Barn owl | *Tyto alba* |

| | | | |
|---|---|---|---|
| 9 | Batasi | House swift | *Apus affinis* |
| 10 | Bauri | Coppersmith Barbet | *Megalaima haemacephala* |
| | | Lesser Golden backed Woodpeaker | |
| 11 | Katthokra | | *Dinopium benghalense* |
| | | Falvous brested pied Woodpeaker | |
| 12 | Katthokra | | *Picoides macei* |
| 13 | Bene bau | Black headed Oriole | *Oriolus xanthomus* |
| 14 | Kubo | Pheasant or Coucal | *Centropus sinensis* |
| 15 | Phinge | Black Drongo | *Dierurus adsimilis* |
| 16 | Go Salik | Pied Myna | *Sturnus contra* |
| 17 | Salik | Common Myna | *Acridotheres tristis* |
| 18 | Jhunt Salik | Jungle Myna | *Acridotheres fuscus* |
| 19 | Handichacha | Indian Tree pie | *Dendrocitta vagabunda* |
| 20 | Kak | House Crow | *Corvus splendens* |
| 21 | Danr Kak | Jungle Crow | *Corvus macrorhynchos* |
| 22 | Sipahi Bulbul | Red Whiskered Bulbul | *Pycononotus jacosus* |
| 23 | Bulbuli | Red Vented Bulbul | *Pycononotus cafer* |
| 24 | Chatare | Jungle Babbler | *Turdoides striatus* |
| 25 | Tuntuni | Tailor Bird | *Orthotomus sutorins* |
| 26 | Doyel | Magpie Robin | *Copsychus saularis* |
| | Sada Khanjan | | |
| 27 | | White Wagtail | *Motacilla alba* |
| | Durga Tuntuni | | |
| 28 | | Purple Sunbird | *Nectarinia asiatica* |
| 29 | Moutusi | Purple Rumped Sunbird | *Nectarinia zeylonica* |

### 12.2. Vegetative propagation

To learn how to propagate the garden vegetation, training program is organized for students every year by expert gardener. Students learned various propagation techniques like cutting, grafting, gooty etc.

### 12.3 Uses of medicinal plants

There are some medicinal plants are planted in college campus. Identification of suitable place for planting medicinal plant should be look into. Educating students about scientific nomenclature and the usability of the medicinal plants will certainly help the students in the long-term.

### 12.4 Identification of plant species

Existing profile of the trees and plantation is given below

| Sl. No. | Local Name | English Name | Scientific Name |
|---|---|---|---|
| 1 | Dumur | Fig | *Ficus hispida* |
| 2 | Dau | Monkey fruit | *Artocarpus lakoocha* |
| 3 | Debdaru | Mast tree | *Polyalthia longifolia* |
| 4 | Shiuli | Night Jasmine | *Nyetanthes arbor-pristis* |
| 5 | Ashoke | Ashoka | *Saraca asoca* |
| 6 | Kanthal | Jack tree | *Artocarpus heterophyllus* |
| 7 | Aam | Mango | *Mangifera indica* |
| | Rudra palash | | |
| 8 | | African tulip tree | *Spathodea campanulata* |
| 9 | Tagar | Tagara | *Valiriana wallichi* |
| 10 | Kath Badam | country-almond | *Terminalia catappa* |
| 11 | Cycus | Cycus | *Cycus sp.* |
| 12 | Mahagoni | Mahagony | *Swietnia mahagoni* |
| 13 | Amlaki/Amla | Indian gooseberry | *Phyllanthus embelica* |
| 14 | Jaba | Hibiscus | *Hibiscus rosasinensis* |
| 15 | Jaam/Jamun | Black plum | *Syzygium cuminii* |
| 16 | Pata Bahar | garden croton | *Codiaeum variegatum* |
| 17 | Bakul | Spanish cherry | *Mimusops elengi* |
| 18 | Radhachura | Copperpod | *Peltophorum pterocarpum* |
| 19 | Peyara | Guava | *Psidium guajava* |
| 20 | Neem | Neem | *Azadirachta indica* |
| 21 | Jarul | Queen of flowers | *Lagerstroemia speciosa* |
| 22 | Sheora | Indian toothbrush tree | *Streblus asper* |

| | | | |
|---|---|---|---|
| 23 | Shishoo | North Indian Rosewood | *Dalbergia sissoo* |
| 24 | Kadam | Old man's head | *Neolamarekia cadamba* |
| 25 | Bot | Banyan | *Ficus bengalensis* |
| 26 | Ashwaththa | Pipal | *Ficus riligiosa* |
| 27 | Palm | | |
| 28 | Shimul | Red silk cotton tree | *Bombax ceiba* |

## 13. Conclusion

The college campus follows a height of carbon neutrality practices with an endeavour to greening almost fifty percent of its electricity from solar power plant. Most of the students use bicycle for their daily commute. Available shade free rooftop may generate solar power which may exceed the annual energy requirement of the college. However, existing rooftop solar policy of the state government / DISCOM may not support the switch to solar power completely but majority of electrical requirement can be replaced by rooftop solar system.

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