# Environment and Green Audit


## INVERTIS UNIVERSITY

INVERTIS VILLAGE, BAREILLY–LUCKNOW NATIONAL HIGHWAY,
NH-24, BAREILLY, UTTAR PRADESH - 243123

CONDUCTED BY :

**A-Z ENERGY ENGINEERS PVT. LTD.**

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# Executive Summary

A nation's growth starts from its educational institutions, where the ecology is thought as a prime factor of development associated with environment. A clean and healthy environment aids effective learning and provides a conducive learning environment. Educational institutions now a day are becoming more sensitive to environmental factors and moreconcepts are being introduced to make them eco-friendly. To preserve the environmentwithin the campus, various viewpoints are applied by the several educational institutes to solve their environmental problems such as promotion of the energy savings, recycle ofwaste, water reduction, water harvesting etc. The activities pursued by university can also create a variety of adverse environmental impacts.

**Environmental auditing** is a process whereby an organisation's environmental performance is tested against its environmental policies and objectives.

Green audit is defined as an official examination of the effects a university has on the environment. As a part of such practice, internal environmental audit (Green Audit) is conducted to evaluate the actual scenario at the campus.

Green audit can be a useful tool for a university to determine how and where they are using the most energy or water or resources; the university can then consider how to implement changes and make savings. It can also be used to determine the type and volume of waste, which can be used for a recycling project or to improve waste minimization plan. Green auditing and the implementation of mitigation measures is a win-win situation for all the university, the learners and the planet. It can also create health consciousness and promote environmental awareness, values and ethics. It provides staff and students better understanding of Green impact on campus. Green auditing promote financial savings through reduction of resource use. It gives an opportunity for the development of ownership, personal and social responsibility for the students and teachers.

If self-enquiry is a natural and necessary outgrowth of a quality education, it could also be stated that institutional self enquiry is a natural and necessary outgrowth of a quality educational institution. Thus it is imperative that the university evaluate its own contributions toward a sustainable future. As environmental sustainability is becoming an increasingly

important issue for the nation, the role of higher educational institutions in relation to environmental sustainability is more prevalent.

# Introduction

In INVERTIS UNIVERSITY, Bareilly the audit process involved initial interviews with management to clarify policies, activities, records and the cooperation of staff and students in the implementation of mitigation measures.

This was followed by staff interviews, review of records, observation of practices and observable outcomes. In addition, the approach ensured that the management and staff are active participants in the green auditing process in the university.

The baseline data prepared for the INVERTIS UNIVERSITY, Bareilly will be a useful tool for campus greening, resource management, planning of future projects, and a document for implementation of sustainable development of the university. Existing data will allow the university to compare its programmes and operations with those of peer institutions, identify areas in need of improvement, and prioritize the implementation of future projects. We expect that the management will be committed to implement the green audit recommendations.

Water is a very precious commodity and merely by un-restricted drawing of water from bore wells and its very low subsidized tariff from municipal authority is a main impediment in water conservation in India.

Though, water is renewable and is replenished through water cycle but increasing population and industrial requirement are posing a very serious threat on availability of water for all on the Earth.

It is excellent that the management of INVERTIS UNIVERSITY, Bareilly and other staff has great respect for sustainable living and are always acting at the right time for remedial measures for protection of Environment and ultimately caring for Society by reduction of resource use.

**The Mantra followed is REDUCE-REUSE AND RECYCLE.**

# General Recommendations

- Display of Green Policy at following prominent locations inside the premises.
  a. Near main gate
  b. At main entrance of Administrative Building
  c. All Hostels/Mess
  d. Academic Blocks
  e. Auditorium
  f. Canteen/Cafeteria.
- Signage for Tobacco free campus be displayed at prominent locations in campus.
- Signage for Food wastage be displayed at important locations of Canteen/Messes and Cafeteria in campus.
- Signage for Water conservation be displayed at important locations in campus.
- Signage for plastic free campus
- Signage for Segregation of waste.
- Provision of different dust bins as a set at a common location.
- Stack Height of DG set exhaust is not as per CPCB requirement.
- Fume exhaust hoods are not provided in chemistry lab which is not proper. It should be discharged above building height. Presently fumes are dispersing around building affecting local environment.

# Environmental & Green Policy– Invertis University Bareilly

## Policy Statement

The Invertis University, Bareilly is committed to managing its estates in accordance with responsibilities to the environment. These responsibilities shall be demonstrated within the following areas as a minimum:

1. **Tobacco Free premises**: The college administration pledges to make the premises totally tobacco free. No smoking or other type of tobacco products shall be allowed to inside the University campus.

2. **Purchasing:** In purchasing its services, materials, equipment and consumable items, the University will, where possible, purchase items produced in ways which do least environmental harm, which are not supplied with excessive packaging; which are benign or at least harmless in their effect on the environment. Where possible, preference will be given to local or regional suppliers to maximize the university input to the local community as well as reduction of environmental impact due to transportation.

3. **Cleaning**: The University shall use cleaning products based on environmental considerations as well as cost and suitability. It will monitor its working practices with a view to administering dosages so as to reduce the risk of over concentration and excess residue of unused cleaning mixtures finding their way into piped waste disposal systems.

4. **Waste Disposal and Recycling**: The University will seek to minimize its generation of waste by reduction of purchased materials where this does not compromise its primary functions, or by re-use of materials within or outside the university campus. Where reduction or re-use is not feasible, materials will be recycled wherever possible. University already has vermin composting pits in the backyard of ground.

5. **Energy**: The University is environmentally responsible for its use of energy, and will therefore consider the sources, type, origin and destination of energy input and output throughout the College. This will require careful monitoring of consumption, the elimination of excessive or unnecessary use, and an ongoing program of energy

conservation. There is already renewable energy solar PV plants installed and in future also efforts shall be made to use renewable energy to the extent possible for mitigation of impact of energy use by university on environment.

6. **New Build and Building Refurbishment:** The College will ensure that whenever new construction or refurbishment, work is planned and executed in a manner which reflects environmentally-responsible approaches defined by the National Building Code-2016.

7. **Green Travel Plan**: The University actively promotes the use of public transport, walking and cycling. The College owns vehicle and requires staff where possible to use public transport when on College assignments. This plan is regularly reviewed. The travelof students shall also be encouraged through public transport.

8. **Food Policy** : The College, will ensure that decisions pertaining to the purchase of food, together with the use and disposal of plastic crockery/cutlery, should at all times include environmental implications as well as such factors as cost and nutritional value.

9. **Environmental Rules and Guidelines**: The College commit to ensure compliance to extant pollution control and other applicable environmental guidelines. University is already installing 700 plants every year and reporting to Divisional Forest Officer, Bareilly.

10. **Water Use**: The University intends to promote optimization of water use by avoidance of wastage.

11. **E-Waste:** University has already signed a MoU to dispose its E-Waste and committed toward it.

12. **The college also commits for Plastic free environment in college premises**.

13. **University has certification for ISO 9001: 2015 (Quality Management System), ISO/IEC 27001: 2013 (Information Security Management System) & ISO 14001:2015 (Environment Management System).**

**The policy shall be reviewed annually or as per requirement.**

# Description of Campus

## There are following blocks constructed in campus

1. Admin office
2. M-Block
3. B-Tech building
4. Seminar building
5. Faculty quarter A
6. Faculty quarter B
7. Nilgiri hostel
8. Shivalik hostel
9. Himgiri hostel
10. Bhagirathi hostel main tank
11. Bhagirathi hostel
12. University building
13. Caffee

### Pre-Audit meeting

A pre-audit meeting provided an opportunity to reinforce the scope and objectives of the audit and discussions were held on the practicalities associated with the audit. This meeting isan important prerequisite for the green audit because it is the first opportunity to meet the University concerned personnel for audit and deal with any concerns.

### Management's Commitment

The Management of the university has shown the commitment towards the green auditing during the pre-audit meeting. They were ready to encourage all green activities. It was decided to promote all activities that are environment friendly. Awareness programs on the environment are regularly conducted, the management of the University was willing toformulate policies based on green auditing report.

### Scope and Goals of Green and Environment Auditing

A clean and healthy environment aids effective learning and provides a conducive learning environment. There are various efforts around the world to address environmental education issues. Green Audit is the most efficient and ecological way to manage environmental

problems. It is a kind of professional care, which is the responsibility of each individual who are the part of economical, financial, social, environmental factor. It is necessary to conduct green audit in university campus because students become aware of the green audit, its advantages to save the planet and they become good citizen of our country. Thus, Green audit becomes necessary at the university level.

## Benefits of the Green and Environment Auditing

- More efficient resource management
- To provide basis for improved sustainability
- Financial savings through a reduction in resource use
- Enhance the alertness for environmental guidelines and duties
- Development of ownership, personal and social responsibility for the University and its environment
- Enhancement of university profile
- To create a green campus
- To enable waste management through reduction of waste generation, solid- waste and water recycling
- To create plastic free campus and evolve health consciousness among the stakeholders
- Recognize the cost saving methods through waste minimizing and managing and monitoring of environmental and sustainable development
- Developing an environmental ethic and value systems in youngsters.
- Point out the prevailing and forthcoming complications
- Authenticate conformity with the implemented laws
- Empower the organizations to frame a better environmental performance
- Impart environmental education through systematic environmental management approach and Improving environmental standards
- Benchmarking for environmental protection initiatives

- Green audit is a valuable tool in the management programs of the university.

## Target Areas of Green and Environment Auditing

Green audit forms part of a resource management process. Although they are individual events, the real value of green audits is the fact that these are carried out at defined intervals, and their results can illustrate improvement or changeover time. Eco-campus concept mainly focuses on the efficient use of energy and water; minimize waste generation or pollution and also economic efficiency.

All these indicators are assessed in process of "Green Auditing of educational institute". Eco-campus focuses on the reduction of contribution to emissions, procure a cost effective and secure supply of energy, encourage and enhance energy use conservation, promotes personal action, reduce the institute's energy and water consumption, reduce wastes to landfill, and integrate environmental considerations into all contracts and services considered to have significant environmental impacts. Target areas included in this green auditing are water, energy, waste, green campus and carbon footprint.

## Auditing for Energy Management

Energy cannot be seen, but we know it is there because we can see its effects in the forms of heat, light and power. This indicator addresses energy consumption, energy sources, energy monitoring, lighting, appliances, and vehicles. Energy use is clearly an important aspect of campus sustainability and thus requires no explanation for its inclusion in the assessment. An old incandescent bulb uses approximately 60W to 100W while an energy efficient light emitting diode (LED) uses only less than 10 W. Energy auditing deals with the conservation and methods to reduce its consumption related to environmental degradation. It is therefore essential that any environmentally responsible institution examine its energy use practices. **LED use also has a peculiar advantage towards environment that LED's are not using any mercury as the case of CFL's or Fluorescent tubes.**

**There is an endeavour to check, manage and optimize energy use for mitigating the impact of university activities on Environment.**

**Also the university has taken a lead for producing green energy from Solar PV panels already installed 800 kWp.**

# Auditing for Waste Management

**The university has entered into a contract with agency for food waste management handling.**

Pollution from waste is aesthetically unpleasing and results in large amounts of litter in our communities, which can cause health problems. Plastic bags and discarded ropes and strings can be very dangerous to birds and other animals.

This indicator addresses waste production and disposal, plastic waste, paper waste, food waste, and recycling. Solid waste can be divided into two categories:

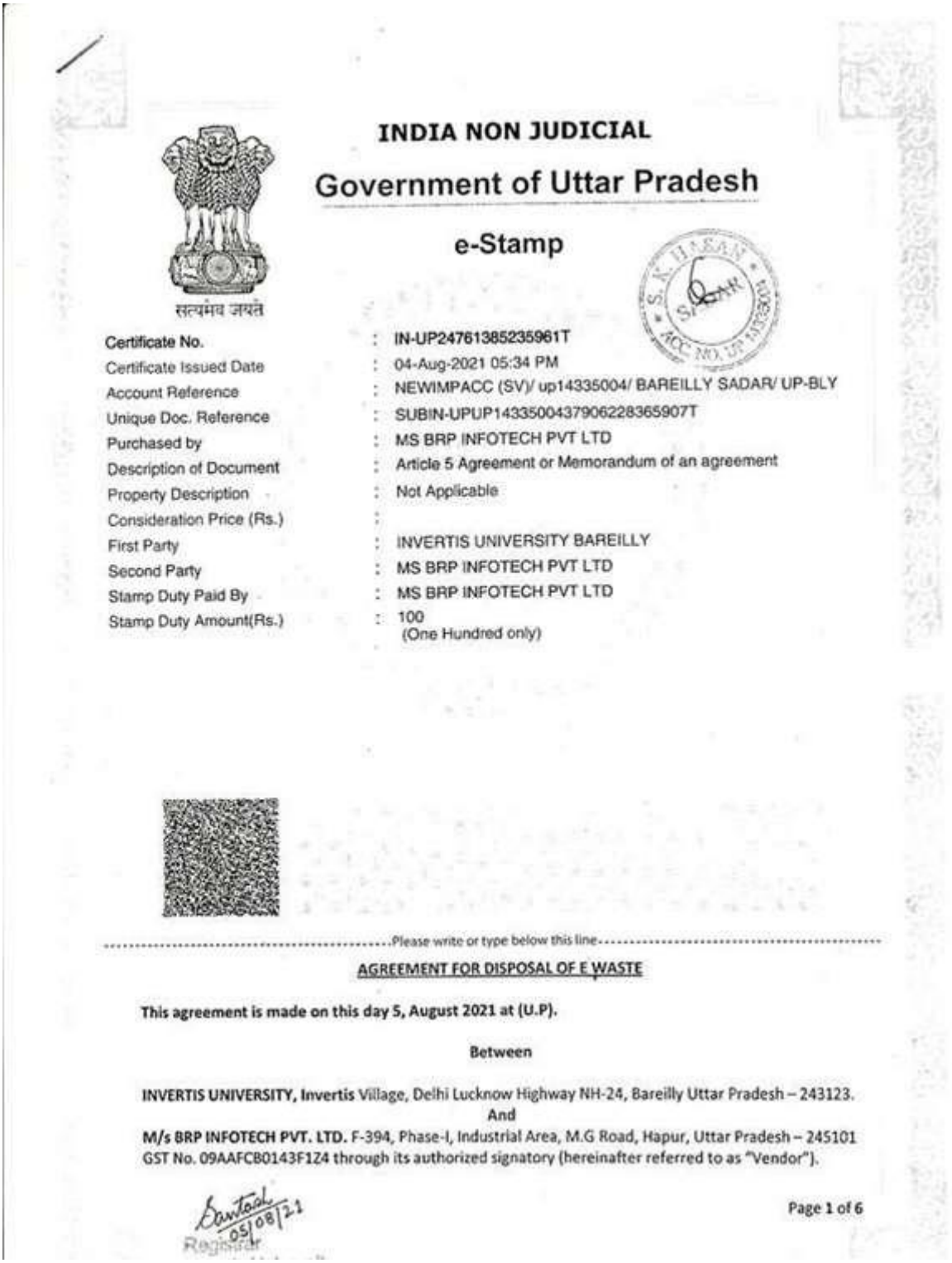
### General waste and hazardous waste

General wastes include what is usually thrown away in homes and schools such as garbage, paper, tins and glass bottles. Hazardous waste is waste that is likely to be a threat to health or the environment like cleaning chemicals and petrol. Unscientific landfills may contain harmful contaminants that leach into soil and water supplies, and produce greenhouse gases contributing to global climate change.

Furthermore, solid waste often includes wasted material resources that could otherwise be channelled into better service through recycling, repair, and reuse. Thus the minimization of solid waste is essential to a sustainable campus. The auditor diagnoses the prevailing waste disposal policies and suggests the best way to combat the problems. It is therefore essential that any environmentally responsible institution examine its waste processing practices.

**E-Waste:** The old computers are sold back to vendor which is again put to beneficial use by repairing and it is good sustainable practice. Material not reusable is re-cycled as per extant guidelines. Key Boards and mouse, which become un-serviceable are also disposed-off. It is required to be ensured that vendor dealing with E-waste is authorised to collect E-waste.

**Presently university has a MoU with E-Waste authorised vendors who can handle E-waste are being engaged for management of E-waste.**



सत्यमेव जयते

**INDIA NON JUDICIAL**

**Government of Uttar Pradesh**

**e-Stamp**

| | | |
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| Certificate No. | : | IN-UP24761385235961T |
| Certificate Issued Date | : | 04-Aug-2021 05:34 PM |
| Account Reference | : | NEWIMPACC (SV)/ up14335004/ BAREILLY SADAR/ UP-BLY |
| Unique Doc. Reference | : | SUBIN-UPUP14335004379062283659O7T |
| Purchased by | : | MS BRP INFOTECH PVT LTD |
| Description of Document | : | Article 5 Agreement or Memorandum of an agreement |
| Property Description | : | Not Applicable |
| Consideration Price (Rs.) | : | |
| First Party | : | INVERTIS UNIVERSITY BAREILLY |
| Second Party | : | MS BRP INFOTECH PVT LTD |
| Stamp Duty Paid By | : | MS BRP INFOTECH PVT LTD |
| Stamp Duty Amount(Rs.) | : | 100 (One Hundred only) |

.....Please write or type below this line.....

**AGREEMENT FOR DISPOSAL OF E WASTE**

**This agreement is made on this day 5, August 2021 at (U.P).**

**Between**

**INVERTIS UNIVERSITY, Invertis** Village, Delhi Lucknow Highway NH-24, Bareilly Uttar Pradesh – 243123.

And

**M/s BRP INFOTECH PVT. LTD.** F-394, Phase-I, Industrial Area, M.G Road, Hapur, Uttar Pradesh – 245101 GST No. 09AAFCB0143F1Z4 through its authorized signatory (hereinafter referred to as "Vendor").

05/08/21

Registrar

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**Hazardous Waste**: Lead Acid Cell Batteries are returned to Vendors for re-cycling of lead and other constituents.

**Fluorescent tubes** are handed over to Junk dealer who in turn should send them to Local re-cycling units. Storage of Fluorescent tubes in university should be as per recommended practice.

## Auditing for Green Campus Management

Unfortunately, biodiversity is facing serious threats from habitat loss, pollution, over consumption and invasive species. Species are disappearing at an alarming rate and each loss affects nature's delicate balance and our quality of life. Without this variability in the living world, ecological systems and functions would break down, with detrimental consequences for all forms of life, including human beings. Newly planted and existing trees decrease the amount of carbon dioxide in the atmosphere. Trees play an important ecological role within the urban environment, as well as support improved public health and provide aesthetic benefits to cities. In one year, a single mature tree will absorb up to 48 pounds of carbon dioxide from the atmosphere, and release it as oxygen. The amount of oxygen that a singletree produces is enough to provide one day's supply of oxygen for people. So while youare busy studying and working on earning those good grades, all the trees on campus are also working hard to make the air cleaner for us. Trees on our campus impact our mental health aswell; studies have shown that trees greatly reduce stress, which a huge deal is considering many students are under some amount of stress.

## E-Waste disposal

The record of use and handling of E-waste is maintained .While disposing/Auction or sale of E-waste credential of purchaser should be documented to ensure that vendor is authorised for collection and ensuring re cycling of E-waste as per extant guidelines.

- **Hazardous waste (toxic)-yes**

  For safe handling and management of hazardous waste in an environmentally soundmanner, Govt. of India has notified the Hazardous Waste (Management & Handling) Rules, 1989, under the Environment (Protection) Act, 1986. However, these Rules were suppressed with re notification of the Hazardous Wastes (Management, Handling and Trans boundary Movement) Rules, 2008. Under the said Rules, hazardous waste has been

defined as those wastes which by reason of any of its physical, chemical, reactive, toxic, flammable, explosive or corrosive characteristics causes danger or is likely to cause danger to health or environment, whether alone or when in contact with other wastes or substances, and shall include wastes as specified in Schedules of the Rules.

- Solid waste-yes-Extra waste removed through truck and disposed in municipal waste collection points
- Dry leaves-Yes-Used in university for making manure/compost
- Canteen waste-yes-Used for Compost in university
- Liquid waste-yes-Preserved and used in university
- Glass-Yes-sent for recycling.
- Unused equipment-yes-Returned to vendors through sale
- Plastic waste-Yes-Segregated and removed

## Canteen Waste-Handling practice

There are signs provided in Mess and Cafeteria for avoiding food wastage and take food as per requirement and there should not be any food wastage. These signage are required to be provided in all area where food is served or consumed.

1. All Hostel Mess
2. Canteen
3. Cafeteria

## Food Procurement And Disposal

1. Food is prepared in Canteen/Mess and any food waste that is generated is now planned to be filled in compost pits for preparation of natural manure.
2. A good effort has been made to maintain all waste data for food. Record for all other types of wastes is also required to be maintained for better management.
3. Effort should be made for reduction of onsite wastages.

**Consumer Level:**

As per the present observed practice at consumer level in the society at large, often, the used lamps are collected by the kabari from the households and collectively handed over to the glass recyclers for the recovery of glass material.

This is all operative in a highly unorganized sector. It has, also, been observed that, the used lamps are thrown in the garbage bins and finally into the municipal garbage dumpsites, contaminating air, water and soil. Most of the used lamps are broken either at transit solid waste bins (provided by local civic authority) or broken during the transport to the final disposal site.

A portion of the mercury, in vapor form, is released into the air; whereas rest of the mercury is released onto the soil with further possibility of getting into the surface and/or ground water bodies through the leachate from soil.

**User Awareness**:

All the consumers, individual domestic consumers and bulk consumers (offices, institutions, large residential complexes, etc.) should get fully aware about the potential health impact of mercury-bearing lamps, through audio-visual media and the product leaflets. The precautions, to be taken while cleaning up the broken FLs should, also, be known to the consumers. As a part of such awareness programs, the consumers, even at individual level, are expected to participate actively with constructive suggestions and provide the feedback, for the overall success of mercury management in fluorescent lamp

Collection: The collection of used lamps may be done mainly by two ways: (i) Collection of used lamp (FLs) from bulk consumers may either be arranged by the management of above set-up (institutions, etc.) for direct disposal to LRU or by the LRU which may arrange to pickup used lamps from such collection sites through an identified collection agency. (ii) Collection of used lamps (FLs) from individual domestic consumer may be arranged by the LRU, either through kabaris (individuals appointed for the purpose by LRU) or an identified collection agency for door to door pickup. Transportation: (i) The Handler (e.g. Kabari or representative of LRU) of used FLs in transit should take care of selection of proper vehicle and carriage so as to minimize breakage of used FLs.

(ii) There should not be any intermediate transfer of materials in the transit stage. The collected used FLs should be straight transported to the LRF for further processing. (iii) The Handler should be trained to take care of mercury spills, if any, that takes place en-route the journey to LRU.

# Noise Pollution

### 1. Sounds of Normal Conversations:

***Sound Intensity:*** 40-60 dB

***Health Hazard:*** Sound less than 80 dB is safe for the ear.

### 2. Sounds emanating from Tape recorders or an Orchestra:

***Sound Intensity:*** 70 dB

***Health Hazard:*** It is safe for ear.

### 3. Sounds of Heavy Traffic:

***Sound Intensity:*** 90 dB

***Health Hazard:*** Constant exposure to sound greater than 80 dB causes temporary hearing loss and if they are not treated immediately, causes permanent impairment.

### 4. Sounds of Pneumatic drills and other machines:

***Sound Intensity:*** 100 dB

***Health Hazard:*** Constant exposure causes temporary hearing loss and if they are not treated immediately, causes permanent impairment.

### 5. Sounds of Aircraft engine:

***Sound Intensity:*** 100-200 dB

***Health Hazard:*** Higher noise level of 160 dB cause total deafness, rupturing eardrums, damaging inner ear. It also causes high blood pressure, ulcer in stomach, palpitation, nervous problems, irritation, anger, and affects pregnant women's embryo.

### 6. Sounds of Rockets during Takeoff:

***Sound Intensity:*** 200 dB

***Health Hazard:*** It is dangerously causing total deafness by rupturing the eardrums and damaging the inner ear. It also causes high blood pressure, ulcer in stomach, palpitation, nervous problems, irritation, anger, and affects pregnant women's embryo.

## Decibels Measurement –Invertis University

| Sr.No. | Location | Decibel level Measurement | Remarks |
|---|---|---|---|
| 1 | Admin office | 48 | Satisfactory |
| 2 | M-Block | 47 | Satisfactory |
| 3 | B-Tech building | 48 | Satisfactory |
| 4 | Seminar building | 49 | Satisfactory |
| 5 | Faculty quarter A | 46.5 | Satisfactory |
| 6 | Faculty quarter B | 48 | Satisfactory |
| 7 | Nilgiri hostel | 49.5 | Satisfactory |
| 8 | Shivalik hostel | 52.7 | Satisfactory |
| 9 | Himgiri hostel | 51.3 | Satisfactory |
| 10 | Bhagirathi hostel main tank | 51.0 | Satisfactory |
| 11 | Bhagirathi hostel | 50.5 | Satisfactory |
| 12 | University building | 47.2 | Satisfactory |

**Sound/Decibel level measured is satisfactory and there is no adverse impact of the same on occupants.**

## Custodial Chemical Use

Chemical for one year requirement are used in Labs and these are stored in a separate store. The store requires to be ventilated and hazard analysis should be got done through Material Specification Data Sheet and record should be maintained. Proper ventilation with hoods should be designed.

There is practice of burial of chemical waste in the soil in the university campus, This causes pollution of soil. The chemicals collected be disposed as per guidelines so that there is

## Transportation Practices

Most of students are using shared transport, there is a university bus arranged to ferrystudents from nearest bus stand to university campus, which is sustainable. Students are usingBuses, Shared auto. There are many buses owned by the university. The consumption of HSDby buses is monitored for optimised consumption.

Teaching and Non Teaching faculty is also sensitized for using pooled transportation for working towards sustainability and reducing resource use and encouragement of resource conservation.

## Procurement Practices To Be Followed

**Presently there is no practice to consider impact of procurement of different items on the Environment.**

Procurement team is required to be made aware regarding procurement of goods and services that are sustainable. The sensitization is required for all purchases in a way that optimized utilisation of natural resources is possible.

1. Paper with Recycle content

2. AC's using refrigerant with Zero ODP Refrigerant

3. Environmental friendly Housekeeping Chemicals

4. Paints, Adhesives, sealants with recommended percentage of volatile organic compound.

## Paper Use and Printing Goals

1. Efforts should be directed through use of E-Books for reducing the use of paper.
2. Students are encouraged to make use of E- Library.

3. There are instructions to staff and student to resort to printing only if it is un-avoidable.

4. Papers should be purchased that have recycled content.

**Recommended Paper use and Printing Goal to be followed. All concerned are required to be sensitized for adhering to these practices.**

1. Distribute memos, reports, purchase orders and brochures electronically.
2. Encourage re-use of scrap paper for printing and note taking. Larger printers should have one dedicated tray for the reuse of scrap paper.
3. Print on letterhead paper only as needed; use electronic letterhead whenever possible
4. Network all printing to shared copiers/printers and eliminate stand-alone printers where possible
5. Discourage reckless printing and copying by requiring use of an account/password
6. Promote a 'Think before you Print' culture
7. Desktop drafting and editing of documents
8. Reduce default margin settings
9. Use toner-saving fonts (e.g. EcoFont) or smaller-sized fonts
10. Encourage increased use of Blackboard /Electronic Board as a paper-free resource
11. Training and Adherence - Distribute (an) email(s) with detailed instructions, including "screen shots" on how to change settings on computers, copiers, faxes, printers
12. Establish duplex (two-sided) copying and printing as standard
13. Phase out meeting handouts and distribute/project them electronically (this needs to be better defined).
14. Digitize forms and administrative and admission processes. Continue replacing paper based processes and administration.
15. Double-sided student assignments as standard (with electronic submission, grading & return)
16. Faxes: phase out fax machines, utilize computer faxing, end use of fax cover pages (research applicable technology/software: Win fax? E-fax?)
17. Increase electronic archiving and record keeping (this needs to be better defined and targets identified; work with Purchasing, Personnel, Academic Department and/or Student Records to be determined)

# E-Library

**E-books v/s Traditional books data and year wise history to moving from traditional to E-system.**

**There is constant endeavour to promote use of E-Books, which is a very positive effort.**

Despite fewer in numbers the e-books have advantage of being used by multiple students/ faculty simultaneously and thus creating better impact on sustainability in contrary to hard copy that can be read by only one person at a time.

The following recommendations are made

1. Use of E-books be promoted for students and faculty members specially in present Covid situation.
2. No. of E-books made available should be increased continuously.
3. Training on sustainability should be provided.
4. Adaption be promoted considering it to be a new normal.
5. Targets for increasing E-books should be fixed on continual basis.

**Training and Awareness**

The university is regularly conducting awareness program for students and faculty members.

**Governance**

Through enactment Waste Management and Green Initiative policy and its circulation to all stake holders, sustainability can be achieved. The results are regularly required to be verified at Periodical intervals. These can be managed through internal or external audits.

# Plantation at Invertis University, Bareilly

## Plantation Inventory

There is regular plantation program in vogue. University is planting 700 trees yearly from last three years and reporting to divisional forest officer.

INVERTIS
UNIVERSITY BAREILLY

Ref No IU/RE-/2021 Date

To,
The DFO,
Bareilly.

Subject: Regarding plantation status and digging of pits at Invertis University, Bareilly

Dear Sir,

Kindly find the report regarding digging of pits and plants required at Invertis University,
Bareilly to meet the guidelines of the Government.

We have a target of 700 plants for this year and we have already planted some saplings and prepared 190 pits for plantation. Therefore, you are requested to provide 300 saplings for plantation to achieve our assigned target.

Thanking you, with regards.

23/06/2021

Santosh Kumar
Associate Professor
Registrar
Invertis University, Bareilly
Contact No.09690017906

To :- Higher Education officer, Bareilly

Received 24/6/21

Invertis Village, Bareilly Lucknow National Highway-24, Bareilly (UP)-243 123
• Ph. & Telefax: (0581) 2460142, 2460443, 3350000
• Fax: (0581) 3304233, 2460454 • Email: info@invertis.org

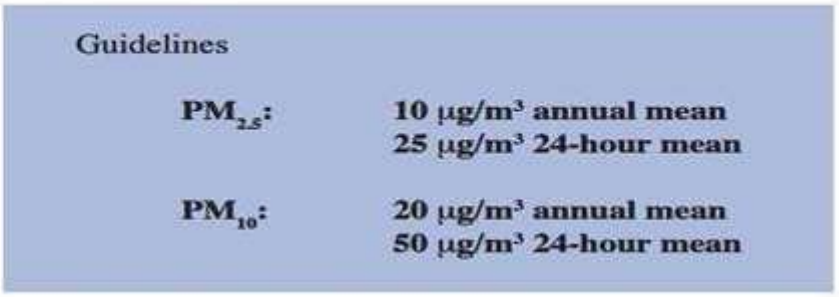
# Air Quality

**CPCB GUIDELINES**

**Exhaust of DG Set is required to be raised as per CPCB requirement**.
There is no record of air quality testing done earlier. Generally, the dust level is found normal since university is located outside the town .

As per WHO guidelines the following should be the limits for Air Quality

**Particulate matter**




## Air Quality Measurement

| Sr. no | Location | PM-2.5 | PM - 10 | Particles | CO-2 | HCHO | Remarks |
|---|---|---|---|---|---|---|---|
| 1 | Admin office | 60.1 | 88.3 | 6940 | 851 | 2.245 | Higher HCHO-Formaldehyde-Slightly Higher PM |
| 2 | M-Block | 59.4 | 89.8 | 7092 | 1023 | 0.147 | Slightly Higher PM |
| 3 | B-Tech building | 54.5 | 82.7 | 6872 | 745 | 0.027 | Slightly Higher PM |
| 4 | Seminar building | 57.4 | 87.6 | 6417 | 752 | 0.021 | Slightly Higher PM |
| 5 | Faculty quarter A | 57.1 | 88.8 | 6245 | 761 | 0.001 | Slightly Higher PM |
| 6 | Faculty quarter B | 55.5 | 82.3 | 6718 | 755 | 0.018 | Slightly Higher PM |
| 7 | Nilgiri hostel | 28 | 45.5 | 2828 | 666 | 0.02 | Slightly Higher PM |
| 8 | Shivalik hostel | 22.9 | 38.2 | 2849 | 779 | 0.077 | Slightly Higher PM |
| 9 | Himgiri hostel | 24.9 | 36.8 | 2953 | 780 | 0.45 | Slightly Higher PM |
| 10 | Bhagirathi hostel main tank | 70.2 | 102.3 | 7744 | 790 | 0.028 | Slightly Higher PM |
| 11 | Bhagirathi hostel | 60.3 | 90.7 | 7422 | 810 | 0.005 | Slightly Higher PM |
| 12 | University building | 70.2 | 102.3 | 7744 | 790 | 0.028 | Slightly Higher PM |

The values of PM-2.5 and PM-10 are slightly high and limits are dangerous for human beings. Values of CO2 and Formaldehyde are generally satisfactory except for Admn. area. There is not much that can be done by University for management of particulate matter. Only any loose soil or construction material inside premises should be sprinkled with water to mitigate to some extent.

## Significance of Refrigerant for Environment

**Table depicting properties of Refrigerants**

| Refrigerant | Global Warming Poetential | Ozone Depletion Potential |
|---|---|---|
| R 22 | 1810 | Medium |
| R 410A | 2088 | Nil |
| R 32 | 675 | Nil |
| R 134A | 1430 | Nil |
| R 290 | 3 | Nil |
| R 600A | 3 | Nil |

| Refrigerant | Type | ODP | GWP | Atmospheric lifetime (years) |
|---|---|---|---|---|
| R12 | CFC | 0.9 | 8500 | 102 |
| R22 | HCFC | 0.06 | 1700 | 13.3 |
| R134a | HFC | 0 | 1300 | 14 |
| R407C | HFC blend | 0 | 1610 | 36 |
| R410A | HFC blend | 0 | 1900 | 36 |
| Ammonia (R717) | Natural compound | 0 | 0 | < 1 |
| Propane (R290) | HC | 0 | 3 | < 1 |
| R1234yf | HFC unsat. | 0 | 6 | Very low |
| R1234ze | HFC unsat. | 0 | 6 | Very low |

### Detail of Refrigerant used in installed Air Conditioners

Data of Refrigerants not maintained. It is recommended that in future all procurement for AC's, Water cooler etc. be made with consideration for Environment friendly refrigerants.

### Recommendations

1. It is recommended that in future care should be taken to purchase Air conditioners with refrigerants for which GWP is low and ODP is nil.
2. Life cycle cost should be considered for making decision about purchase of Air Conditioners.
3. All AC's that were procured more than 8 years ago should be replaced with best in class energy efficient Air Conditioners after taking into consideration Life Cycle Cost. This will eliminate existing AC's impact on environment through low impact refrigerant and also with low consumption of Electricity thus reducing

## ECO Friendly House Keeping Materials

**Presently chemicals not complying to Green Pro certification are used. It isrecommended that in future housekeeping chemicals with Green Pro standard certification be only used.**

It is recommended that Eco Friendly material and Sustainable material as per NBC-2016 guidelines to be procured and used.

**GreenPro Certification Standard for**

**Cleaning Chemicals**

**Version 1.0**

## *GreenPro Certification – Life Cycle Approach*

The Green Products Rating adopts a holistic approach based on the 'Life Cycle' of the product. The rating system encourages the product manufacturers to implement measures that would result in environmental, health and wellbeing benefits at the following stages of the life cycle of the products.

1. Product Design
2. Raw materials
3. Manufacturing Process
4. Product Performance during use
5. Disposal / Recycling

For Users

Use of rated Green products leads to significant tangible and intangible benefits for the end users.

Some of the benefits for the users are highlighted as below:

1. Time and effort in carrying out due diligence in selecting a green product is saved
2. The user is assured of the performance of the product and equipment
3. Ensures Toxic and hazardous substances free products which in turn decrease "health and wellbeing" risks of the users
4. Improved product performance during use to reduce resource consumption and environmental impacts
5. Recognition and credits for achieving national and international Certification for the buildings

## *National Priorities addressed in Certification*

GreenPro Certification addresses the following which are priorities of the Government at the National level:

*Water:*

Water is a major concern in most part of the country. Implementation of water efficiency measures and "zero Liquid Discharge" are being encouraged to address the water related issues.

*Land:*

Availability of land and increase in land pollution are major areas of concern. The Certification system demands for increased recycling of material after use which would result in reduction in landfills and hence reduction in land pollution.

*Energy Efficiency:*

The Certification system encourages the product manufacturers to adopt energy efficiency improvement measures and reduce their energy consumption which is in line with the National Mission on Enhanced Energy Efficiency. This also addresses

**The key objective of the council is to facilitate Green product market transformation in India through 'Green Product Certification'.**

The initial focus of the council will be on Green building products and related technologies. Over a period of time, the council will expand its focus to other areas such as Industrial products, consumer items, services etc.

**Why GreenPro Certification?**

The GreenPro Certification is a tool for facilitating Green Product market transformation in the country. The GreenPro Certification is expected to:

1. Enable green building projects in selecting the right product and equipment
2. Increase the market demand for the Green products
3. Put a system in place for a product to be called 'green'

Eliminate exposure to prohibited substances that can lead to long term health effects either through respiration / direct contact.

Mandatory Requirement Manufacturer to provide Material Safety Data Sheet (MSDS) for the products. The MSDS should have the following details:

1. Chemical Identify

2. Manufacturer's information

3. Hazardous ingredients / Identify information

4. Physical, Chemical characteristics

5. Fire and explosion hazard data

6. Reactivity data

7. Health hazard data

8. Precautions of safe handling and use

9. Control measures

10. Emergency and first aid procedures

## General Purpose Cleaners

**Presently there is no practice for procurement of Eco Friendly chemical.**

Eco friendly housekeeping materials are recommended to be used for all cleaning application should be Green Pro or any similar Indian standard should be procured in future and records of such procurement b documented for future references.

The cleaning material may be required for following applications and also may be some other in addition to these.

1. Glass Cleaners
2. Bathroom Cleaners
3. Disinfectants and Sanitizers
4. Cleaner/Degreasers
5. Carpet and Upholstery Cleaners
6. Floor Cleaners
7. Liquid Hand Soap
8. Furniture Polish

## Ventilation Assessment

**There is no area which is not Air-conditioned. Mechanical ventilation has since been provided.**

### Fire Safety:

No halon based fire extinguishers have been used, it is very good initiative. As a future guideline It is recommended that of fire suppression system is to be used for any fire extinguishing system, only clean agents with minimum environmental impact should be installed.

# Sustainable Development Goals

Sustainable development should always be practiced in all activities of university.


## Consideration for New Constructions

**There are no construction presently going on and is also not mooted in near future.**

**There should be an effort to Encourage use of local materials**

Always encourage use of locally available material. With this we will help local population and their Social Development Index will get a boost. Also low energy shall be expanded on transportation that will ultimately save fossil fuels and make decision of an organization more sustainable.

**Low VOC (Volatile Organic Compound)%**

The following material contains VOC

1. Paints
2. Adhesives
3. Sealants
4. Other materials

It should be ensured that while procurement or issuing PO's for work it should be ensured that only material with permitted percentage of VOC are procured or used in of works awarded. Special conditions in contract/specifications shall be incorporated.

Team responsible for PMC shall ensure that material brought to site and used in execution of work is in compliance to Green specifications.

**Use of Low Impact material and Zero ODP material**

Where ever relevant and applicable care should be taken to include in specifications use of low impact material and only zero ODP material shall be procured or used in execution of works by contractors/Vendors.

## Guidelines for Environment Friendly and Green Initiatives

**VOC limits of materials**

| Type of Material | VOC Limit (g/L less water) |
|---|---|
| **Paints** | |
| Non- Flat (Glossy) paint | 150 |
| Flat (Mat) paint | 50 |
| Anti- corrosive/ anti-rust paints | 250 |
| Varnish | 350 |
| **Adhesives** | |
| Glazing adhesives | 100 |
| Tiles adhesives | 65 |
| Wood adhesive | 30 |
| Wood flooring adhesive | 100 |

**Minimum Ventilation Rates in Various Functional Zones***

| Occupancy Category | People Outdoor Air Rate | Area Outdoor Air Rate |
|---|---|---|
| | Cfm/person | Cfm/ sq.ft |
| **Correctional Facilities** | | |
| Dayroom, Guard station | 5 | 0.06 |
| Booking/ waiting | 7.5 | 0.06 |
| **Education Facilities** | | |
| Daycare (through age 4), daycare sickroom, Art Classroom, science laboratories, college laboratories, wood, metal shop | 10 | 0.18 |
| Classrooms (ages 5-8), (age 9+), computer lab, media centre | 10 | 0.12 |
| Lecture Room/ hall (fixed seating) | 7.5 | 0.06 |
| Music/ theater/ dance, | 10 | 0.06 |
| Multi use assembly | 7.5 | 0.06 |
| **Food & Beverages Services** | | |
| Restaurant dining rooms/ cafeteria/ fast food dining/ Bars/ Cocktail Lounges | 7.5 | 0.18 |
| **General** | | |
| Break Rooms, Coffee stations, conference/ meeting | 5 | 0.06 |
| Corridors | - | 0.06 |
| Storage Rooms | - | 0.12 |
| **Hotels, Motels, Resorts, Dormitories** | | |
| Bedroom/ living room, barracks sleeping areas | 5 | 0.06 |
| laundry rooms | 5 | 0.12 |
| Lobbies/ prefunction | 7.5 | 0.06 |
| Multipurpose assembly | 5 | 0.06 |

| Occupancy Category | People Outdoor Air Rate | Area Outdoor Air Rate |
|---|---|---|
| | Cfm/person | Cfm/ sq.ft |
| **Office Building** | | |
| Office Spaces, Reception Areas, Telephone, data entry, Main entry Lobbies | 5 | 0.06 |
| Electrical Equipment rooms | - | 0.06 |
| Elevator machine rooms | - | 0.12 |
| Pharmacy (prep area) | 5 | 0.18 |
| Photo Studios | 5 | 0.12 |
| Shipping/ receiving | - | 0.12 |
| Telephone closets | - | 0.00 |
| Transportation waiting | 7.5 | 0.06 |
| Warehouses | - | 0.06 |
| **Public Assembly Spaces** | | |
| Auditorium seating area, Place of religious worship, Courtrooms, Legislative Chambers, Lobbies | 5 | 0.06 |
| Libraries | 5 | 0.12 |
| Museums (children's) | 7.5 | 0.06 |
| Museum/ galleries | 7.5 | 0.06 |
| **Retail** | | |
| Sales | 7.5 | 0.12 |
| Mall common Areas | 7.5 | 0.06 |
| Barber Shop | 7.5 | 0.06 |
| Beauty & nail salons | 20 | 0.12 |
| Pet Shops (animal areas) | 7.5 | 0.18 |
| Super Market, Coin operated Laundries | 7.5 | 0.06 |

| Occupancy Category | People Outdoor Air Rate | Area Outdoor Air Rate |
|---|---|---|
| | Cfm/person | Cfm/ sq.ft |
| **Sports & Entertainment** | | |
| Sports arena (Play Area), Gym, stadium (play area) | - | 0.30 |
| Spectator area | 7.5 | 0.06 |
| Swimming (pool & deck) | - | 0.48 |
| Disco/dance floor/ health club/ aerobics room/ weight rooms | 20 | 0.06 |
| Bowling alley (seating) | 10 | 0.12 |
| Gambling casinos/ game arcades | 7.5 | 0.18 |
| Stages, studios | 10 | 0.06 |

* *Total outdoor air flow in functional zone =*

$$\left\{\begin{array}{c}\text{Outdoor air flow rate required per person as per the above table}\\ \times\\ \text{Zone population}\end{array}\right\} + \left\{\begin{array}{c}\text{Outdoor air flow rate required per unit area as per the above table}\\ \times\\ \text{Net occupiable zone area}\end{array}\right\}$$

## Landscape Water Demand Reduction

Plant factor for various species

| Plant species | Plant factor |
|---|---|
| Lawns | 1 |
| Native grass | 0.45 |
| Existing native trees | 0 |
| Newly planted native shrubs | 0.3 |
| Newly planted exotic shrubs | 0.9 |
| Newly planted native trees | 0.15 |
| Newly planted exotic trees | 1.65 |

| Plant species | Plant factor |
|---|---|
| Vertical gardens | 0.35 |
| Newly planted native shrubs on podium | 1.3 |
| Newly planted exotic shrubs on podium | 1.9 |
| Newly planted native trees on podium | 1.15 |
| Newly planted exotic trees on podium | 2.65 |
| ***Note: For potted plants, calculate the water requirement as volume of pot and divide it by 4.*** | |

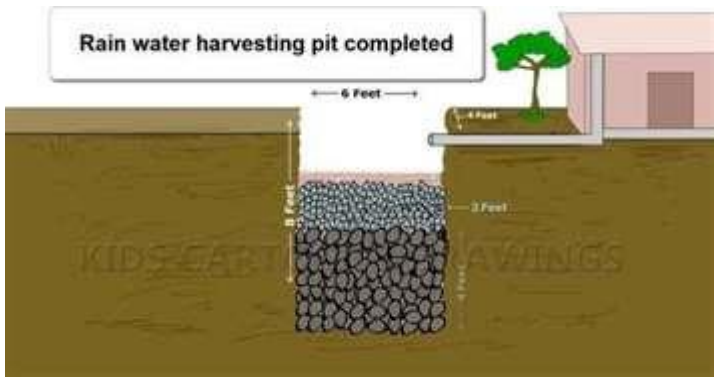
**Table 2** Irrigation system efficiency

| Type of irrigation system | Efficiency (%) |
|---|---|
| Flood | 65 |
| Furrow | 80 |
| Sprinkler | 85 |
| Drip | 90 |

# Photographs-Environmental Concerns

| Photographs Depicting Issues Related To Green And Environment Audit<br>Invertis University, Bareilly | |
|---|---|
|  | Two type of Bins have been provided for segregation of waste at source bins as shown in next photograph should be provided. |
|  | PREFERRED BINS-Onsite segregation of waste is not presently practiced. These type of bins should be provided at all locations. |

| | |
|---|---|
|  | Stack of DG sets are not as per requirement of CPCB Guidelines. These are required to be taken above height of building and stack height should be as following formula<br><br>Ht. of Stack = Ht of Building+ 0.2 * sq. root of kVA of DG set |
|  | Environment Parameters measurement-PM2.5, PM-10, CO2 and Formaldehyde and Total Particulate matter |

| | |
|---|---|
|  | Exhaust hoods of Labs not provided for chemistry Lab fumes. The fume hood is required to be providedraised to level above building. The final exhaust should be raised above building for proper dispersion of fumes. |
|  | Cool roof may be provided with covering at roof level for exposedroof with broken china mosaic tiles. The Air conditioning energy for the top floor shall be reduced to the extent of 15 % |
|  | Rain water harvesting pit is installed to collect water instead of charging ground water. |
|  | These type of pits should be provided in the premises all locations. |

# Annexures

**ISO 9001: 2015 (Quality Management System)**

Certificate

Otabu

Certificate of Registration

This is to certify that

INVERTIS UNIVERSITY

INVERTIS VILLAGE, BAREILLY - LUCKNOW NATIONAL HIGHWAY - 24,
BAREILLY UTTAR PRADESH - 243123, INDIA

has been assessed and certified by Otabu Certification Limited
as meeting the requirements of

ISO 9001:2015
Quality Management System

For the following activities

POST GRADUATE AND UNDERGRADUATE PROGRAMS - MANAGEMENT, LAW, COMMERCE, COMPUTER APPLICATION, PHARMACY, EDUCATION, JOURNALISM, MASS COMMUNICATION, BIO SCIENCE TECHNOLOGY SCIENCE, FASHION DESIGN, ENGINEERING TECHNOLOGY AND AGRICULTURE

| | |
|---|---|
| Date of Registration | : 10 September 2020 |
| 1st Surveillance Due | : 09 September 2021 |
| 2nd Surveillance Due | : 09 September 2022 |
| Certificate Expiry (subject to the company maintaining its system to the required standard) | : 09 September 2023 |

Certificate No:- 200910607

To Verify this certificate please visit at www.otabucert.co.uk

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SAF

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Email:- info@otabucert.co.uk Website - www.otabucert.co.uk

Suite 48, 88-90 Hatton Garden, London, EC1N 8PN, UK

Registrar
University
Bareilly

**ISO/IEC 27001: 2013 (Information Security Management System)**

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as meeting the requirements of

ISO/IEC 27001:2013
Information Security Management System

For the following activities

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| | |
|---|---|
| Date of Registration | : 10 September 2020 |
| 1st Surveillance Due | : 09 September 2021 |
| 2nd Surveillance Due | : 09 September 2022 |
| Certificate Expiry (subject to the company maintaining its system to the required standard) | : 09 September 2023 |

Certificate No:- 200910609

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Authorised Signatory

Registrar
University

Otabu Certification Limited (UK)

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Suite 48, 88-90 Hatton Garden, London, EC1N 8PN, UK

**ISO 14001:2015 (Environment Management System)**

14.JPG

Certificate

Otabu

# Certificate of Registration

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INVERTIS VILLAGE, BAREILLY - LUCKNOW NATIONAL HIGHWAY - 24,
BAREILLY UTTAR PRADESH - 243123, INDIA

has been assessed and certified by Otabu Certification Limited
as meeting the requirements of

## ISO 14001:2015
## Environmental Management System

For the following activities

POST GRADUATE AND UNDERGRADUATE PROGRAMS - MANAGEMENT, LAW, COMMERCE, COMPUTER APPLICATION, PHARMACY, EDUCATION, JOURNALISM, MASS COMMUNICATION, BIO SCIENCE TECHNOLOGY SCIENCE, FASHION DESIGN, ENGINEERING TECHNOLOGY AND AGRICULTURE

| | |
|---|---|
| Date of Registration | : 10 September 2020 |
| 1st Surveillance Due | : 09 September 2021 |
| 2nd Surveillance Due | : 09 September 2022 |
| Certificate Expiry (subject to the company maintaining its system to the required standard) | : 09 September 2023 |

Certificate No:- 200910608

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SAF

Registrar

Otabu Certification Limited (UK)

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*Suite 48, 88-90 Hatton Garden, London, EC1N 8PN, UK*

# DETAILED ENERGY AUDIT

INVERTIS UNIVERSITY BAREILLY


AUGUEST 2021

## INVERTIS VILLAGE, BAREILLY-LUCKNOW NATIONAL HIGHWAY, N.H. 24, BAREILLY - 243123 (U.P)

ed By:-

A-Z ENERGY ENGINEERS PVT. LTD.

PLOT NO. 12, 4860-62, HARBANS SINGH STREET, KOTHI NO. 24,
WARD NO. II, DARYA GANJ, NEW DELHI-11002
011-23240541, 9811402040 pp_mittal@yahoo.com

# INDEX

# List of Tables

# LIST OF FIGURES

# ABBREVIATIONS

| | |
|---|---|
| ***AC*** | Air Conditioning |
| ***APFC*** | Automatic Power Factor Control |
| ***CFL*** | Compact Fluorescent Lamp |
| ***CFM*** | Cubic Feet per Minute |
| ***CoP*** | Coefficient of Performance |
| ***$CO_2$*** | Carbon Dioxide |
| ***CT*** | Cooling Tower |
| ***CW*** | Cooling Water |
| ***DG*** | Diesel Generator |
| ***EE*** | Energy Efficient |
| ***EER*** | Energy Efficiency Ratio |
| ***ENCON*** | Energy Conservation Measures |
| ***EPI*** | Energy Performance Index |
| ***FRP*** | Fibre Reinforced Plastic |
| ***FTL*** | Fluorescent Tube Light |
| ***HP*** | Horse Power |
| ***HPSV*** | High Pressure Sodium Vapour |
| ***HT*** | High Tension |
| ***HVAC*** | Heating, Ventilation and Air conditioning |
| ***ID*** | Induced Draft |
| ***IEEE*** | Institute of Electrical and Electronics Engineers |
| ***INR*** | Indian Rupees |
| ***IRR*** | Internal Rate of Return |
| ***kVA*** | Kilovolt Ampere |
| ***kVAh*** | Kilovolt Ampere Hour |
| ***kVAR*** | Kilovolt Ampere Reactive |
| ***kWh*** | Kilowatt Hour |
| ***LED*** | Light Emitting Diode |
| ***LT*** | Low Tension |
| ***MH*** | Metal Halide |
| ***Mkcal*** | Million Kilo Calories |
| ***PF*** | Power Factor |
| ***THD*** | Total Harmonic Distortion |
| ***TR*** | Ton of refrigeration |
| ***TRh*** | Ton of refrigeration in one hour |
| ***TOD*** | Time of Day |
| ***VFD*** | Variable Frequency Drive |
| ***WBT*** | Wet Bulb Temperature |

# BACKGROUND

Most of present human activities draw its energy from fossil fuel energy sources. The secondary form of energy, the Electricity, which is mainly generated from fossil fuel, is the lifeline of today's modern and highly mechanized lifestyle. Energy is a basic requirement for economic development in almost all major sectors of economy i.e. agriculture. Industry, transport, commercial, and residential (domestic); Consequently, consumption of energy in different forms has been steadily rising all over the country, and more so in Commercial Buildings, which has maintained a steady growth pattern in the past and the trend is likely to continue in future as well. However major concern is that the fossil fuel based sources of Energy are limited and these sources will get exhausted soon. Therefore Every nation whether developed or under-developed is very much concerned about optimal utilization of energy resources. Energy conservations is one of the initiatives which is a proven measure to optimize the uses to retard the depletion of energy resource.

Therefore considering the vast potential of energy saving and benefits of energy efficiency, the Government of India enacted the Energy Conservation Act, 2001 in October 2001. The Energy Conservation Act.2001, become effective from 1st March 2002. The Act provides for institutionalizing and strengthening delivery mechanism for energy efficiency programs in the country and provides a framework for the much needed coordination between various government entities. As per the EC Act, Government of India established "Bureau of Energy Efficiency" (BEE) with the mission to develop policy and strategies with a thrust on self-regulation and market principles, within the overall frame work of the Energy Conservation Act (EC Act) 2001 with the primary objective of reducing the energy intensity of the Indian economy.

# ACKNOWLEDGEMENT

We are thankful to the Management of Invertis University for awarding the energy audit study of this university to A-Z Energy Engineers Pvt. Ltd. Energy Audit was conducted in the month of August 2021. This report captures the outcomes of Energy Audit conducted at Invertis University.

We are thankful and appreciative of the keen interest and commitment of Management and we convey our special thanks to;

| Name | Designation | Mobile |
|---|---|---|
| Mr. Santosh Kumar | Registrar | 9690017906 |

We also thank to each & every official of Engineering Section for showing keen interest and co-operation during the course of our study.

# AUDIT TEAM

**Audit team for this assignment consisted of** Energy Auditors, Engineers and Experts namely Dr. P.P. Mittal, Accredited Energy Auditor (AEA-0011), Sh. Pankaj Chauhan, Sr. Energy Consultant & Sh. Alok Tiwari, Sr. Engineer.

NOTE: It is intimated that this whole exercise is for Identifying Energy Saving Potential and for Quality of Power.

Place: **DELHI** Date: **AUGUST 2021**

# 1. Project Background & Introduction

## 1.1 The Project

With the advent of energy crisis and exponential hikes in the costs of different forms of energy, Energy Audit is manifesting its due importance in every establishment. Energy Audit helps to understand more about the way's energy is used in any establishment and helps in identifying areas where waste may occur and scope for improvement exists.

It was with this objective that "**M/s. A-Z Energy Engineers Pvt. Ltd**., Plot No.12, 4860-62, Harbans Singh Street, Kothi No. 24, Ward No. II, Darya Ganj, New Delhi-11002, was entrusted with the job of conducting Energy Audit of "Invertis University", Bareilly.

Invertis University is a private university located in Bareilly, Uttar Pradesh, India. It is situated on Bareilly-Lucknow NH-24, equidistant 250 km from the national capital Delhi and state capital Lucknow. The Chancellor of the university is Umesh Gautamand the Vice-Chancellor is Y. D. S. Arya.

## 1.2 Scope of work

The present audit laid emphasis on the following areas to identify energy saving opportunities**:**

- ✓ Power Distribution System
- ✓ Lighting system
- ✓ ACs & Ventilation
- ✓ Water Pumping and treatment System
- ✓ Transformers
- ✓ DG Sets
- ✓ APFC
- ✓ Renewable Energy

## 1.3 Instruments Used for Energy Audit

The following portable instruments were used for data measurement:

- ✓ 3 – phase Power Analyzer
- ✓ Single phase Power Analyzer
- ✓ Anemometer
- ✓ Hygrometer
- ✓ Digital Thermometer
- ✓ Pressure gauge
- ✓ Lux Meter
- ✓ Thermograph Camera
- ✓ Flow Meter
- ✓ Earth Tester

## 1.4 Object of Study

The purpose of this study is to demonstrate the technical and financial feasibility of implementation of energy efficiency measures in Invertis University. The purpose of this report is:–

(i) to analyze the present energy consumption pattern

(ii) to investigate for energy conservation measures without compromising the production level

(iii) to assess the techno-economic feasibility of the energy conservation measure

# 2. Approach & Methodology

## 2.1 Approach

A team of 3 engineers was involved in carrying out the study, the general scope of which was as follows:

- Identify areas of opportunity for energy saving and recommend an action plan to bring down total energy cost
- Conduct energy performance evaluation and process optimization study
- Conduct efficiency test of equipment's and make recommendations for replacement (if required) by more efficient equipment with projected benefits
- Suggest improved operation & maintenance practices
- Provide details of investment for all the proposals for improvement
- Evaluate benefits that accrue through investment and payback period
- Analyze various energy conservation measures and to prioritize based on the maximum energy saving & investment i.e. short, medium and long term.

| PRIORITIZATION | PAYBACK PERIOD |
|---|---|
| Short Term Project | Less than 1 year |
| Medium Term Project | Between 1 and 3 years |
| Long Term Project | More than 3 years |

## 2.2 Methodology

The general methodology followed is captured in the following figure –


The study was conducted in 3 stages:

- Stage 1: Walk through audit to understand process energy drivers, measurability and formulation of audit plan
- Stage 2: Detailed Energy Audit
- Stage 3: Off-site work for data analysis and report preparation

# 3. About the energy audit location

Invertis University is a private university located in Bareilly, Uttar Pradesh, India. It is situated on Bareilly-Lucknow NH-24, equidistant 250 km from the national capital Delhi and state capital Lucknow. The Chancellor of the university is Umesh Gautamand the Vice-Chancellor is Y. D. S. Arya.

Invertis University has its roots with the Invertis Institute of Management Studies, established 1998 with 83 students. In 2010 it was established as a university

| PARTICULARS | UNITS | DETAILS |
|---|---|---|
| Name of the establishment | - | Invertis University |
| Address | - | Invertis Village, Bareilly-Lucknow National Highway – 24,<br>Bareilly (U.P)- 243123 |
| Contact Person | - | Sh. Mr. Santosh Kumar, Registrar |
| Coordinates | | 28.2923317°N 79.4915667°E |
| Website | | www.invertisuniversity.ac.in |

# 4. Base Line Data

| Contact Details | | |
|---|---|---|
| Brief description of Assignment | : | Detailed Energy Audit of Electrical Systems & Utility Equipment's |
| Name & Address of the Building | : | Invertis University |
| Operational Days | : | 5 |
| Contact Officer | : | Sh. Santosh Kumar, Registrar |
| **Power** | | |
| Source | ; | Madhyanchal Vidyut Vitaran Nigam Ltd. (MVVNL) |
| AC No. | : | 761702356284 |
| Contracted Load | : | 800 KVA |
| **Average Purchased Power Cost** | : | |
| Energy Charge (0-2500 Unit) | : | Rs. 8.32 per KVAh |
| Energy Charge (2500 Above) | : | Rs. 8.68 per KVAh |
| Fixed Charges | : | Rs. 430 per KVA |
| Solar Energy Charges | : | Rs. 6.19 per KWh |

# 5. Present Energy Scenario

## 5.1 Purchased Power

Invertis University draws power from the Madhyanchal Vidyut Vitaran Nigam Ltd. (MVVNL) at 11 kV; subsequently the voltage is stepped down by transformers from 11 KV to 0.433 KV. The Contracted load is 800 KW. Billing is done on 11 KV.

## 5.2 Power Consumption

Invertis University draws power from the Madhyanchal Vidyut Vitaran Nigam Ltd. (MVVNL); for campus comprising of various blocks, building, Hostel & staff quarters etc. The campus is being billed on kVAh basis; therefore the effect of power factor is inbuilt in the billing structure.

## 5.3 Self-generated Power

The premises has two Nos. DG Sets of 380 & 750 KVA are installed for in-house power generation during power cut. The operation of the DG Sets is during in power cut & testing only.

## 5.4 Solar PV

The University management has installed 800 KWp solar panel on building roof.

# 6. Executive Summary

The Electricity, HSD and solar are sources of energy for the campus. The Invertis University is getting electrical power supply from Madhyanchal Vidyut Vitaran Nigam Ltd. (MVVNL) at 11 kV supply. There are three transformers of 630 KVA, 630 kVA & 400 kVA (11kV/ 0.433 kV) installed and feed to campus. The premise is also having two diesel generators of 380 KVA & 750 KVA provide power supply during power failure/emergency. The one-year electrical bill analysis indicates there is very variation in MDI. The major energy consuming equipment's in the premises are lights, A/C unit, water pumping system, Computer, Printer and other equipment's etc.

- *The Detailed Energy Audit of Invertis University was carried out in the month of June-July 2021 to find out the energy saving potential and the performance level of campus. The report provides the major highlights on potential energy saving opportunities available in the campus and quality of power.*
- *Invertis University draws power from the MVVNL, at 11 kV; subsequently the voltage is stepped down by three transformers of 630 KVA x 2Nos. & 400 KVA from 11 KV to 0.433 KV. The Connected load of premises is 800 KVA.*
- *The campus is being billed on KVAh basis; therefore, the effect of power factor is inbuilt in the billing structure. There are two APFC Panels installed in substation but both APFC panel not working condition. The operating power factor measured varied from 0.695 to 0.991 in main income. However, if we look at the overall average power factor is around 0.938, which is at lower side.*

  *APFC Panel or the capacitor banks wherein the delivery is poor (less than 70%) or out of order may be replaced, so that the overall system power factor is maintained at around 0.99 (lag). Improvement in the power factor would subsequently reduce the KVAh consumption, the resultant benefits in terms of energy savings. The details of measurement is given in Capacitor chapter.*

➲ *The harmonics levels in main incomer has been measured and found within range limits in both voltage & current.*

| Harmonic Level of Main Supply | | | |
|---|---|---|---|
| **Voltage** | **Max.** | **Min.** | **Ave.** |
| THD Phase1 (V) | 2.6 | 0.7 | 1.3 |
| THD Phase2 (V) | 3.5 | 0.7 | 1.4 |
| THD Phase3 (V) | 2.2 | 0.7 | 1.4 |
| **Current** | | | |
| THD Phase1 (A) | 4.4 | 3.8 | 4.0 |
| THD Phase2 (A) | 4.4 | 3.6 | 4.0 |
| THD Phase3 (A) | 4.4 | 3.6 | 3.9 |

➲ *The Building Management is highly conscious about its Energy Efficiency and cost and has initiated several measures to reduce the energy consumption, which include replacement of conventional lamps with LEDs*

➲ *Around 2777 No's of LED Fixture and non LED Fixture installed in premises at different locations and LED Light, Street Light, Flood Light, PL, etc. Energy Efficient LED Lights offer reduction in the power consumption besides excellent color rendering properties and high luminous efficacy*

➲ *During the site visit, measurements were taken to record the load profile of the building, which included the variations in the voltage, current, power factor, harmonics etc. Analysis of the recordings indicated that the average voltage level was around 240 Volts. This may be an adequate voltage for motive loads like motors etc., but for the lighting systems normally, the voltage should be around 220 volts (phase to neutral). A reduction of around 15% in the lighting voltage can reduce the power consumption by around 20%.*

➲ *Although there is no simpler way to reduce the amount of energy consumed by lighting system than to manually turn OFF whenever not needed, this is not done as often as it could be. In response, automatic lighting control strategies like installation of occupancy sensors can be considered to Control light in response to the presence or absence of*

*people in the space. Quantification of energy savings on this account is not possible.*

- ➲ *The Management is highly conscious with regard to its energy efficiency levels and they have initiated several measures to reduce the energy consumption. There are 304 nos. Split AC's, Window A.C & Cassette A.C of various capacity & type installed in the complex. Out of these 304 nos. ACs 220 Nos. are Cassette AC, 46 Nos. are Window AC's, 21 Nos. are Split AC's, 5 Nos. are Floor standing AC's & 12 Nos. Centralized AC's of different Star rating. A-Z Energy Engineers Pvt. Ltd. acknowledges and appreciates the commitment of the management towards conservation of Energy.*
- ➲ ***The Management is highly conscious about its Energy Efficiency Levels and they have initiated several measures to reduce the energy consumption, which include amongst others the use of LED lights, Star Rated AC & solar PV etc. A-Z Energy Engineers Pvt. Ltd., acknowledges and appreciates the commitment of the management towards conservation of Energy***

## The summary of recommendations are as under:

1. APFC panel required to be maintained properly with adequate numbers of capacitors to improve the Power Factor up to 0.999
2. Installation of capacitors at load-end to raise Power Factor.
3. Proper maintaining of record regarding unit generation from DG Set.
4. Light Sensor be used in office areas.
5. Replacing left-over non-star rated Lighting Fixture with LEDs fixtures and non-star rated ACs with Star rated ACs.
6. Use of smart building management system.
7. Energy Management Certification (ISO 50001 Certification) of the Campus.
8. Cleaning of all light points.
9. Switching of lights in day time where ever not required
10. Switching off lights in day time at locations where there is enough light.
11. Street-light should be in automatic mode, providing the necessary sensors.

# 7. Energy Input & Savings

## 7.1 Energy inputs

| | |
|---|---|
| Electricity (Utility & Solar PV) | For various machines, equipment, illumination system- offices and work place lighting, platforms, colony, motors, pumps, Instruments etc. |
| HSD | DG Sets |
| Renewable Energy | Solar PV |

### *7.1.1* Energy Consumption

There are two source of Energy i.e. Grid supply & own generation through Solar and DG Sets. The Electricity is major Energy input of the premises. The historical consumption pattern for last 12 months are as per following details:

***Table.1: Details of Electrical Energy uses from power utility***

| Sr. No. | Billing Month | MDI | Total electricity consumption (kVAh) |
|---|---|---|---|
| **1** | Mar 2020 | 366.6 | 33810.0 |
| **2** | April to Aug. 2020 | 440.0 | 36350.0 |
| **3** | Sep. 2020 | 412.0 | 19235.0 |
| **4** | Oct. 2020 | 412.0 | 19270.0 |
| **5** | Nov. 2020 | 111.6 | 15835.0 |
| **6** | Dec. 2020 | 133.6 | 40490.0 |
| **7** | Jan. 2021 | 146.2 | 38620.0 |
| **8** | Feb. 2021 | 130.6 | 33200.0 |
| | **Total** | | **236810** |
| | **Avg.** | **269.1** | **29601.3** |
| | **Max** | **440.0** | **40490.0** |
| | **Min** | **111.6** | **15835.0** |

*Table. 2: Details of Electrical Energy from Solar PV*

| Srl. | Month | Unit Generated (kWh) |
|---|---|---|
| 1 | Jul. 2020 | 90695.3 |
| 2 | Aug. 2020 | 88610.1 |
| 3 | Sep. 2020 | 82052.4 |
| 4 | Oct. 2020 | 87089.0 |
| 5 | Nov. 2020 | 70417.0 |
| 6 | Dec. 2020 | 55866.0 |
| 7 | Jan. 2021 | 49230.0 |
| 8 | Feb. 2021 | 67327.0 |
| 9 | Mar. 2021 | 89215.0 |
| 10 | Apr. 2021 | 102463.0 |
| 11 | May. 2021 | 108453.0 |
| 12 | Jun. 2021 | 101573.0 |
| | **Total** | **992990.80** |

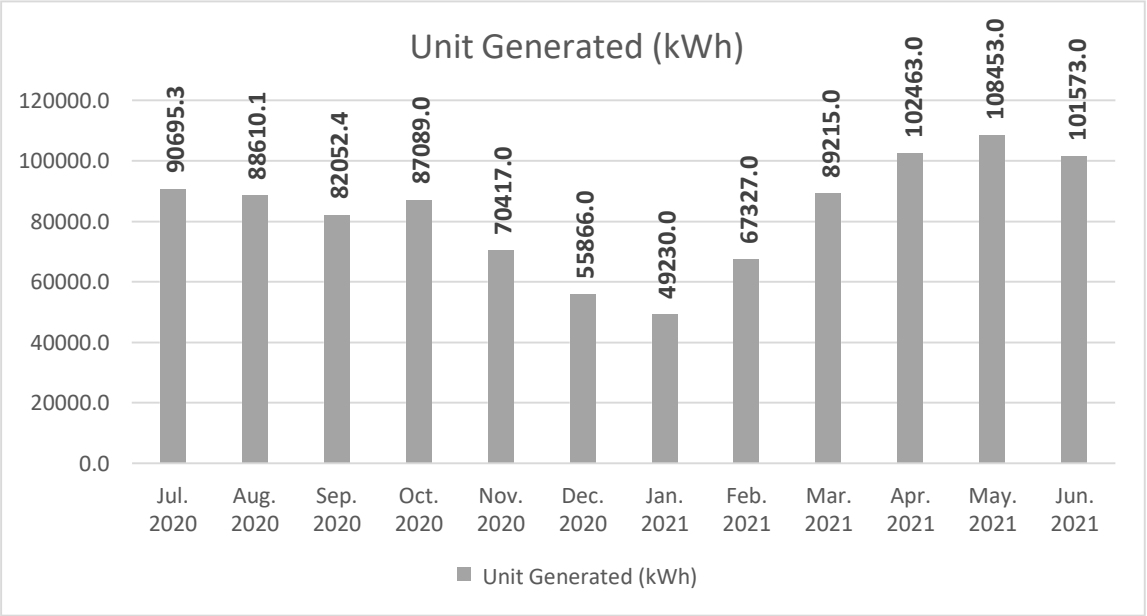


*Table. 3: Details of Electrical Energy from DG*

| Srl. | Month | Diesel Consumption (Ltrs.) |
|---|---|---|
| 1 | Aug. 2020 | 1687.9 |
| 2 | Sep. 2020 | 1068.8 |
| 3 | Oct. 2020 | 331.9 |
| 4 | Nov. 2020 | 609.3 |
| 5 | Dec. 2020 | 777.3 |
| 6 | Jan. 2021 | 378.3 |
| 7 | Feb. 2021 | 546.5 |
| 8 | Mar. 2021 | 706.8 |
| 9 | Apr. 2021 | 702.3 |
| 10 | May. 2021 | 1001.1 |
| 11 | Jun. 2021 | 1079.3 |
| 12 | Jul. 2021 | 1497.8 |
| | **Total** | **10387** |

## 7.2 Proposed Summary of Savings

*Table.4: Summary of savings*

| S. No. | Proposed energy conservation measures | Annual energy savings (kVAh/kWh) | Annual monetary savings (INR) | Anticipated investment (INR) | Simple payback period (Month ) |
|---|---|---|---|---|---|
| 1 | Improvement of Power Factor to 0.999 | 16356.0 | 130848.00 | 100000.00 | 9-10 |
| 2 | Replacement of existing unitary non-star ACs with higher energy five star rated ACs | 21641 | 17312.40 | 367500.00 | 25-26 |
| 3 | Replacement of Old Celling Fan with New Energy Efficient Ceiling Fan | 4374 | 34992.00 | 100000.00 | 34-35 |
| 4 | single phase by load voltage optimization in lighting system | 24000 | 192000.00 | 200000.00 | 12-13 |

# 8. Lighting Details

Lighting fixtures are installed in different areas and locations. Premises has already installed energy efficient LED Lights at most of the places. But still some lighting fixtures needs to be replaced with LEDs. Energy Efficient LED Lights offer reduction in the power consumption besides excellent color rendering properties and high luminous efficacy.

*Table 5: Types of LED Light*

| Srl | Fixture | Power Rating (Watt) |
|---|---|---|
| 1 | LED Tube (18W) | 18 |
| 3 | LED Tube (12W) | 12 |
| 6 | LED COBE (18W) | 18 |
| 7 | LED Round (36W) | 36 |
| 8 | LED-36W (2'x2') | 36 |
| 10 | LED Light (30W) | 30 |
| 11 | LED Light (60W) | 60 |
| 11 | LED Light (200W) | 200 |

## 8.1 Timed Based Control or Daylight Linked Control

Timed-turnoff switches are the least expensive type of automatic lighting control. In some cases, their low cost and ease of installation makes it desirable to use them where more efficient controls would be too expensive. Newer types of timed-turnoff switches are completely electronic and silent. The best choice is an electronic unit that allows the engineering staff to set a fixed time interval behind the cover plate. This system is recommended for street Lighting application in the building. Photoelectric cells can be used either simply to switch lighting on and off, or for dimming. They may be mounted either externally or internally. It is however important to incorporate time delays into the control system to avoid repeated rapid switching caused, for example, by fast moving clouds. By using an internally mounted photoelectric dimming control system, it is possible to ensure that the sum of daylight and electric lighting always reaches the design level by sensing the total light in the controlled area and adjusting the output of the electric lighting accordingly. If daylight alone is able to meet the design requirements, then the electric lighting can be turned off. The energy saving potential of dimming control is greater than a simple photoelectric switching system

## 8.2 Localized Switching

Localized switching should be used in applications, which contain large spaces. Local switches give individual occupants control over their visual environment and also facilitate energy savings. By using localized switching it is possible to turn off artificial lighting in specific areas, while still operating it in other areas where it is required, a situation which is impossible if the lighting for an entire space is controlled from a single switch.

## 8.3 Percentage load of Equipment's

**Table 6: Load of Equipment**

| SL. NO. | NAME OF PLACE | TYPES OF LIGHT | NO. OF LIGHT | COMPANY | WATT |
|---|---|---|---|---|---|
| 1 | MAIN GATE | LED BULB | 4 | STANZO | 40 W |
| 2 | GUARD ROOM | TUBE LIGHT | 3 | PHILIPS | 40 W |
| 3 | ATM SIDE BOUNDARY | LED BULB | 23 | STANZO | 40 W |
| 4 | GUARD ROOM SIDE | LED BULB | 9 | STANZO | 40 W |
| 5 | TRANSPORT OFFICE | TUBE LIGHT | 1 | PHILIPS | 40 W |
| 6 | MAIN GATE LEFT SIDE WALL | LED LIGHT | 1 | HAVELLS | 40 W |
| 7 | MAIN GATE RIGHT SIDE WALL | LED LIGHT | 1 | HAVELLS | 40 W |
| 8 | POLE | LED LIGHT | 1 | HAVELLS | 40 W |
| 9 | CAR GARAGE | FOCUS LIGHT | 9 | ORPAT | 40 W |
| 10 | CAR GARAGE SIDE | PANJI LIGHT | 1 | CROMPTON | 40 W |
| 11 | LIFT SIDE | LAMP LIGHT | 12 | ORPAT | 40 W |
| 12 | ADMIN OFFICE MAIN ENTRANCE | LED LIGHT | 5 | STANZO | 40 W |
| 13 | VICE CHANCELLOR SIR'S OFFICE | TUBE LIGHT/ LED LIGHT | 9 | PHILIPS /STANZO | 40 W |
| 14 | ADMIN KITCHEN | TUBE LIGHT | 1 | PHILIPS | 40 W |
| 15 | ADMIN OFFICE | | 39 | STANZO | 40 W |
| 16 | MARCOM OFFICE | LED LIGHT | 11 | STANZO | 40 W |
| 17 | HR OFFICE | LED LIGHT | 13 | STANZO | 40 W |
| 18 | ADVISOR ROOM | LED LIGHT | 7 | STANZO | 40 W |
| 19 | CONFERENCE HALL 1 | LED LIGHT | 7 | STANZO | 40 W |
| 20 | CONFERENCE HALL 2 | LED LIGHT | 15 | STANZO | 40 W |
| 21 | EXECUTIVE DIRECTOR SIR'S OFFICE | LED LIGHT | 20 | STANZO | 40 W |
| 22 | CHANCELLOR SIR'S OFFICE | LED LIGHT | 12 | STANZO | 40 W |
| 23 | ACCOUNTS OFFICE | LED LIGHT | 12 | STANZO | 40 W |
| 24 | NEAR COMPUTER CENTRE | PANJI LIGHT | 1 | CROMPTON | 40 W |
| 25 | COMPUTER CENTRE BACK SIDE | PANJI LIGHT | 1 | CROMPTON | 40 W |
| 26 | BUS STAND SIDE | LED LIGHT | 1 | HAVELLS | 40 W |
| 27 | M-BLOCK SIDE POLE | LED LIGHT | 2 | HAVELLS | 40 W |
| 28 | FRONT OF PETROL PUMP | LED LIGHT | 4 | HAVELLS | 40 W |
| 29 | FRONT OF AUDITORIUM POLE | LED LIGHT | 6 | HAVELLS | 40 W |

| SL. NO. | NAME OF PLACE | TYPES OF LIGHT | NO. OF LIGHT | COMPANY | WATT |
|---|---|---|---|---|---|
| 30 | CRICKET GROUND UNIVERSITY BUILDING | LED LIGHT | 6 | HAVELLS | 40 W |
| 31 | FOOTBALL GROUND UNIVERSITY BUILDING | LED LIGHT | 6 | HAVELLS | 40 W |
| 32 | B.TECH BUILDING POLE | LED LIGHT | 2 | HAVELLS | 40 W |
| 33 | UNIVERSITY BUILDING ROAD | HANDI LIGHT | 35 | STANZO | 40 W |
| 34 | KAVERI HOSTEL (GIRLS HOSTEL) | | | | 40 W |
| 35 | GROUND FLOOR | TUBE LIGHT | 25 | PHILIPS | 40 W |
| 36 | FIRST FLOOR | TUBE LIGHT | 25 | PHILIPS | 40 W |
| 37 | SECOND FLOOR | TUBE LIGHT | 25 | PHILIPS | 40 W |
| 38 | OPEN AREA KAVERI HOSTEL | | | | 40 W |
| 39 | GROUND FLOOR | TUBE LIGHT | 4 | PHILIPS | 40 W |
| 40 | FIRST FLOOR | TUBE LIGHT | 6 | PHILIPS | 40 W |
| 41 | SECOND FLOOR | TUBE LIGHT | 4 | PHILIPS | 40 W |
| 42 | BHAGIRATHI HOSTEL | | | | 40 W |
| 43 | GROUND FLOOR | TUBE LIGHT | 65 | PHILIPS | 40 W |
| 44 | FIRST FLOOR | TUBE LIGHT | 64 | PHILIPS | 40 W |
| 45 | SECOND FLOOR | TUBE LIGHT | 65 | PHILIPS | 40 W |
| 46 | THIRD FLOOR | TUBE LIGHT | 64 | PHILIPS | 40 W |
| 47 | OPEN AREA BHAGIRATHI HOSTEL | | | | 40 W |
| 48 | GROUND FLOOR | TUBE LIGHT | 12 | PHILIPS | 40 W |
| 49 | FIRST FLOOR | TUBE LIGHT | 12 | PHILIPS | 40 W |
| 50 | SECOND FLOOR | TUBE LIGHT | 11 | PHILIPS | 40 W |
| 51 | THIRD FLOOR | TUBE LIGHT | 11 | PHILIPS | 40 W |
| 52 | GROUND FLOOR WASHROOM | TUBE LIGHT | 12 | PHILIPS | 40 W |
| 53 | FIRST FLOOR WASHROOM | TUBE LIGHT | 12 | PHILIPS | 40 W |
| 54 | SECOND FLOOR WASHROOM | TUBE LIGHT | 12 | PHILIPS | 40 W |
| 55 | TOP FLOOR WASHROOM | TUBE LIGHT | 12 | PHILIPS | 40 W |
| 56 | GODAVARI HOSTEL | | | | 40 W |
| 57 | GROUND FLOOR | TUBE LIGHT | 31 | PHILIPS | 40 W |
| 58 | FIRST FLOOR | TUBE LIGHT | 41 | PHILIPS | 40 W |
| 59 | SECOND FLOOR | TUBE LIGHT | 37 | PHILIPS | 40 W |
| 60 | OPEN AREA GODAVARI HOSTEL | | | | 40 W |
| 61 | GROUND FLOOR | TUBE LIGHT | 15 | PHILIPS | 40 W |
| 62 | FIRST FLOOR | TUBE LIGHT | 12 | PHILIPS | 40 W |
| 63 | SECOND FLOOR | TUBE LIGHT | 11 | PHILIPS | 40 W |
| 64 | WARDEN'S OFFICE | TUBE LIGHT | 2 | PHILIPS | 40 W |
| 65 | HIMALAYA HOSTEL ( BOYS HOSTEL ) | | | | 40 W |
| 66 | GROUND FLOOR | TUBE LIGHT | 22 | PHILIPS | 40 W |
| 67 | FIRST FLOOR | TUBE LIGHT | 25 | PHILIPS | 40 W |

| | | | | | |
|---|---|---|---|---|---|
| 68 | SECOND FLOOR | TUBE LIGHT | 25 | PHILIPS | 40 W |
| 69 | HIMGIRI HOSTEL | | | | 40 W |

| SL. NO. | NAME OF PLACE | TYPES OF LIGHT | NO. OF LIGHT | COMPANY | WATT |
|---|---|---|---|---|---|
| 70 | GROUND FLOOR | TUBE LIGHT | 37 | PHILIPS | 40 W |
| 71 | FIRST FLOOR | TUBE LIGHT | 34 | PHILIPS | 40 W |
| 72 | SECOND FLOOR | TUBE LIGHT | 36 | PHILIPS | 40 W |
| 73 | NILGIRI HOSTEL | | | | 40 W |
| 74 | GROUND FLOOR | TUBE LIGHT | 85 | PHILIPS | 40 W |
| 75 | FIRST FLOOR | TUBE LIGHT | 85 | PHILIPS | 40 W |
| 76 | SECOND FLOOR | TUBE LIGHT | 85 | PHILIPS | 40 W |
| 77 | THIRD FLOOR | TUBE LIGHT | 85 | PHILIPS | 40 W |
| 78 | SHIVALIK HOSTEL | | | | 40 W |
| 79 | GROUND FLOOR | TUBE LIGHT | 26 | PHILIPS | 40 W |
| 80 | FIRST FLOOR | TUBE LIGHT | 25 | PHILIPS | 40 W |
| 81 | SECOND FLOOR | TUBE LIGHT | 24 | PHILIPS | 40 W |
| 82 | THIRD FLOOR | TUBE LIGHT | | PHILIPS | 40 W |
| 83 | GUEST HOUSE NO. 1 | TUBE LIGHT | | PHILIPS | 40 W |
| 84 | GUEST HOUSE NO. 2 | TUBE LIGHT | 5 | PHILIPS | 40 W |
| 85 | GUEST HOUSE NO.3 | TUBE LIGHT | 5 | PHILIPS | 40 W |
| 86 | GUEST HOUSE NO. 4 | TUBE LIGHT | 6 | PHILIPS | 40 W |
| 87 | GUEST HOUSE NO. 5 | TUBE LIGHT | 5 | PHILIPS | 40 W |
| 88 | GUEST HOUSE NO. 6 | TUBE LIGHT | 5 | PHILIPS | 40 W |
| 89 | VICE CHANCELLOR SIR'S RESIDENCE | TUBE LIGHT | 11 | PHILIPS | 40 W |
| 90 | DIRECTOR ADMINISTRATION SIR'S RESIDENCE | TUBE LIGHT | 11 | PHILIPS | 40 W |
| 91 | ACADEMIC BLOCK -1 (M-BLOCK ) | CONCEALEDLIGHT/ TUBELIGHT | 180 | STANZO / PHILIPS | 40 W |
| 92 | ACADEMIC BLOCK - 2 ( B.TECH BUILDING ) | CONCEALEDLIGHT/ TUBELIGHT | 300 | STANZO/ PHILIPS | 40 W |
| 93 | UNIVERSITY BUILDING | CONCEALEDLIGHT/ TUBELIGHT | | STANZO/ PHIPLIPS | 40 W/ 18 W |
| 94 | STAFF QUARTER | TUBE LIGHT | 30 | PHILIPS | 40 W |
| 95 | FACULTY QUARTER | TUBE LIGHT | 134 | PHILIPS | 40 W |
| 96 | MESS DOMATTORY | TUBE LIGHT | 24 | PHILIPS | 40 W |
| 97 | COMPUTER CENTRE | TUBE LIGHT | 125 | PHILIPS | 40 W |
| 98 | WORKSHOP | TUBE LIGHT | 51 | PHILIPS | 40 W |
| 99 | SEMINAR BUILDING | TUBE LIGHT | 29 | PHILIPS | 40 W |
| 100 | STORE | TUBE LIGHT | 4 | PHILIPS | 40 W |
| 101 | MESS | TUBELIGHT/ CONCEALEDLIGHT | 89 | STANZO/ PHILIPS | 40 W |
| 102 | AUDITORIUM | TUBE LIGHT | 20 | PHILIPS | 40 W |
| 103 | OLD LIBRARY | TUBE LIGHT | 86 | PHILIPS | 40 W |
| 104 | NEW LIBRARY IN UNIVERSITY BUILDING | CONCEALED LIGHT | 191 | STANZO | 18 W |
| 105 | POWER HOUSE | TUBE LIGHT | 1 | PHILIPS | 40 W |

| | | | | | |
|---|---|---|---|---|---|
| 106 | DRIVER ROOM | TUBE LIGHT | 1 | PHILIPS | 40 W |

# 9. Improvement in operating Power Factor

The premises is being billed on kVAh basis; therefore the effect of power factor is inbuilt in the billing structure. There are two APFC Panel installed in substation but both APFC panel not working & de-rated. Based on the electrical bills the operating power factor on the main incomer is varies from 0.695 - 0.991, the average power factor was around 0.938, which appears to be on the lower side. It is thus recommended to install more capacitor banks on the main feeder so that the overall system power factor is maintained at around 0.99 (lag). Improvement in the power factor would subsequently reduce the KVAh consumption, resulting in energy savings as follows:

**The month of July-2020 MVVNL bill power factor show 0.920, which is low side**. However, it is recommended that capacitor (200 KVAR) are required to be installed/shifted at load center-end for improving the power factor

## 9.1 Improvement in the Operating Power Factor

The campus is being billed on KVAh basis; therefore, the effect of power factor is inbuilt in the billing structure. However, it is recommended that capacitor (200 KVAR) are required to be installed/shifted at load center-end for improving the power factor.

It is thus recommended to install additional capacitor banks on the APFC Panel or the capacitor banks wherein the delivery is poor (less than 70%) or out of order may be replaced, so that the overall system power factor is maintained at around 0.99 (lag). Improvement in the power factor would subsequently reduce the KVAh consumption, resulting in energy savings as follows:

## 9.2 Energy Saving

*Table 7: Energy saving potential to improved power factor*

| | **July 2020 Billing** | |
|---|---|---|
| A | Power Consumption at Present | 17015 KWh |
| B | Power Consumption at Present | 18550 KVAh |
| C | Average Operating Power factor at present (A/B) | 0.920 |
| D | Average Power Consumption post improvement of power factor from 0.920 to 0.99 (A/0.99) | 17187 KVAh |

| | | |
|---|---|---|
| E | Net Reduction in Power Consumption May Month Bill (B-D) | 1363 KVAh per month |
| F | Total Monitory Benefit month of Avg (**Rs. 8.0/kVAh)** | Rs. 10904 |
| G | Average Total Monitory Benefit per Annual (F X 12) | 130848 |
| H | Estimated Investments [for Capacitor Panel] | Rs 1.0 Lakhs |
| I | Simple Payback Period | 9-10 |

Implementation of this measure needs an investment of INR 1.0 Lakhs and will have a simple payback period of 9-10 months.

# 10. Lighting system in single phase by load voltage optimization

During our study, we found that the voltage level of the plant was at 237-240 volt for Single phase and 426 – 431 for three phase system.

It was observed that there is no segregation for lighting / single phase load and three phase motive load i.e. all three phases and single phase load are running with common voltage supply.

It is our suggestion that all lighting single phase load should be separated and be feed by a suitable rating voltage stabilizer. A huge amount of power can be saved because all single phase load appliances are designed for 220 V supply.

## Example

Total single phase load measured for lighting Load approx. = 120 KW

Average 60 % load is running = 72 KW

Existing voltage level = 240 V

Proposed voltage level = 200 V

Percentage deduction in voltage = 16.67%

Power saving in KW / hour = 12 KW

Saving in power = 24000 kWh per year

Annual monitory saving @ Rs. 8.00 / kWh

12.0 x 8 x 250 x 8.00 = Rs. 192000/-

Investment required for voltage optimizer of 1 no. 200 KVA SVS for lighting and other connected load with LT panel for output voltage of 330 - 440 V, output voltage 380 is Rs. 2,00,000/- Payback period = 12-13 months (Approximate)

# 11. Window/Split AC Units Specification

Split / Window AC's are installed at several locations in the campus. The details of AC are as follows:

**Table 8: Details of AC's**

| SL. NO. AREA | NAME OF BUILDING | TYPES OF AC | NO. OF AC | CAPACITY (TR) | COMPANY |
|---|---|---|---|---|---|
| 1 | ADMIN BUILDING | | | | |
| | CHANCELLOR SIR'S OFFICE | CASSETTE AC | 1 | 3 | DAIKIN |
| | VICE CHANCELLOR SIR'S OFFICE | WINDOW AC | 1 | 1.5 | DAIKIN |
| | MARCOM OFFICE | WINDOW AC | 2 | 1.5 | SAMSUNG |
| | HR OFFICE | WINDOW AC | 1 | 1.5 | GODREJ |
| | ADMIN ( ADMISSION CELL DESK) | CASSETTE AC, FLOOR STANDING AC | 1, 2 | 2 , 4 | DAIKIN |
| | CONFERENCE HALL 1 | SPLIT AC | 1 | 1.5 | DAIKIN |
| | CONFERENCE HALL 2 | CASSETTE AC | 3 | 3 | DAIKIN |
| | ACCOUNTS OFFICE | SPLIT AC | 1 | 1.5 | DAIKIN |
| | EXECUTIVE DIRECTOR | SPLIT AC | 1 | 1.5 | DAIKIN |
| | | | | | |
| 2 | SEMINAR BUILDING | | | | |
| | CRC OFFICE | SPLIT AC | 2 | 1.5 | DAIKIN |
| | SEMINAR HALL 1 | CASSETTE AC | 5 | 3 | DAIKIN |
| | SEMINAR HALL 2 | CASSETTE AC | 5 | 3 | DAIKIN |
| | | | | | |
| 3 | ACADEMIC BLOCK 1 ( M-BLOCK ) | | | | |
| | DIRECTOR ADMINISTRATOR SIR'S OFFICE | WINDOW AC | 1 | 1.5 | SAMSUNG |
| | DEAN OF ENGINEERING | SPLIT AC | 1 | 1.5 | DAIKIN |
| | ROOM NO. 1 | FLOOR STANDING AC | 1 | 4.5 | DAIKIN |
| | FACULTY CABIN GROUND FLOOR | WINDOW AC | 1 | 1.5 | SAMSUNG |
| | ROOM NO. 8 | WINDOW AC | 1 | 1.5 | SAMSUNG |
| | FACULTY CABIN SECOND FLOOR | WINDOW AC | 1 | 1.5 | SAMSUNG |
| | ROOM NO. 18 | WINDOW AC | 1 | 1.5 | SAMSUNG |

| | | | | | |
|---|---|---|---|---|---|
| | CHIEF PROCTOR'S OFFICE | WINDOW AC | 1 | 1.5 | SAMSUNG |
| | ROOM NO. 29 | CASSETTE AC | 1 | 3 | DAIKIN |
| | ROOM NO.30 | CASSETTE AC | 1 | 3 | DAIKIN |
| | ROOM NO.32 | CASSETTE AC | 1 | 3 | DAIKIN |
| | | | | | |
| 4 | COMPUTER CENTRE | | | | |

| SL. NO. AREA | NAME OF BUILDING | TYPES OF AC | NO. OF AC | CAPACITY (TR) | COMPANY |
|---|---|---|---|---|---|
| | LAB NO. 1 | CENTRALIZED AC | 1 | 8 | DAIKIN |
| | LAB NO. 2 | CENTRALIZED AC | 1 | 8 | DAIKIN |
| | LAB NO. 3 | CENTRALIZED AC | 1 | 8 | DAIKIN |
| | LAB NO. 4 | CENTRALIZED AC | 1 | 8 | DAIKIN |
| | LAB NO.5 | CENTRALIZED AC | 1 | 8 | DAIKIN |
| | LAB NO. 6 | CENTRALIZED AC | 1 | 8 | DAIKIN |
| | LAB NO. 7 | CENTRALIZED AC | 1 | 8 | DAIKIN |
| | LAB NO.8 | CENTRALIZED AC | 1 | 8 | DAIKIN |
| | LAB NO.9 | CENTRALIZED AC | 1 | 8 | DAIKIN |
| | LAB NO. 10 | CENTRALIZED AC | 1 | 8 | DAIKIN |
| | LAB NO. 11 | CENTRALIZED AC | 1 | 8 | MITSHUBHI |
| | LAB NO. 12 | CENTRALIZED AC | 1 | 8 | DAIKIN |
| | | | | | |
| 5 | ACADEMIC BLOCK 2 (B.TECH BUILDING ) | | | | |
| | DEAN STUDENT WELFARE | SPLIT AC | 1 | 1.5 | SAMSUNG |
| | ROOM NO. 1 | CASSETTE AC | 1 | 4.5 | DAIKIN |
| | ROOM NO. 2 | CASSETTE AC | 1 | 4.5 | DAIKIN |
| | ROOM NO. 3 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 4 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 5 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 6 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 7 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 8 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 9 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 10 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 11 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 12 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 13 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 14 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 15 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 16 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 17 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 18 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 19 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 20 | CASSETTE AC | 2 | 4.5 | DAIKIN |

| | | | | | |
|---|---|---|---|---|---|
| | ROOM NO.21 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO.22 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO.23 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO.24 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 25 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 26 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO.27 | CASSETTE AC | 2 | 4.5 | DAIKIN |

| SL. NO. AREA | NAME OF BUILDING | TYPES OF AC | NO. OF AC | CAPACITY (TR) | COMPANY |
|---|---|---|---|---|---|
| | ROOM NO. 28 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO.29 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 30 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | HoD CABIN | WINDOW AC | 1 | 1.5 | SAMSUNG |
| | FACULTY CABIN FIRST FLOOR RIGHT SIDE | WINDOW AC | 1 | 1.5 | SAMSUNG |
| | FACULTY CABIN FIRST FLOOR LEFT SIDE | WINDOW AC | 1 | 1.5 | SAMSUNG |
| | FACULTY CABIN SECOND FLOOR RIGHT SIDE | WINDOW AC | 1 | 1.5 | SAMSUNG |
| | FACULTY CABIN SECOND FLOOR LEFT SIDE | WINDOW AC | 1 | 1.5 | SAMSUNG |
| | | | | | |
| 6 | ACADEMIC BLOCK 3 ( UNIVERSITY BUILDING) | | | | |
| GROUND FLOOR | ROOM NO. 1 | CASSETTE AC | 2 | 4.5 / 2.5 | DAIKIN |
| | ROOM NO. 2 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 3 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 4 | CASSETTE AC | 2 | 4.5 / 2.5 | DAIKIN |
| | ROOM NO. 5 | CASSETTE AC | 2 | 4.5 / 2.5 | DAIKIN |
| | ROOM NO. 6 | CASSETTE AC | 2 | 4.5 / 2.5 | DAIKIN |
| | ROOM NO. 7 | CASSETTE AC | 2 | 4.5 / 2.5 | DAIKIN |
| | ROOM NO. 8 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 9 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 10 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 11 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 12 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | TEA POINT | SPLIT AC | 1 | 1.5 | DAIKIN |
| | ASST. REGISTRAR | SPLIT AC | 1 | 1.5 | DAIKIN |
| | REGISTRAR OFFICE | SPLIT AC | 1 | 1.5 | DAIKIN |
| | FACULTY CABIN | CASSETTE AC | 1 | 4.5 | DAIKIN |
| | MOOT COURT | CASSETTE AC | 1 | 4.5 | DAIKIN |
| | CONFERENCE ROOM | CASSETTE AC | 2 | 4.5 /2.5 | DAIKIN |
| FIRST FLOOR | ROOM NO. 13 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 14 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 15 | CASSETTE AC | 2 | 4.5 | DAIKIN |

| | | | | | |
|---|---|---|---|---|---|
| | ROOM NO. 16 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 17 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO.18 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 19 | CASSETTE AC | 2 | | DAIKIN |
| | ROOM NO. 20 | CASSETTE AC | 1 | 4.5 | DAIKIN |
| | ROOM NO. 21 | CASSETTE AC | 1 | 4.5 | DAIKIN |
| | ROOM NO. 22 | CASSETTE AC | 1 | 4.5 | DAIKIN |

| SL. NO. AREA | NAME OF BUILDING | TYPES OF AC | NO. OF AC | CAPACITY (TR) | COMPANY |
|---|---|---|---|---|---|
| | ROOM NO. 23 | CASSETTE AC | 1 | 4.5 | DAIKIN |
| | ROOM NO.24 FACULTY CABIN | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | CHIEF PROCTOR'S OFFICE | SPLIT AC | 1 | 1.5 | DAIKIN |
| | HoD CABIN LEFT SIDE | SPLIT AC | 1 | 1.5 | DAIKIN |
| | HoD CABIN RIGHT SIDE | SPLIT AC | 1 | 1.5 | DAIKIN |
| | FACULTY CABIN RIGHT SIDE | CASSETTE AC | 1 | 4.5 | DAIKIN |
| | FACULTY CABIN LEFT SIDE | CASSETTE AC | 1 | 4.5 | DAIKIN |
| | | | | | |
| SECOND FLOOR | DEAN'S ACADEMIC | SPLIT AC | 1 | 1.5 | DAIKIN |
| | ROOM NO. 30 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO.31 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO.32 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 44 CABIN | CASSETTE AC | 1 | 4.5 | DAIKIN |
| | ROOM NO. 45 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 46 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO 47 | CASSETTE AC | 1 | 4.5 | DAIKIN |
| | HoD CABIN | SPLIT AC | 1 | 4.5 | DAIKIN |
| | HoD CABIN | SPLIT AC | 1 | 4.5 | DAIKIN |
| | ROOM NO. 50 | CASSETTE AC | 1 | 4.5 | DAIKIN |
| | ROOM NO. 51 | CASSETTE AC | 1 | 4.5 | DAIKIN |
| | ROOMK NO.52 | CASSETTE AC | 1 | 4.5 | DAIKIN |
| | GAME LAB | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | COMPUTER LAB | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO.55 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 56 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 57 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | SERVER ROOM | CASSETTE AC | 1 | 4.5 | DAIKIN |
| | ROOM NO. 59 LAB | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 60 LAB | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 61 LAB | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. LAB 62 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 66 FACULTY CABIN | CASSETTE AC | 1 | 4.5 | DAIKIN |
| | ROOM NO. 67 | CASSETTE AC | 1 | 4.5 | DAIKIN |

| | | | | | |
|---|---|---|---|---|---|
| | ROOM NO. 68 | CASSETTE AC | 1 | 4.5 | DAIKIN |
| | ROOM NO. 69 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | CHIEF PROCTOR SIR'S OFFICE | SPLIT AC | 1 | 4.5 | DAIKIN |
| TOP FLOOR | ROOM NO. 72 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 73 | CASSETTE AC | 2 | 4.5 | DAIKIN |

| SL. NO. AREA | NAME OF BUILDING | TYPES OF AC | NO. OF AC | CAPACITY (TR) | COMPANY |
|---|---|---|---|---|---|
| | ROOM NO. 74 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 75 BIOTECH LAB | CASSETTE AC | 1 | 4.5 | DAIKIN |
| | ROOM NO.87 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 88 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 89 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | HOD CABIN | SPLIT AC | 1 | 4.5 | DAIKIN |
| | HOD CABIN | SPLIT AC | 1 | 4.5 | DAIKIN |
| | ROOM NO. 92 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 93 | CASSETTE AC | 3 | 4.5 | DAIKIN |
| | ROOM NO. 94 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 96 ARCHITECTURE HALL | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 97 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 98 | CASSETTE AC | 1 | 4.5 | DAIKIN |
| | ROOM NO. 99 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 100 ARCHITECTURE | CASSETTE AC | 4 | 4.5 | DAIKIN |
| | ROOM NO. 104 FACULTY CABIN | CASSETTE AC | 1 | 4.5 | DAIKIN |
| | ROOM NO. 105 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 106 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | ROOM NO. 107 | CASSETTE AC | 2 | 4.5 | DAIKIN |
| | | | | | |
| 7 | GUEST HOUSE NO.1 | | | | DAIKIN |
| | ROOM NO. 1 | WINDOW AC | 1 | 1.5 | GODREJ |
| | ROOM NO.2 | WINDOW AC | 1 | 1.5 | GODREJ |
| | ROOM NO. 3 | WINDOW AC | 1 | 1.5 | GODREJ |
| 8 | GUEST HOUSE NO. 2 | | | | |
| | ROOM NO. 1 | WINDOW AC | 1 | 1.5 | GODREJ |
| | ROOM NO. 2 | WINDOW AC | 1 | 1.5 | GODREJ |
| | ROOM NO.3 | WINDOW AC | 1 | 1.5 | GODREJ |
| 9 | GUEST HOUSE NO.3 | | | | |
| | ROOM NO. 1 | WINDOW AC | 1 | 1.5 | GODREJ |
| | ROOM NO. 2 | WINDOW AC | 1 | 1.5 | GODREJ |
| | ROOM NO. 3 | WINDOW AC | 1 | 1.5 | GODREJ |
| 10 | GUEST HOUSE NO.4 | | | | |
| | ROOM NO. 1 | WINDOW AC | 1 | 1.5 | GODREJ |

| | | | | | |
|---|---|---|---|---|---|
| | ROOM NO. 2 | WINDOW AC | 1 | 1.5 | GODREJ |
| | ROOM NO. 3 | WINDOW AC | 1 | 1.5 | GODREJ |
| 11 | GUEST HOUSE NO.5 | | | | |
| | ROOM NO. 1 | WINDOW AC | 1 | 1.5 | GODREJ |
| | ROOM NO. 2 | WINDOW AC | 1 | 1.5 | GODREJ |
| 12 | GUEST HOUSE NO. 6 | | | | |
| | ROOM NO. 1 | WINDOW AC | 1 | 1.5 | GODREJ |

| SL. NO. AREA | NAME OF BUILDING | TYPES OF AC | NO. OF AC | CAPACITY (TR) | COMPANY |
|---|---|---|---|---|---|
| | ROOM NO.2 | WINDOW AC | 1 | 1.5 | GODREJ |
| 13 | VICE CHANCELLOR SIR'S RESIDENCE | | | | |
| | ROOM NO. 1 | WINDOW AC | 1 | 1.5 | GODREJ |
| | ROOM NO. 2 | WINDOW AC | 1 | 1.5 | GODREJ |
| 14 | DIRECTOR ADMINISTRATOR SIR RESIDENCE | | | | |
| | ROOM NO. 2 | WINDOW AC | 1 | 1.5 | GODREJ |
| 15 | FACULTY QUARTER A2 | WINDOW AC | 1 | 1.5 | DAIKIN |
| 16 | FACULTY QUARTER B1 | WINDOW AC | 2 | 1.5 | DAIKIN |
| 17 | OLD CAFFE | CASSETTE AC | 8 | 4.5 | DAIKIN |
| 18 | NEW CAFFE | CASSETTE AC | 4 | 4.5 | DAIKIN |
| 19 | NILGIRI BOYS HOSTEL | WINDOW AC | 1 | 1.5 | DAIKIN |
| 20 | HIMGIRI BOYS HOSTEL GYM | SPLIT AC | 2 | 1.5 | DAIKIN |
| 21 | HIMALAYA BOYS HOSTEL | WINDOW AC | 3 | 1.5 | DAIKIN |
| 22 | SHIVALIK BOYS HOSTEL | WINDOW AC | 3 | 1.5 | DAIKIN |
| 23 | LIBRARY UNIVERSITY BUILDING | CASSETTE AC | 5 | 4.5 | DAIKIN |
| 24 | OLD LIBRARY | FLOOR STANDING AC | 3 | 4 | DAIKIN |
| 25 | GODAVARI GIRLS HOSTEL GYM | WINDOW AC | 2 | 1.5 | |

**Indicative TR Load Profile for Air Conditioning**

| | | |
|---|---|---|
| Small Office Cabins | : | 0.1 TR $m^2$ |
| Medium Size Office with 10-30 people occupancy with Central A/c | : | 0.06 TR/$m^2$ |
| Large Multistoried office complex with Central A/c | : | 0.04 TR/$m^2$ |

There are 304 nos. Split AC's, Window A.C & Cassette A.C of various capacity & type installed in the complex. Out of these 304 nos. ACs 220 Nos. are Cassette AC, 46 Nos. are Window AC's, 21 Nos. are Split AC's, 5 Nos. are Floor standing AC's & 12 Nos. Centralized AC's of different Star rating. Some Air conditioning system is not operating during the energy audit. AZ Energy Engineers Pvt. Ltd. acknowledges and appreciates the commitment of the management towards conservation of Energy. Further it is recommended to replace left-over non-star rates ACs with Star Rated ACs, resulting further saving in energy.

| Existing Non-star AC to be replaced with 5 Star AC's | | |
|---|---|---|
| **Particulars** | **Unit** | **Value** |
| Existing ACs need to be replaced | Number (1.5 tr) | 10 |
| Total Cooling Load | TR | 15 |
| Cost of Energy Efficient ACs | INR/Piece | 35000 |
| **Operating parameters** | | |
| **Particulars** | **Unit** | **Value** |
| Number of running hours | Per Day | 10 |
| Number of operating Days | Per Year | 210 |
| Average life of Energy Efficient ACs | Years | 8 |
| Average Electricity tariff | INR/kVAh | 8 |
| **Energy and financial savings** | | |
| **Parameters** | **Unit** | **Value** |
| Power consumption of Non Star Acs-Measured value | **kW/TR** | 2.364 |
| Power Consumption of 5 Star rated | **kW/TR** | 1.677 |
| Total Power consumption of Existing Non-Star rated ACs | **kW** | 35.46 |
| Total power consumption of 5 star rated ACs | **kW** | 25.16 |
| Energy Savings | **kW** | 10.31 |
| Annual energy savings | **kWh/year** | 21641 |
| Annual monetary savings | **INR/year** | 173124 |
| Installation charges | **@5%** | 17500 |
| Total investment required | **INR** | 367500 |
| Simple payback period | **Months** | 25 |
| Internal rate of return (IRR) | **%** | 41.04% |

**Table 9: Savings in replacement of Non star AC'S to star rated AC'S**

## Recommendation/ Observation of AC System

- Monthly cleaning schedule Air Filters
- Replace Damage filters.
- Yearly service
- Check and clean condenser coils
- Check and clean air filters
- Check pipe Insulation

# 12. Ceiling Fan

There are many number of ceiling fans installed at various office rooms & building in the University. All these ceiling fans are very old and consumes around 60-70 W. In market more efficient fan is available so management change to old fan to new energy efficient fan BEE star rated in face manner.

### General Suggestion

Present power consumption of the conventional fan is 70-80 Watt. We have suggested replace this fan with 5 star fan, as per Star BEE labelling programme Notification. 5 Star rated fan power consumption is 43 Watt. Monetary saving is describe below table,

**Table 10: Old Celling Fan replace by New Energy Efficient Fan**

| Parameter | Units | Watt |
|---|---|---|
| Conventional Fan Power Consumption | Watt | 70 |
| Conventional Fan Air Delivery | m3/min | 200 |
| 5 Star Energy Efficient Fan Power Consumption | Watt | 43 |
| 5 Star Energy Efficient Fan Air Delivery | m3/min | 220 |
| Celling Fan Quantity | Nos. | 50 |
| Saving in Power Consumption | kW | 1.35 |
| Calculated Annual Saving In Power Consumption @ 270 Days @ 12 Hr. | kWh | 4374 |
| Calculated Annual Cost Saving @ INR 8.0/kWh | INR | 34992 |
| Estimated Investment for New Fan @ INR 2000/fan | INR | 100000 |
| Simple Pay Back Period | Month | 34-35 |

# 13. Self-Power Generation (D.G)

The campus has two nos. DG Sets of 380 kVA & 750 kVA installed for in- house power generation & supply during power cut, power failure and backup during day/night operations. The technical details of these DG sets are as under:

## 13.1 D.G. Rated Specification

*Table 11: Technical details of DG sets*

| Name Plate Data | | DG-1 | DG-2 |
|---|---|---|---|
| **ALTERNATOR** | | | |
| Rated | kVA | 380 | 750 |
| | KW | 304 | 600 |
| Voltage | L.V. | 415 | 415 |
| Amp. | L.V. | 529 | 1043 |
| Phase | | 3 | 3 |
| P.F. | | 0.8 | 0.8 |
| RPM | | 1500 | 1500 |
| Frequency | Hz | 50 | 50 |
| Excitation | Volts | 48 | 52 |
| Excitation | Amps | 2.3 | 2.5 |

Historical data of DG set running hours and fuel consumption given below.

## 13.2 Performance Assessment of D.G

During the audit we measured the specific fuel consumption (kWh/Ltr.) of DG sets. The load profile of the electrical parameters was recorded by using a portable 3-phase power analyzer. During the recording, the power analyzer recorded all the electrical parameters for further detailed analysis. The analysis of the different parameters recorded 1 Hr. Reading at the L.T. incoming main supply and during this period the diesel consumption was also recorded empty tank method.

| Particular | Unit | DG-2 (380 KVA) |
|---|---|---|
| Time | Hr. | 1 Hr. |
| Unit Generate | kWh | 210 |
| Fuel Consumption | Ltr. | 75.0 |
| SEC | kWh/Ltr. | **2.9** |

## 13.3 Historical Fuel Analyses Data

Analyses of last one-year DG log book details for Aug 2020 to Jul. 2021. Specific energy consumption shows in below table as per standard

*Table 12: Historical Energy Consumption of DG set*

| Srl. | Month | Diesel Consumption (Ltr.) |
|---|---|---|
| 1 | Aug. 2020 | 1687.9 |
| 2 | Sep. 2020 | 1068.8 |
| 3 | Oct. 2020 | 331.9 |
| 4 | Nov. 2020 | 609.3 |
| 5 | Dec. 2020 | 777.3 |
| 6 | Jan. 2021 | 378.3 |
| 7 | Feb. 2021 | 546.5 |
| 8 | Mar. 2021 | 706.8 |
| 9 | Apr. 2021 | 702.3 |
| 10 | May. 2021 | 1001.1 |
| 11 | Jun. 2021 | 1079.3 |
| 12 | Jul. 2021 | 1497.8 |
| | **Total** | **10387** |
| | **Avg.** | **866.0** |

**Further observations and recommendations are as under:**

1. The specific fuel consumption (SFC) of DG sets in the range of 2.8 to 3.5 kWh/ltr, as present Average SPC of all DG set is 2.9 kWh/Ltr. which is okay.
2. D.G. sets are neat & clean
3. DG set room have been with Proper Ventilation
4. However, there is No-Load Testing schedule

## 13.4 Fuel Gas Analyses

**1. TYPICAL DIESEL EXHAUST GAS COMPOSITION**

| Component | | Typical Component Concentration Range in Diesel Exhaust Gas | Component Concentration in Natural Dry Ambient Air |
|---|---|---|---|
| Nitrogen | $N_2$ | 75 – 77 %-vol | 78.08 %-vol |
| Oxygen | $O_2$ | 11.5 – 15.5 %-vol | 20.95 %-vol |
| Carbon dioxide | $CO_2$ | 4 – 6.5 %-vol | 0.038 %-vol |
| Water | $H_2O$ | 4 – 6 %-vol | |
| Argon | Ar | 0.8 %-vol | 0.934 %-vol |
| Totally | | > 99.7 %-vol | |

%-vol: Concentration, percentage, volume basis

ppm-vol: Concentration, parts per million, volume basis

Additional components found in diesel exhaust – typical concentration range (steady state, high load, residual and distillate fuel oil):

| | | |
|---|---|---|
| Nitrogen oxides | $NO_x$ | 1000 - 1500 ppm-vol |
| Sulphur oxides | $SO_x$ | 30 - 900 ppm-vol: Fuel composition related |
| Carbon monoxide | CO | 20 - 150 ppm-vol |
| Total Hydrocarbons | THC (as $CH_4$) | 20 - 100 ppm-vol |
| Volatile org.comp. | VOC (as $CH_4$) | 20 - 100 ppm-vol |
| Particulates *) | PM | 20 - 100 mg/Nm$^3$, dry, 15% $O_2$: Fuel composition related |
| Smoke: | Related to low load (<50% load), start-up and fast load increase | |

## 13.5 Diesel Generator Stack Height

DG sets emit some amounts of oxides of Nitrogen, Carbon Monoxide, Sulphur Dioxide, and other particulate matter, which can harm the surrounding habitat and organisms. This is why the CPCB has laid down a specific formula for deriving a minimum stack height of the DG sets' exhaust outlet with respect to the height of the facility it is installed in to ensure that the emissions don't come on contact with the surrounding habitat.

**Calculating Stack Height of DG sets For A Facility:**

The minimum height of stack to be provided with each generator set can be worked out using the following formula:

$$\mathbf{H = h+0.2 \times \sqrt{KVA}}$$

Where:

H = Total height of stack in meter

h = Height of the building in meters where the generator set is to be installed

KVA = Total generator capacity of the set in KVA

This is an explicit formula for DG SET stack height calculation, irrespective of the type of industries where the generator set is installed.

Based on the above formula the minimum stack height to be provided with different range of generator sets

| | |
|---|---|
|  | DG Set exhaust not provided as per CPCB requirement. It should be raised to a height required as per norms |

**Recommendations for Energy Efficiency Measures in DG Sets**

1. Ensure Steady load condition on the DG set and avoid idle running.
2. Improve air filtration.
3. Ensure fuel oil storage, handling and preparation as per manufacturers' guidelines/oil company data.
4. Calibrate and overhaul fuel injectors and injection pumps regularly as recommended by manufacturer.
5. Ensure compliance with maintenance checklist
6. Ensure steady load conditions, avoiding fluctuations, imbalance in phases, harmonic loads.
7. Carryout regular field trials to monitor DG set performance, and maintenance planning as per requirements.
8. Efficiency of DG Set can be increase by loading 70-80% load
9. The starting current of squirrel cage induction motor is as much as six times the rated current for a few seconds with direct-on-line starters. In practice, it has been found that the starting current value should not exceed 200% of the full load capacity of the alternator. The voltage and frequency throughout the motor starting

interval recovers and reaches rated values usually much before the motor has picked up full speed

**10.** It is always recommended to have the load as much balanced as possible, since the unbalanced loads can cause heating of the alternator, which may result in unbalanced output voltage. The maximum unbalanced load between phases should not exceed 10% of the capacity of the generating sets.

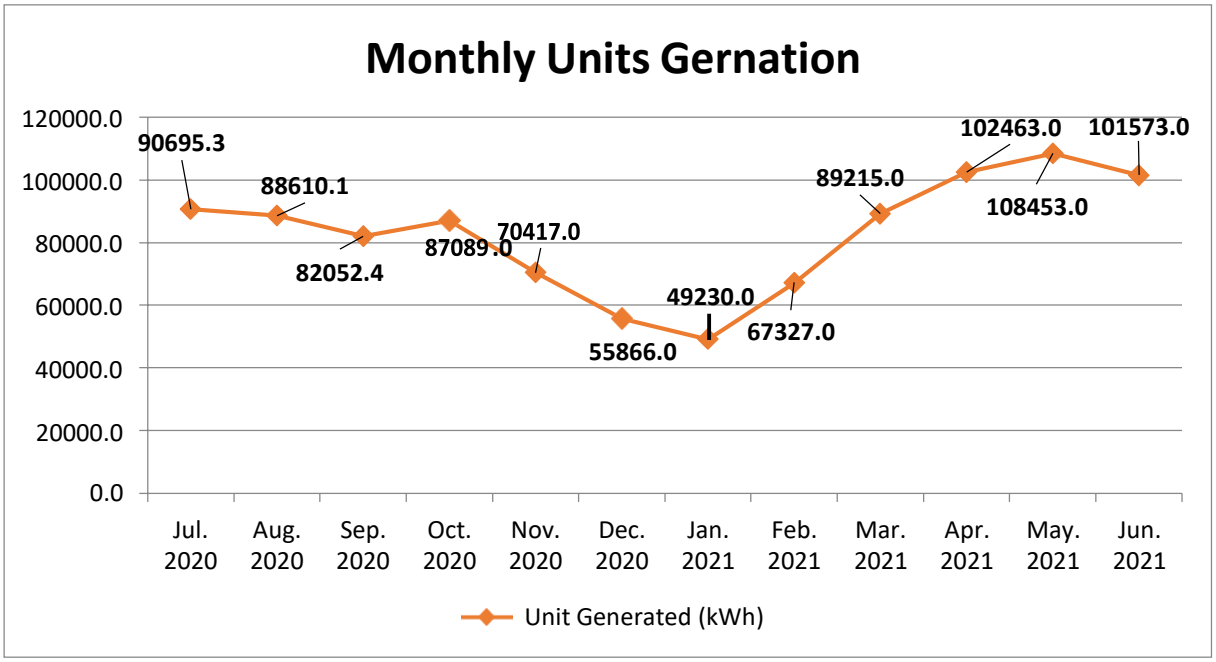
**11.** The electricity rules clearly specify that two independent earths to the body and neutral should be provided to give adequate protection to the equipment in case of an earth fault and to drain away any leakage of potential from the equipment to the earth.

# 14. Solar Photovoltaic Cell


The campus has already installed 800 kWP Solar PV. Solar generation power is connected to the panel and consumed energy in-house plant. A photovoltaic power system is an electricity generating Solar PV power system that is connected to the main LT panel. The total generation recorded since installation up to the time of energy audit is as follows:

*Table 13: Details of Power Generation from Solar Plant*

| Sr No. | Month | No of days | Unit Generated (kWh) | kWh/ Day | kWh/kWp /day | Amount | CUF (%) |
|---|---|---|---|---|---|---|---|
| 1 | Jul. 2020 | 31 | 90695.3 | 2925.65 | 3.66 | 545079 | 15.2 |
| 2 | Aug. 2020 | 31 | 88610.1 | 2858.39 | 3.57 | 532547 | 14.9 |
| 3 | Sep. 2020 | 30 | 82052.4 | 2735.08 | 3.42 | 493135 | 14.2 |
| 4 | Oct. 2020 | 31 | 87089.0 | 2809.32 | 3.51 | 523405 | 14.6 |
| 5 | Nov. 2020 | 30 | 70417.0 | 2347.23 | 2.93 | 423206 | 12.2 |
| 6 | Dec. 2020 | 31 | 55866.0 | 1802.13 | 2.25 | 335755 | 9.4 |
| 7 | Jan. 2021 | 31 | 49230.0 | 1588.06 | 1.99 | 295872 | 8.3 |
| 8 | Feb. 2021 | 28 | 67327.0 | 2404.54 | 3.01 | 404635 | 12.5 |
| 9 | Mar. 2021 | 31 | 89215.0 | 2877.90 | 3.60 | 536182 | 15.0 |
| 10 | Apr. 2021 | 30 | 102463.0 | 3415.43 | 4.27 | 634246 | 17.8 |
| 11 | May. 2021 | 31 | 108453.0 | 3498.48 | 4.37 | 671324 | 18.2 |
| 12 | Jun. 2021 | 30 | 101573.0 | 3385.77 | 4.23 | 628737 | 17.6 |
| | | **365** | **992990.8** | | | **6024122** | **14.2** |



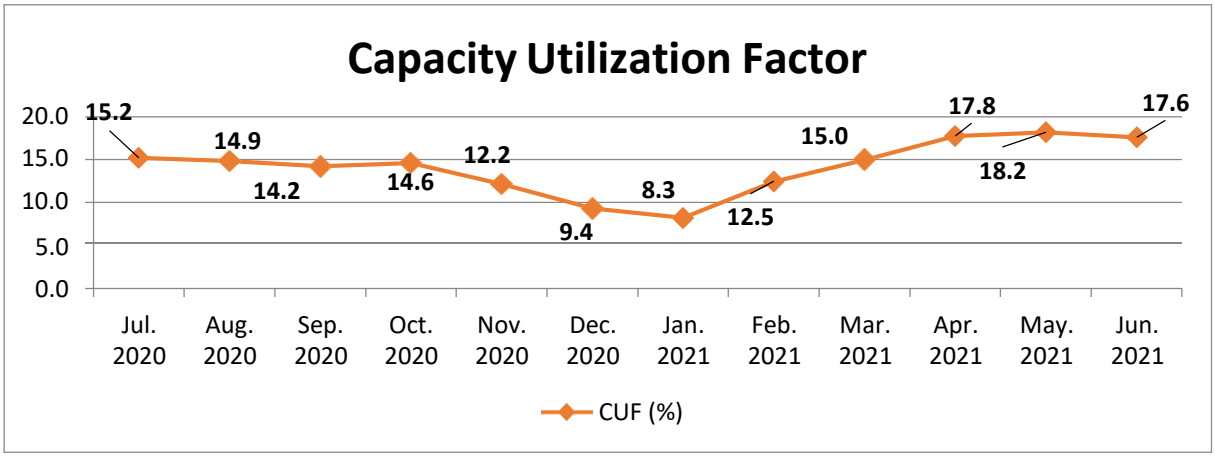

The units or kWh output of a solar panel will depend on the panel efficiency and availability of sunlight in a location. The factor that defines this output is called CUF (or Capacity Utility Factor). For India, it is typically taken as 19% and the calculation of units goes as:

$$\textbf{Capacity Utilization Factor (C.U.F)} = \frac{\textbf{(Actual energy from the plant(kwh))}}{\textbf{(Plant Capacity (kWp) x 24 x 395)}}$$

**Solar photovoltaic technologies** convert solar energy into useful energy forms by directly absorbing solar photons—particles of light that act as individual units of energy—and either converting part of the energy to electricity.

Average solar irradiation in U.P state is 1156.39 W / sq.m. 1 kWp solar rooftop plant will generate on an average over the year 4.6 kWh of electricity per day (considering 5.5 sunshine hours)

The performance of Solar PV plant is national average of 17 & 19%. It is therefore, suggested to regularly clean these panels for better performance.




The less generation of units is due to inadequate maintenance of Solar panel, as dust, found deposited on the surface of solar plates, which act as shield from sun rays thus effecting the Power generation badly. We suggest to regular cleaning of Solar Panels.

The Campus has lot of space at roof-top / shed area. Where additional solar PV panels can be installed. So typically a 1 kW capacity solar system will generate 1600-1700 kWh of electricity per year. This can provide electricity for 25 years.

| | | |
|---|---|---|
| • Total Capacity of SPV | = | 1 KW |
| • Area required per KW | = | 10 m2/ KW |
| • Area required for 50 KW | = | 100 m2 |
| • Facing | = | Shadow free South facing |
| • CUF/PLF | = | 19% |
| • 1 kWp solar rooftop | = | 4.6 kWh |

# 15. Power Quality

## 15.1 HARMONICS

Harmonics are the periodic steady-state distortions of the sine wave due to equipment generating a frequency other than the standard 50 cycles per second as now a day's equipment became more sophisticated and with the proliferations of non-linear loads, harmonics have become a pronounced problem on many power systems. Now a-days in many areas non-linear load are approaching significantly.

**The Effects of the Harmonics current are:**

- Additional copper losses
- Increased core losses
- Increased electromagnetic interference with communication circuits.

**The Effects of the Harmonics Voltage are:**

- Increased dielectric stress on insulation
- Electro static interference with communication circuits
- Resonance between reactance and capacitance

**Causes:** There are many sources of harmonics in Power system but all harmonics sources share a common characteristic. This is a non-linear voltage current operating relationship and any device that alters the sinusoidal wave form of voltage or current is harmonics producer. The following are the source of harmonics: **Electronic ballasts; non—linear loads; variable frequency drives, diodes, transistors, thyrusters, rectifier output, frequency conversion, Transformers; circuit breakers; phone systems; capacitor banks; motors, Computers (power supplies) PC, laptop, mainframe, Servers, Monitors, Video display, Copiers, scanners, FAX machines, printers, plotters, lighting controls, UPS systems, battery charges & data centers etc. etc.**

**Effects:** Overheating of electrical equipment; random breakers tripping, High Neutral current due to 3$^{rd}$ Harmonics, interference with communication, non-proper recording of metering, increase in cooper loss, heating of equipment's such as transformer & generators, breakers & fuse operation occur.

Harmonics contents can place serious Burden on power distribution system. If harmonics distortion may suppose 35%, the distribution of harmonics then will be 5$^{th}$ order 27% 7$^{th}$ order 5%, 11$^{th}$ order – 2 % and 13$^{th}$ order 1%.

**Solutions:** Harmonics filters employ the use of power electronic technology, which monitors the nonlinear load and dynamically corrects a wide range of harmonics, such as the 3rd to 51st harmonics orders. By the injection of a compensating current into the load, the waveform is restored which dramatically reduce distortion to less than 5% THD, meeting IEEE 519 standards. Further to meet other power quality demand surge protection, metering, relay protection, control, SCADA and communication can be one of the solution. Solution can range from simply tightening connections in a switchboard to help overheating of conductors, to use of a 200% rated neutral in a panel board.

**The total harmonic distortion (THD) of current or voltage is equal to the effective value of all the harmonics divided by the effective value of the fundamental.**

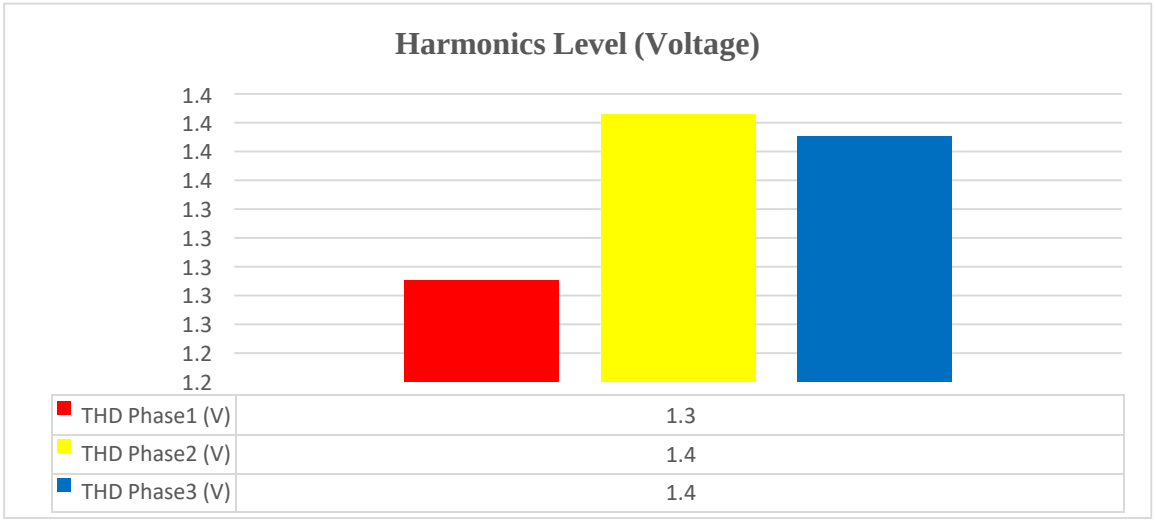



*Figure 15.1: Trend of Transformers harmonics in Voltage*

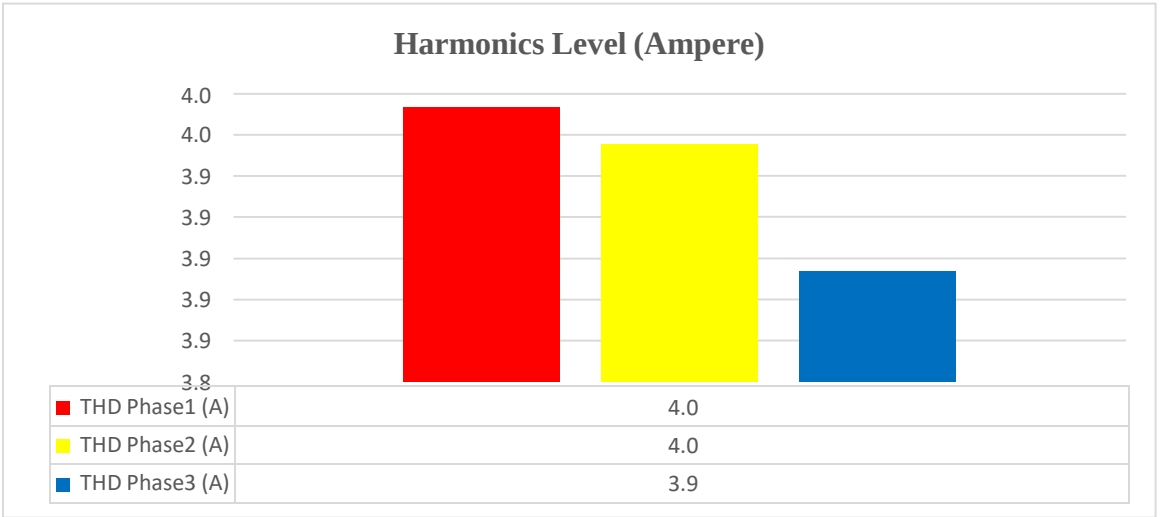



*Figure 15.2: Trend of Transformers harmonics in Current*

**As per IEEE 519-992& IEEE C-57.110-1986 The current harmonics should be less than 8% as higher value may result in mal-operation of electronics system like control & protection etc. and may result in de-rating of transformer, the most preferred international standard of harmonic for Voltage should not be more than 3% and for current it should not be more than 8%.**

**HARMONIC CAN BE LIMITED WITH FOLLOWING METHODS**:

1. 12 Pulse drives
2. Harmonic filters
3. High-end performance drives
4. Power re-distribution

## Further:

**1** Every harmonic can create problem, the nature of problem can be different. Due to higher voltage harmonic there can be components failure in electronic circuits, in higher current harmonics there can be high heat generation, which can lead to burning and fire, again due to higher third & ninth harmonic, there will be higher neutral current which can be very dangerous for maintenance team, due to higher negative harmonic there can be mechanical problems which leads to machine failures etc. Therefore, it will be incorrect to say any harmonic is to be given more preference. Mitigation to harmonic should always be specific to the problem and of course be just not more and not less. This is where many people get mislead by marketing team.

2. Every machine has inbuilt capacity to withstand certain amount of harmonics, be it voltage or current. IEEE 519 A& B gives more details on the subject, though there is nothing much mentioned in Indian standard on the subject (To the best of my knowledge). As per thumb rule, voltage harmonic should be less than 3% and current harmonics should be less than 8%. All odd harmonics are dangerous. As I mentioned earlier third & ninth harmonic will increase neutral current and related problems as these are generated mostly by single phase loads and the circuit is completed through the neutral. Other odd harmonics (5th, 7th, 11th, 13th etc.) will be either positive harmonics or negative harmonics. Besides higher current and heat (Other problems will also be there) the negative harmonics will also cause mechanical problems to complicate the problems further. So the danger level is to be analyzed depending upon the situation and problem at hand.

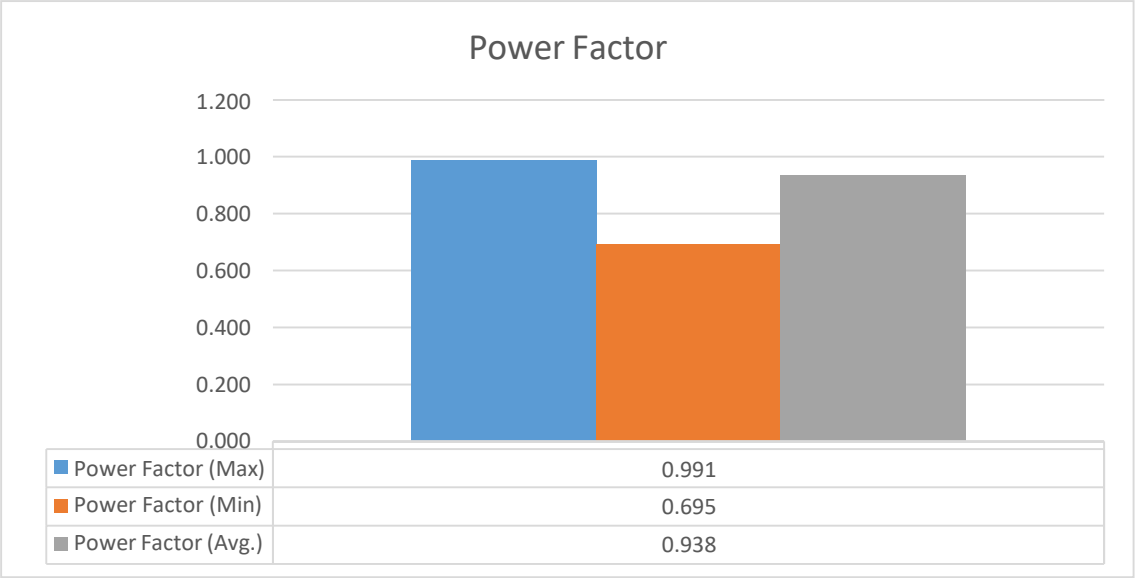
## 15.2 Power factor

**The concept of power factor in the case of sinusoidal voltages and currents, relates tothe real power, reactive power, and apparent power associated with a load consistingof resistance and reactance bringing about a direct phase shift between the voltage and current.**

Capacitor is a device that generates reactive current and consumes very less power. Installing capacitor will improve the power factor and will also reduce the kVA demand of the system and will increase the capacity of the network i.e. the network cables can be loaded further. Reduction in reactive current will result in reduction of $I^2R$ losses and efficiency of the system will improve.

***So it is recommended to keep 50% PF the capacitor at down stream (Load end) of the electrical distribution network and balance 50% at up stream (power house) end with automatic features (APFC).*** It is the best suited reactive compensating method as it will reduce distance transport of reactive power. It is also recommended to replace all the capacitors which have more than 35% reduction in rated capacity.

*Figure 15.3: Trend of power factor of Transformers*




**It is recommended that instead of installing all the capacitors at the beginning 50% should be shifted to load center immediately. As at the main supply system also average power factor recorded is found to be 0.910, it is recommended that at individual locations power factor correction system be installed after conducting**

**detailed study at the time of operation of Air Conditioning system. The location of power factor correction should by taking following into account:**

1. It should be on the main distribution board.
2. It should be either on sub-distribution board
3. It should be at the load end.

**The benefits of power factor can be summarized as under:**

1. Rebate from State Electricity Board
2. Improvement in Voltage
3. Reduction in maximum demand charges
4. Reduce heat loss

# 16. Cables

The electric current corresponds to Total Power (kVA) that depends on power factor, flows from utility-supply point to various load points of the unit through power cables (mostly made of aluminum). During the above power transport, considerable power is wasted to oppose the resistance of the cable. The cable resistance increases with length but decreases with cross-section i.e. increase in size. Therefore, the cable capacity has to be selected accordingly to keep the loss within 0.75% and it is only active load which cause the change in PF from no load to full load. By applying capacitor, we will change the PF of supply system hence $I^2R$ of the old cable between supply source and motor.

## 14.1 Flowing current in feeders

The cable loss is proportional to $I^2R$ (square of current flow and resistance of cable). Normally the current rating given by manufacturer is to withstand thermal stress. Energy conservation point of view, the above needs to be devalued based on length i.e. to curtail excess energy loss caused by off centered powerhouse, longer cables are to carry lesser than the rated current.

## 14.2 Reducing loss

There are two methods to reduce $I^2R$ cable loss in feeders. They are: (i) reducing the current in cables by adding capacitors near to load or bifurcating the overloaded feeders (ii) reducing the resistance of cable by increasing its size or running additional run of cable of equal size.

## 14.3 Capacitor shifting/addition

It is possible to reduce current; thereby $I^2R$ losses in cable by providing additional capacitors near to feeder end/ motor end.

# 17. Energy Demand Management

The energy audit study was under taken at this complex comprising of offices, platforms areas etc. Electricity is the main energy source for this complex. Electricity is used for meeting requirements of equipment's, machines, lightings, fans, air-conditioning, Water pumps & office equipment etc.

## *17.1* Electricity Bill Analysis

**The Invertis University is getting electrical power supply from Madhyanchal Vidyut Vitaran Nigam Ltd. (MVVNL) at 11 kV supply**.

There are three step down transformers of 630 kVA, 630 KVA & 400 kVA (11kV / 0.433kV) to meet the demand of whole complex. The premise is also having two diesel generators to provide power supply during power failure /emergency to the campus.

*Table 14: Technical details of Connection*

| Parameter | Details |
|---|---|
| Consumer Name | M/S INVERTIES UNIVERSITY |
| Address | BAREILLY (U.P) |
| Supply From | Madhyanchal Vidyut Vitaran Nigam Ltd. (MVVNL) |
| Supply Type | 11 KV-HT |
| A/C No. | 761702356284 |
| Meter No | XC435139 |
| Contract Demand (kVA) | 800 |
| Tariff type | HV-1 |

*Table 15: Historical Electrical Bill Analysis*

| Sr. No. | Billing Month | MDI | Total electricity consumption (kVAh) | Solar Export | Energy Consump-tion | Energy Charge | Fixed Charges | ED | Rebate | Arrear | Arrears Sur-charges | Last Pay-ment Sch. | Total Payable Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **Mar 2020** | **366.6** | 33810.0 | 44480.00 | -10670.0 | -91715.6 | 258000.0 | 12471.33 | 1662.84 | - | - | - | **177093.0** |
| 2 | **April to Aug. 2020** | **440.0** | 36350.0 | 210055.0 | -173705.0 | - | 1290000.0 | 96750.00 | 12900.00 | - | - | - | **1363913.0** |
| 3 | **Sep. 2020** | **412.0** | 19235.0 | 406950.0 | -387715.0 | - | 258000.0 | 19350.00 | 2580.00 | - | - | - | **274770.0** |
| 4 | **Oct. 2020** | **412.0** | 19270.0 | 57760.0 | -38490.0 | - | 258000.0 | 19350.00 | 2580.00 | - | - | - | **274770.0** |
| 5 | **Nov. 2020** | **111.6** | 15835.0 | 37660.0 | -21825.0 | - | 258000.0 | 19350.00 | 2580.00 | - | - | - | **274770.0** |
| 6 | **Dec. 2020** | **133.6** | 40490.0 | 21280.0 | 19210.0 | 165842.8 | 258000.0 | 31788.21 | 4238.43 | - | - | - | **451393.0** |
| 7 | **Jan. 2021** | **146.2** | 38620.0 | 18035.0 | 20585.0 | 177777.8 | 258000.0 | 32683.34 | - | 4238.0 | 84.76 | 300.93 | **473085.0** |
| 8 | **Feb. 2021** | **130.6** | 33200.0 | 37875.0 | -4675.0 | - | 258000.0 | 19350.00 | 2580.00 | - | - | - | **274770.0** |
| | **Total** | | **236810** | **834095** | **-597285** | **251905** | **3096000** | **251093** | **29121** | **4238.0** | **84.76** | **300.93** | **3564564** |
| | **Avg.** | **269.1** | **29601.3** | **104261.9** | **-74660.63** | **83968.3** | **387000.0** | **31386.61** | **4160.18** | | | | **445570.5** |
| | **Max** | **440.0** | **40490.0** | **406950.0** | **20585.00** | **177777.8** | **1290000.0** | **96750.00** | **12900.00** | | | | **1363913.0** |
| | **Min** | **111.6** | **15835.0** | **18035.0** | **-387715.00** | **-91715.6** | **258000.0** | **12471.33** | **1662.84** | | | | **177093.0** |

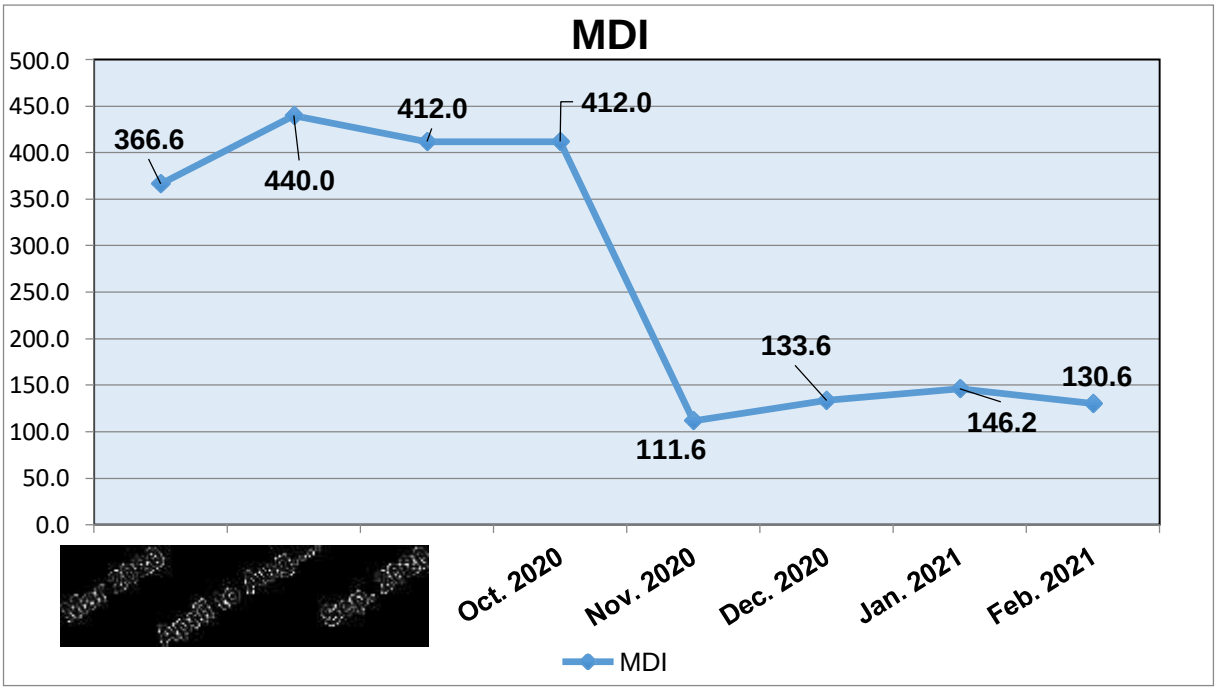



*Figure 17.4: Historical MDI variation*

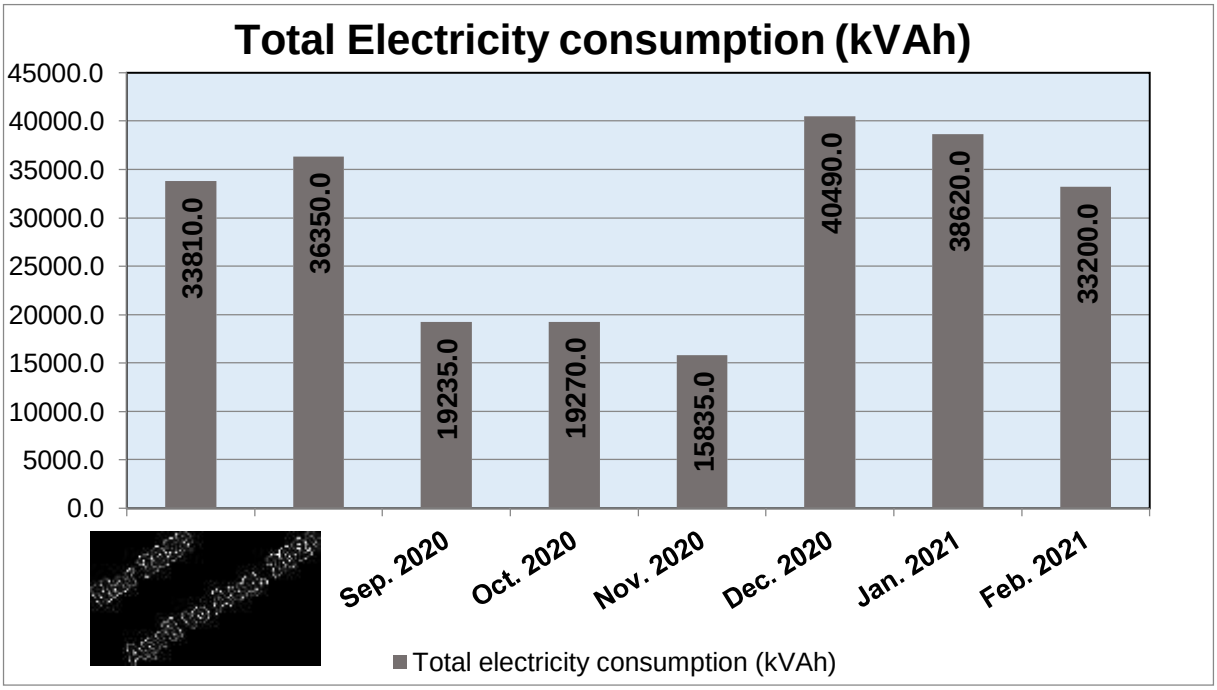
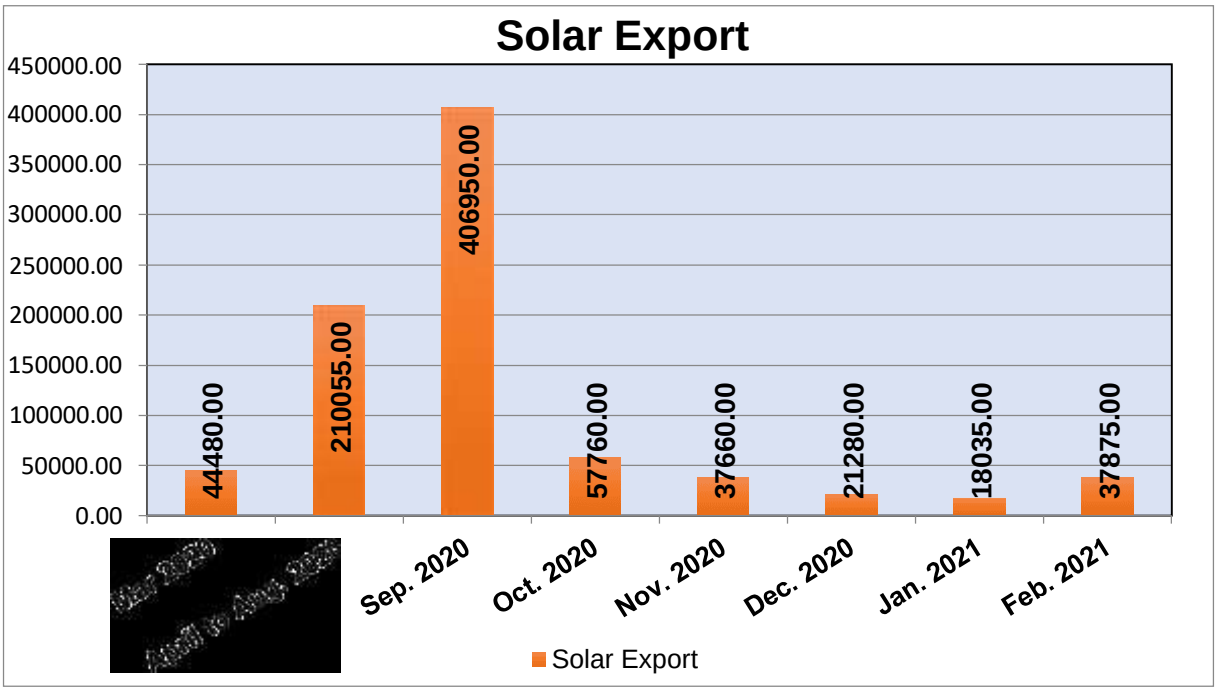



*Figure 17.5: Historical trends of Reactive Power Consumption*



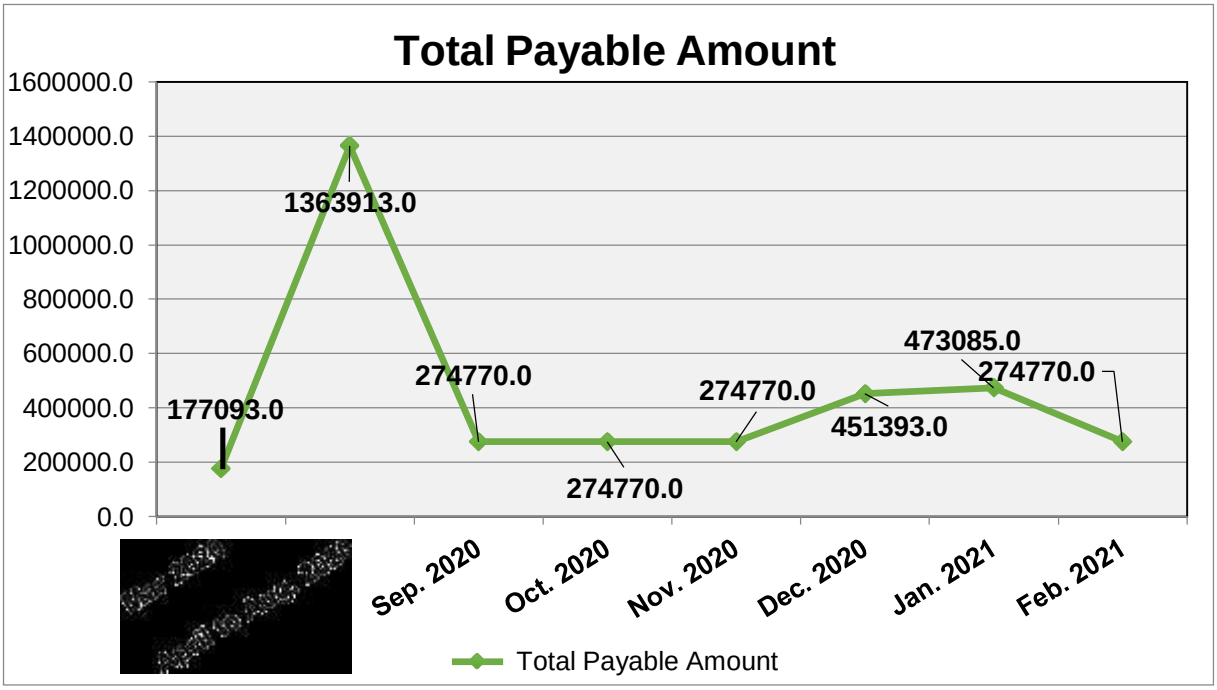




*Figure 17.6: Historical Trends of Electricity cost*

- Total yearly consumption from grid of the premises is 2.37 Lakhs kVAh in the month of Mar 2020 to Feb 2021 and Export electricity to grid 8.34 Lakhs KVAh in the month of Mar 2020 to Feb 2021 for fulfilling energy needs campus has been paying annually campus is paying Rs 35.65 Lakhs.

- Incoming supply voltage is 11 kV which is further stepped down to 433 V with the help of transformer.
- Average demand of the premises is 111.6 KVA, while variation of M.D. is within 111.6 to 440 KVA respectively.

**NOTE**

It is suggested the demand of the Industry to reduce Electricity cost. This can be achieved as below**:**

a. Re-schedule the load
b. Staggering of motor load
c. Shedding of non-essential load.
d. Operation of captive power generation
e. To install reactive power compensator
f. Use demand controller
g. Switching off non-essential loads.

# 18. Illumination & LUX Levels

To study, analyze and identify energy conservation options in lighting, a study of the unit lighting load was conducted. The purpose of the study was to determine the lighting load and its distribution in various sections of the buildings, determine the quality of illumination provided, and recommend measures to improve illumination and reduce electricity consumption.

A high quality and accurate digital LUX meter was used to measure the illumination level at various sections of the building during working hours. Other performance indicators such as type of lamps used, luminaries, mounting height, physical condition of lamps, use of day lighting, etc. were also noted down.

**Major reasons for poor illumination levels at selected locations of the building are as follows:**

- Poor reflectors/no reflector installed for the tube lights.
- Large height of installed fittings from the working plane.
- Reduction in illumination due to ageing.
- Very old fittings and dust deposition on luminaries

*Table 16: Table of assessment of lighting Load*

| Sr. No | Location | Lux Level |
|---|---|---|
| 1 | **New Building** | |
| | Civil Lab-1 | 150-190 |
| | Chemistry Lab-1 | 120-270 |
| | Chemistry Lab-2 | 140-260 |
| 2 | **Engineering Block** | |
| | Room-9 | 260-340 |
| | Room-8 | 250-330 |
| | Room-3 | 270-375 |
| | Room-13 | |
| 3 | **Management Block** | |
| | Room-1 | 211-370 |
| | Room-7 | 208-334 |
| | Room-4 | 200-320 |
| 4 | **Computer Block** | |
| | Lab-2 | 80-120 |

| Sr. No | Location | Lux Level |
|---|---|---|
| | Lab-3 | 80-135 |
| | Lab-1 | 70-110 |
| 5 | **Admin. Block** | |
| | Office | 140-200 |
| | Account office | 130-220 |
| 6 | **Work Shop** | |
| | Work shop | 130-190 |
| | Workshop-Lab | 140-260 |
| 7 | **University Building** | |
| | Room-15 | 260-300 |
| | Room-16 | 241-370 |
| | Room-17 | 230-320 |
| | Room-30 | 210-300 |
| | Room-31 | 190-350 |
| | Room-20 | 220-360 |
| | Room-26 | 200-310 |
| | Room-25 | 190-330 |
| | Room-26 | 210-330 |
| | Room-51 | 220-335 |
| | Room-24 | 210-340 |
| 8 | **Boys Hostel** | |
| | Room | 130-170 |
| | Room | 120-160 |

## Assessment of Lighting System

**Example : Room**

Lux Measured = Average Lux = 286

Length of the Room = 18ft.

Width of the Room = 14ft

Working Place Height = 10ft

| 287 | 284 |
|---|---|

| | | |
|---|---|---|
| **STEP 1** | Measure the Floor area of the interior : | Area = 18 x 14<br>= 252 sqft |
| **STEP 2** | Calculate the Room Index<br>18 x 14 / 10 (18 + 14) = .78 | RI = .78 |

| | | |
|---|---|---|
| **STEP 3** | Determine the total circuit watts of the installation by a power meter if a separate feeder for lighting is available. If the actual value is not known a reasonable approximate can be obtained by totaling up the lamp wattage including the ballasts | Total Circuit watts<br>54 W x 16 = 864<br>32 W x 4 = 128<br>TOTAL = 992W |
| **STEP 4** | Calculate Watts per square meter, Value of Step 3 ÷ Value of Step 1 | $W/m^2$ = 3.9 |
| **STEP 5** | Ascertain the average maintained luminance by using Lux Meter, Eav. Maintained | Eav.maint = 286 |
| **STEP 6** | Divide 5 by 4 to calculate Lux per Watt per square Meter | $Lux/W/m^2$ = 72.77 |
| **STEP 7** | Obtain target $Lux/W/M^2$ lux for type of the type of interior/ application and RI (2) | Target $Lux/W/m^2$ = 36 |
| **STEP 8** | Calculate Installed Load Efficacy Ratio (6 ÷ 7) | ILER = 2.02 |

**ILER 0.75 or over = Satisfactory to Good**

## Measuring Units Light Level – illuminance

Illuminance is measured in foot candles (ftcd, fc, fcd) or lux in the metric SI system). A foot candle is actually one lumen of light density per square foot, one lsux is one lumen per square meter.

- 1 lux = 1 lumen / sq meter = 0.0001 phot = 0.0929 foot candle (ftcd, fcd)
- 1 phot = 1 lumen / Sq centimeter = 10000 lumens / sq meter = 10000 lux
- 1 foot candle (ftcd, fcd) = 1 lumen / sqft = 10.752 lux

## Common Light Level Outdoor

Common light levels outdoor at day and night can be found in the table below :

***Table 17: Lux level of different natural occasions***

| Condition | Illumination | |
|---|---|---|
| | **(ftcd)** | **(lux)** |
| Sunlight | 10,000 | 107,527 |
| Full Daylight | 1,000 | 10,752 |
| Overcast Day | 100 | 1075 |
| Very Dark Day | 10 | 107 |
| Twilight | 1 | 10.8 |
| Deep Twilight | .1 | 1.08 |
| Full Moon | .01 | .108 |
| Quarter Moon | .001 | .0108 |

| | | |
|---|---|---|
| Starlight | .0001 | .0011 |
| Overcast Night | .0001 | .0001 |

## Common and Recommended Light Levels Indoor

The outdoor light level is approximately 10,000 lux on a clear day. In the building, in the area closes to windows, the light level may be reduced to approximately 1,000 lux. In the middle area its may be as low as 25- 50 lux. Additional lighting equipment is often necessary to compensate the low levels.

Earlier it was common with light levels in the range 100 -300 lux for normal activities. Today the light level is more common in the range 500 – 1000 lux – depending on activity. For precision and detailed works, the light level may even approach 1500 – 2000 lux.

The table below is a guidance for recommended light level in different work spaces:

***Table 18: Required lux level for various activities***

| Activity | Illumination (lux, lumen/$m^2$) |
|---|---|
| Public areas with dark surroundings | 20 -50 |
| Simple orientation for short visits | 50 -100 |
| Working areas where visual tasks are only occasionally performed | 100 -150 |
| Warehouse, Homes, Theaters, Archives | 150 |
| Easy Office work, classes | 250 |
| Normal Office work, PC work, Study library, Groceries, show room, laboratories | 500 |
| Supermarkets, Mechanical workshops, Office landscapes | 750 |
| Normal Drawing work, very detailed mechanical works | 1000 |
| Detailed drawing work, very detailed mechanical works | 1500 -2000 |
| Performance of visual tasks of low contract and very small size for prolonged periods of time | 2000 -5000 |
| Performance of visual tasks of low contract and very small size for prolonged period of time | 2000 -5000 |
| Performance of very prolonged and exacting visuals tasks | 5000 – 10000 |
| Performance of very special visual tasks of extremely low contract and small size | 10000 - 20000 |

# 19. Energy Balancing

Energy balancing starts from energy accounting and it is one of the principal activities integrated with energy management system aimed to help the energy manager in preparation of an energy balance sheet. Energy balance sheet helps to identify and fix energy guzzlers and take corrective measures**.** ***It is not possible to prepare an energy balance sheet without metering set-up at important nodes. It is an important activity for the management to initiate and install such metering facilities at least at selected important nodes*** of electrical distribution network starting from transformers outgoing point to motor end. Energy accounting could be done either by manual process or with the aid of data acquisition system supported by menu driven specially software packages to monitor, record and control the process sequences and thereby energy. The diesel storage and distribution system has no measurement, records and monitoring system. The diesel consumed by individual DG set are not measured and recorded, which is not proper practice both for energy efficiency and economic prospective.

# 20. Transformers and load profile

## *20.1* Transformers

**The Campus is getting electrical power supply from Dakshin Haryana Bijli Vitran Nigam (DHBVN) at 11 kV supply**.

There are three step down transformers of 630 kVA x 2 Nos., & 400 kVA (11kV / 0.415kV) to meet the demand of whole complex. During the audit TR-1 (630 KVA) on load and another both Transformer (630 KVA & 400 KVA) are stand by. The premise is also having two diesel generators to provide power backup during day/night. Load profile of power shown in below graphs.

*Table 19: Technical Specifications of transformers*

| Name Plate Data | | TRF-1 | TRF-2 | TRF-3 |
|---|---|---|---|---|
| Rated | kVA | 630 | 400 | 630 |
| Voltage | H.V | 11000 | 11000 | 11000 |
| | L.V | 433 | 433 | 433 |
| Amp. | H.V | 33.33 | 21 | 33.33 |
| | L.V | 840 | 5333.33 | 840 |
| Impedance Volt | % | 4.75 | 4.75 | 4.75 |
| Phase | | 3 | 3 | 3 |
| Frequency | HZ | 50 | 50 | 50 |
| Cooling Type | | ONAN | ONAN | ONAN |
| Vector Group | | Dyn11 | Dyn11 | Dyn11 |
| Mfg. | Year | 2011 | 2002 | 2011 |
| Make | | R.K Industries | R.K Industries | R.K Industries |

## *20.2* Load profile for Main Incomer (Transformer)

The load profile of the electrical parameters was recorded by using a portable 3-phase power analyzer. During the recording, the power analyzer recorded all the electrical parameters for further detailed analysis. The analysis of the different parameters recorded 24 hours reading at the L.T. incoming main supply is given below.

### *20.2.1* Real power (kW) and apparent power (kVA) profile

Load (real power) profile and apparent power profile is the variation in the electrical load versus time. In any electrical system, the vector sum of the active power (kW) and reactive power (kVAR) make up the total (or apparent) power (kVA) used. This is the power generated by a

generation station for the user to perform a given amount of work. The total power is measured in kVA (Kilo Volts-Amperes) and the load or active power is measured in kW (kilowatts) and

they become equal as and when the power factor approaches unity. Total electricity charges (units and demand) are based on the load or active power (kW) and apparent power (kVA).

During the energy audit studies, the total operating load at the transformer was recorded to find out the variation in the load at different times of the day. The following graph depicts the variation in the load and apparent power of the premises:

**Load Profile Real power (kW & kVA) profile of main incomer**

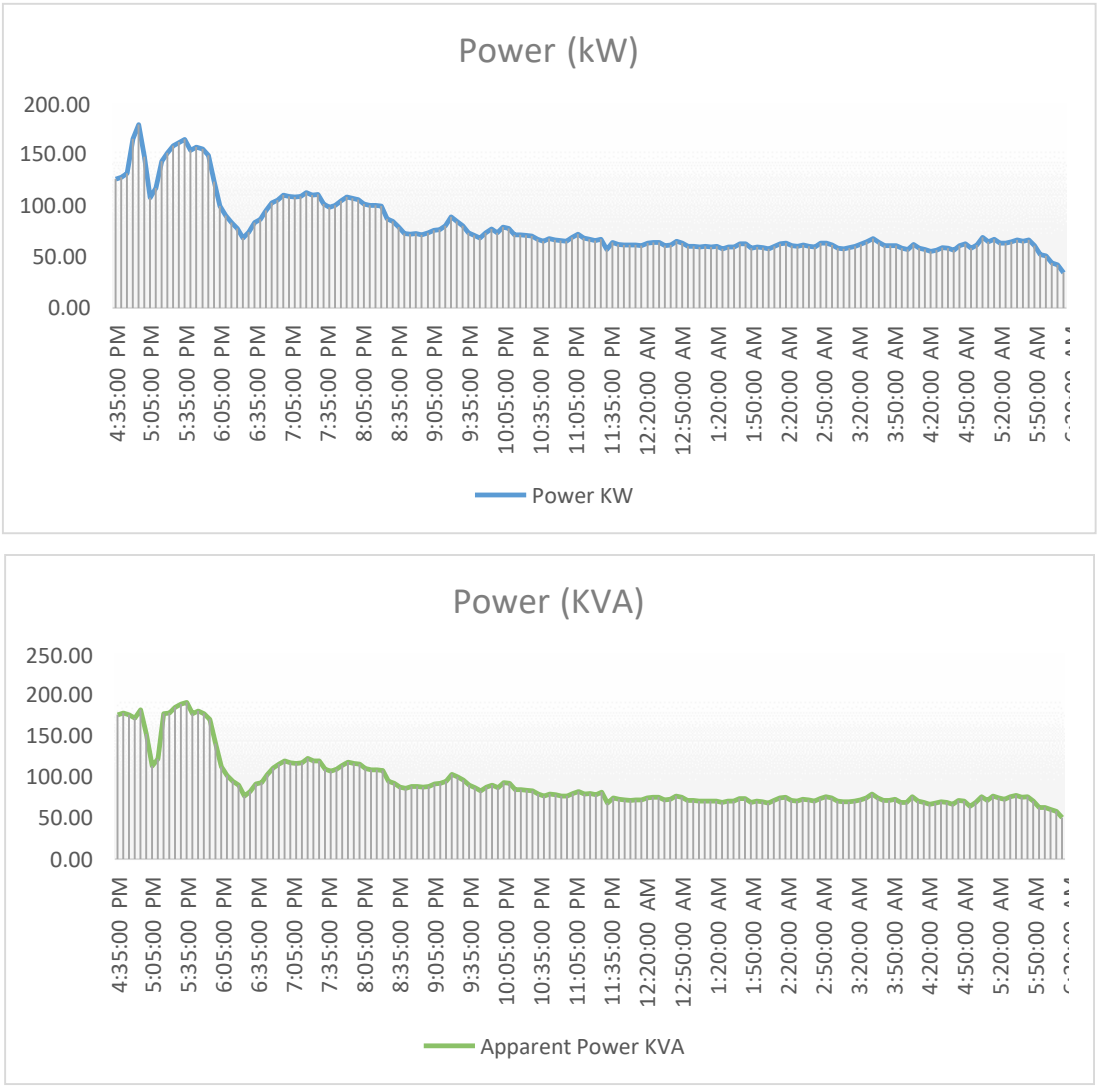



*Figure 20.7: Trends of active and reactive power*

***The observations taken from the graph:***

- The load (kW) variation ranges from 34.35 kW to 178.93 kW during the Load hours of measurement period and Average 79.27.
- The apparent power (kVA) varies from 50.62 kVA to 191.36 kVA during the Load hours of measurement period and Average 92.09.

*Table 20: Maximum and minimum Values of active and reactive Power*

| | Power (KW) | Apparent Power (KVA) |
|---|---|---|
| **Max.** | 178.93 | 191.36 |
| **Min.** | 34.35 | 50.62 |
| **Ave.** | 79.27 | 92.09 |

### *20.2.2* Power factor profile

Under the current tariff system, the billed units are in kVAh and the demand charges for apparent power (kVA) depend on the power factor. If the facility has a low power factor, then the demand drawn from the grid will increase and consequently the facility will incur more demand charges. The variation in the power factor was recorded to explore opportunities for improvement. The graph below presents the variations in the power factor of the power supply to the building:

**Power factor profile for the main Incomer**

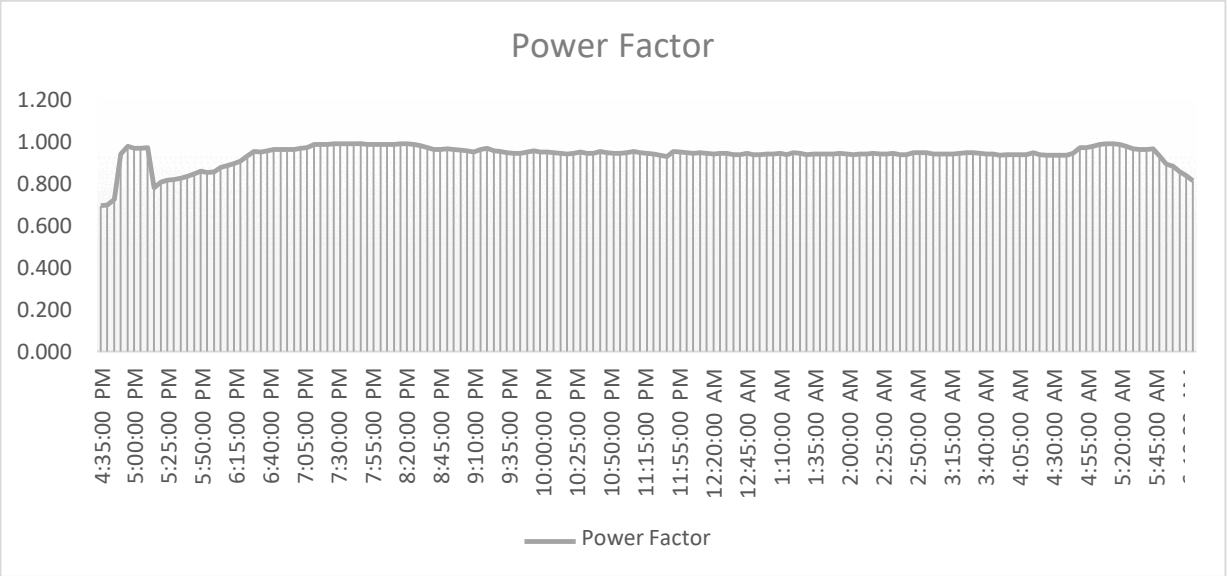



*Figure 20.8: Trends of Power Factor Variation*

**The observations taken from the above graphs:**

- The power factor varied from 0.695 to 0.991 during the load hours of measurement period and Average 0.938.

### *20.2.3* Current profile

Current profile is the variation in the electrical current versus time. The current variations in all the three phases (R, Y and B) were recorded at the main panel of the transformer. The graphs below present the variations in the current:

**Current Profile- Phase wise of the main Supply**

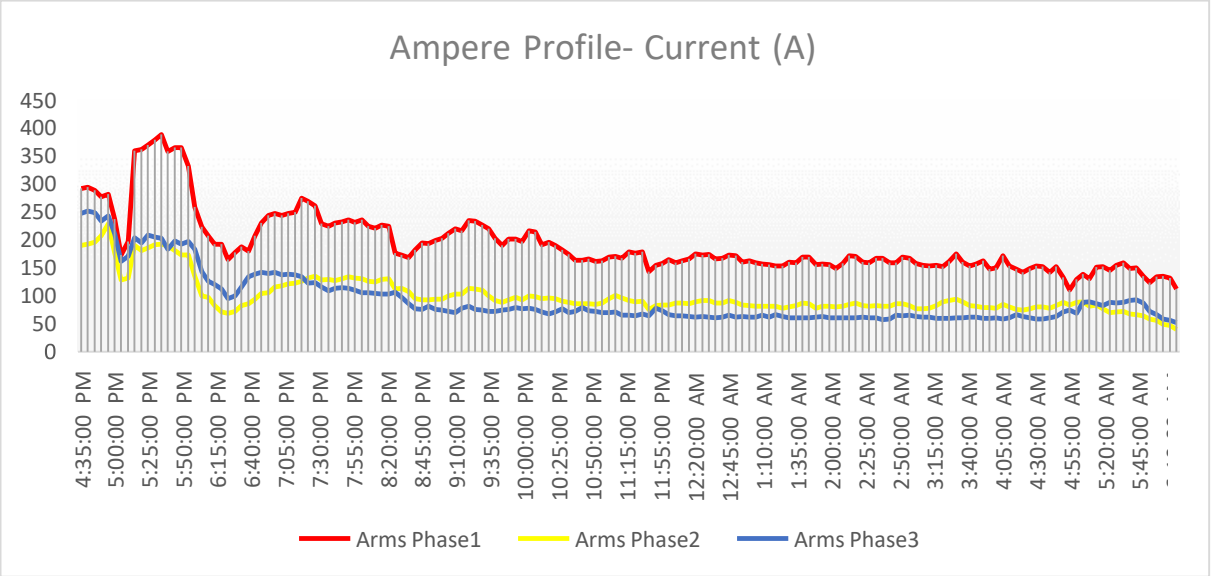



*Figure 20.9: Pattern of recorded current Profile*

**The observations taken from the above graphs:**

- There is a considerable current variation in the different phases and hence the phase-to-phase load is not balanced. The Current variation ranges. during the load hours of measurement period.

*Table 21: Maximum and minimum values of current*

| | Amp. Phase (R) | Amp. Phase (Y) | Amp. Phase (B) |
|---|---|---|---|
| **Max.** | 388.1 | 228.2 | 251.3 |
| **Min.** | 110.4 | 40.1 | 52.1 |
| **Ave.** | 192.2 | 100.4 | 93.1 |

### *20.2.4* Voltage profile

All electrical equipment has a designed range of operating voltage. Therefore, it is important to operate all electrical equipment, within the specified voltage range. The voltage variations in all the three phases (R, Y and B) were recorded at the main Supply. The graphs below depict the variations in the voltage

**Voltage Profile- Phase wise (V)**

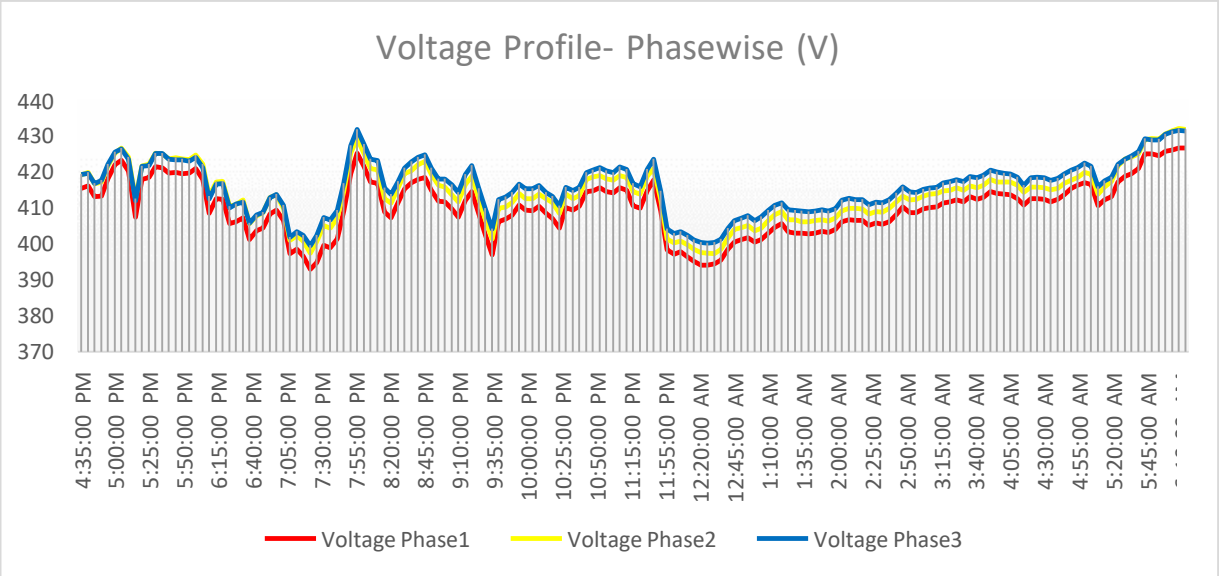



*Figure 20.10: Pattern of voltage Variation*

***The observations taken from the above graphs:***

- There was a slight variation in phase-to-phase voltage.
- The average voltage recorded

*Table 22: Maximum and minimum values of recorded voltage*

| | Voltage (R) Phase | Voltage(Y) Phase | Voltage(B) Phase |
|---|---|---|---|
| **Max.** | 426.6 | 432.0 | 431.8 |
| **Min.** | 392.9 | 397.3 | 399.5 |
| **Ave.** | 410.2 | 414.0 | 415.9 |

### *20.2.5* Frequency profile

The variations recorded in the frequency during the 24 hours of measurement period are provided below:

***Frequency profile of the main Incomer for load hours***

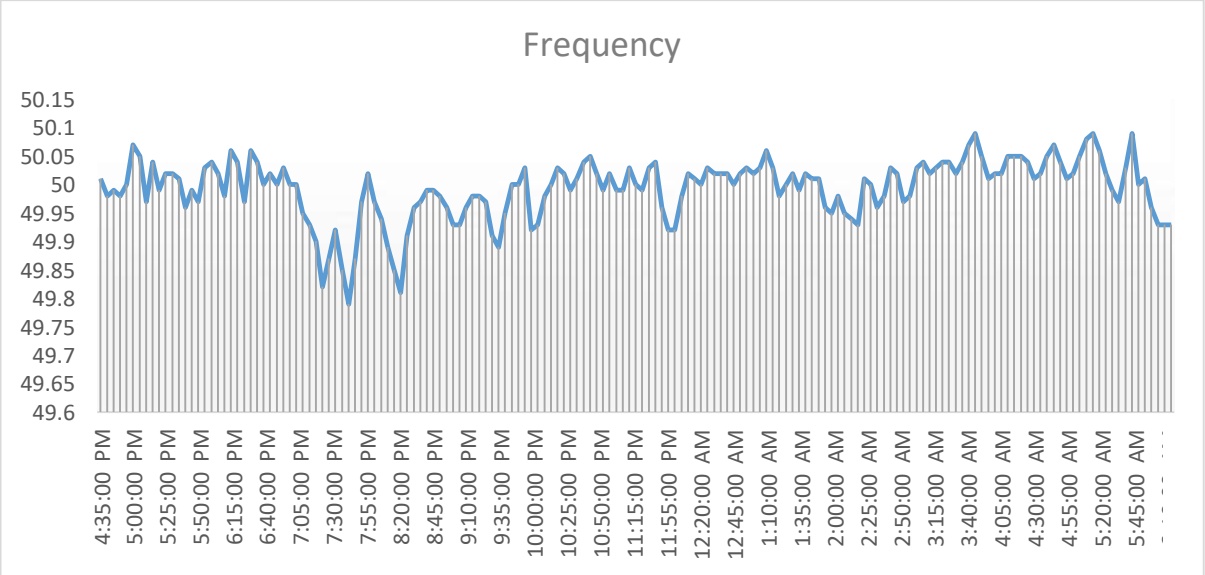



***Figure 20.11: Trends of frequency variations***

**The observations taken from the above graphs:**

- There was a minimal variation in the recorded frequency during the measurement period.
- The frequency varied from 49.8 Hz to 50.1 Hz and the average frequency recorded was 50.0 Hz.

### *20.2.6* Harmonics

Harmonics are the periodic steady-state distortions of the sine wave due to equipment generating a frequency other than the standard 50 cycles per second as now a day's equipment became more sophisticated and with the proliferations of non-linear loads, harmonics have become a pronounced problem on many power systems. Now a-days in many areas non-linear load are approaching significantly.

**The Effects of the Harmonics current are:**

- Additional copper losses
- Increased core losses
- Incresed electromagnetic interference with communication circuits.

**The Effects of the Harmonics Voltage are:**

- Incresed dielectric stress on insulation
- Electro static interference with communication circuits
- Resnance between reactance and capcitance

- **Causes:** There are many sources of harmonics in Power system but all harmonics sources share a common characteristic. This is a non-linear voltage current operating relationship and any device that alters the sinusoidal wave form of voltage or current is harmonics producer. The following are the source of harmonics: **Electronic ballasts; non—linear loads; variable frequency drives, diodes, transistors, thyristors, rectifier output, frequency conversion, Transformers; circuit breakers; phone systems; capacitor banks; motors, Computers (power supplies) PC, laptop, mainframe, Servers, Monitors, Video display, Copiers, scanners, FAX machines, printers, plotters, lighting controls, UPS systems, battery charges & data centers etc. etc.**
- **Effects:** Overheating of electrical equipment; random breakers tripping, High Neutral current due to 3$^{rd}$ Harmonics, interference with communication, non-proper recording of metering, increase in cooper loss, heating of equipment's such as transformer & generators, breakers & fuse operation occur.

Harmonics contents can place serious Burden on power distribution system. If harmonics distortion may suppose 35%, the distribution of harmonics then will be 5$^{th}$ order 27% 7$^{th}$ order 5%, 11$^{th}$ order – 2 % and 13$^{th}$ order 1%.

**Solutions:** Harmonics filters employ the use of power electronic technology, which monitors the nonlinear load and dynamically corrects a wide range of harmonics, such as the 3$^{rd}$ to 51$^{st}$ harmonics orders. By the injection of a compensating current into the load, the waveform is restored which dramatically reduce distortion to less than 5% THD, meeting IEEE 519 standards.

Further to meet other power quality demand surge protection, metering, relay protection, control, SCADA and communication can be one of the solution. Solution can range from simply tightening connections in a switchboard to help overheating of conductors, to use of a 200% rated neutral in a panel board:

The percentage of total current and voltage harmonic distortion in all the three phases (R, Y and B) were recorded at the main incoming panel. The graphs below depict the percentage of total harmonic distortion in the electrical distribution system:

**Percentage of Total Harmonic Distortion (THD) - Phase wise voltage**

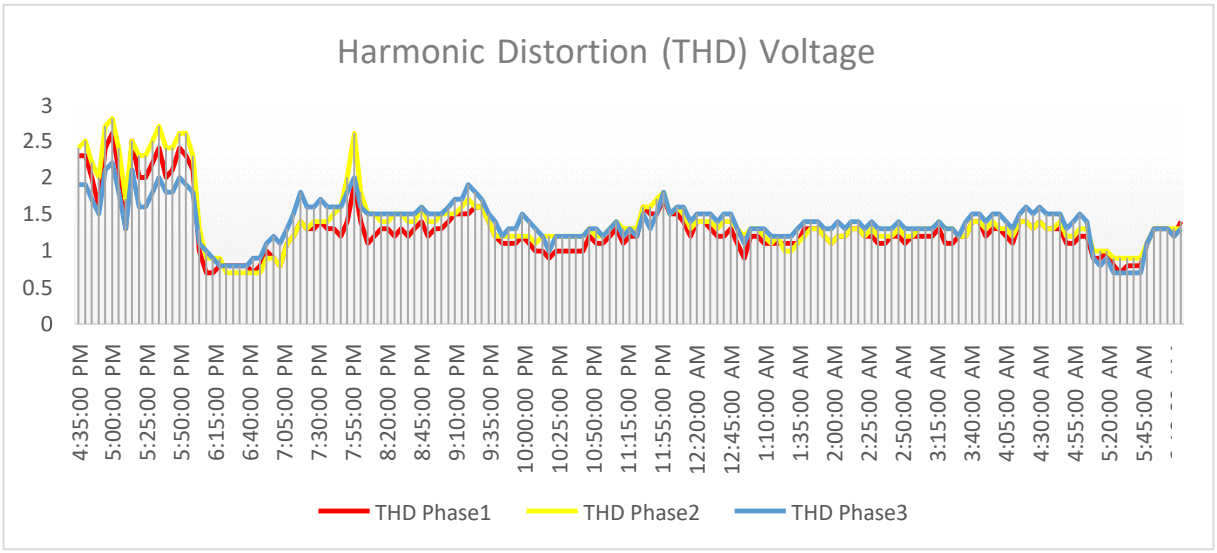



*Figure 20.12: Pattern of harmonics levels in voltage*

**Percentage of Total Harmonic Distortion (THD) - Phase wise current**

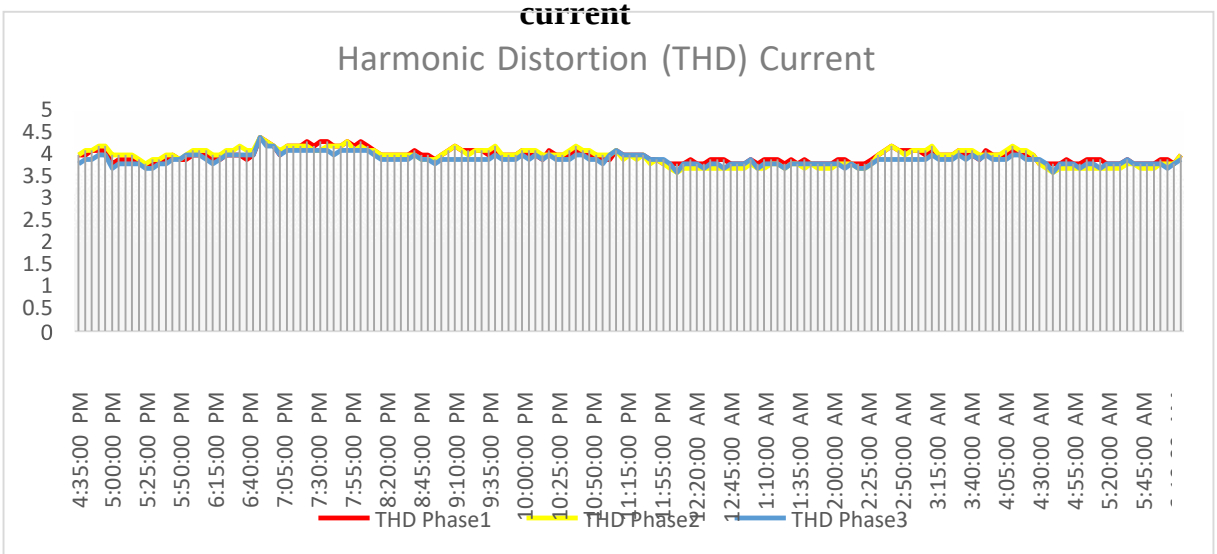



*Figure 20.13: Patterns of harmonics levels in current*

| | Voltage Harmonics % | | | Current Harmonics % | | |
|---|---|---|---|---|---|---|
| **Max.** | 2.6 | 2.8 | 2.2 | 4.4 | 4.4 | 4.4 |
| **Min.** | 0.7 | 0.7 | 0.7 | 3.8 | 3.6 | 3.6 |
| **Ave.** | 1.3 | 1.4 | 1.4 | 4.0 | 4.0 | 3.9 |

**Table 23: Measured Harmonics**

**levelsThe observations taken from the above graphs*:***

- The percentage of average voltage THD is in the range of 0.7 % to 3.5 %. This is well within the recommended limits as per IEEE Standards i.e. 4% variation for voltage & 15% variation for current.
- The percentage of average current THD is in the range of 3.8 % to 4.4 %. The current harmonics in the system are more than the recommended limits as per IEEE Standards. So, it is recommended to install the harmonics controller in the system to bring the Voltage harmonics with in limit & current THD levels within limits.

**The Observations Taken From The Above as:**

- Transformer temperature is Normal
- Silica Gel need to be replace.
- Oil level ok.
- Harmonics Level with in limit

## Overall Power Quality

The analysis of various power quality parameters given above indicates that the overall quality of power received by the facility is good and most of the parameters are within the desired range except the current harmonics in the system.

It is recommended that regular de-hydration of transformer oil should be carried out to remove the moisture. This de-hydration should be got done at regular interval based on condition monitoring.

## Transformer Losses And Efficiency

The efficiency of the transformer not only depends on the design, but also on the effective operating load. Transformer losses consist of two parts No-Load loss and Load loss.

1. No-Load loss (also called core loss): These losses occur whenever the transformer is energized. It does not vary with load.
2. Load-Loss (also called copper loss): It is the power lost in the primary and secondary winding of the transformer. Whenever the transformer remained energized and it varies with square of the current.

# 21. Capacitor

Capacitor is a device that generates reactive current and consumes very less power. Installing capacitor will improve the power factor, will also reduce the kVA demand of the system and will increase the capacity of the network. Capacitor is passive equipment very useful to reduce the load current by improving PF.

There are two APFC Panels installed i.e. 205 KVAr & 400 nos. The power factor shown in the APFC panel is 0.99.

*Table 24: Status of capacitors*

| APFC PANEL-01 | | | | | | |
|---|---|---|---|---|---|---|
| Sr. No. | Capacity (kVAr) | Rated Current (amp) | Measured | | | Remark |
| | | | Measured-R | Measured-Y | Measured-B | |
| 1 | 6 | 7.87 | - | - | - | Capacitor Panel Not Working |
| 2 | 6 | 7.87 | - | - | - | |
| 3 | 10 | 13.1 | - | - | - | |
| 4 | 10 | 13.1 | - | - | - | |
| 5 | 10 | 13.1 | - | - | - | |
| 6 | 15 | 19.6 | - | - | - | |
| 7 | 15 | 19.6 | - | - | - | |
| 8 | 15 | 19.6 | - | - | - | |
| 9 | 15 | 19.6 | - | - | - | |
| 10 | 20 | 26.2 | - | - | - | |
| 11 | 12.5 | 16.4 | - | - | - | |
| 12 | 15 | 19.6 | - | - | - | |
| 13 | 20 | 26.2 | - | - | - | |
| 14 | 5 | 6.6 | - | - | - | |
| 15 | 10 | 13.1 | - | - | - | |
| 16 | 20 | 26.2 | - | - | - | |
| **Total** | **205** | | | | | |

| | APFC PANEL-02 | | | | | |
|---|---|---|---|---|---|---|
| Sr. No. | Capacity (kVAr) | Rated Current (amp) | Measured | | | Remark |
| | | | Measured-R | Measured-Y | Measured-B | |
| 1 | 10 | 13.1 | 0.0 | 0.0 | 0.0 | De-Rated |
| 2 | 20 | 26.2 | 0.0 | 0.0 | 0.0 | De-Rated |
| 3 | 20 | 26.2 | 0.0 | 0.0 | 0.0 | De-Rated |
| 4 | 20 | 26.2 | 0.0 | 0.0 | 0.0 | De-Rated |
| **5** | 25 | 32.8 | 10 | 11 | 11 | De-Rated |

| | | | | | | |
|---|---|---|---|---|---|---|
| 6 | 50 | 65.6 | **0.0** | **0.0** | **0.0** | **De-Rated** |

| | | | | | | |
|---|---|---|---|---|---|---|
| 7 | 50 | 65.6 | **0.0** | **0.0** | **0.0** | **De-Rated** |
| 8 | 20 | 26.2 | **0.0** | **0.0** | **0.0** | **De-Rated** |
| 9 | 20 | 26.2 | **24.0** | **23.0** | **24.0** | **OK** |
| 10 | 20 | 26.2 | **19.0** | **18.5** | **19.2** | **OK** |
| 11 | 20 | 26.2 | **25.0** | **24.0** | **25.0** | **OK** |
| 12 | 25 | 32.8 | **33.0** | **31.0** | **33.0** | **OK** |
| 13 | 50 | 65.6 | **7.0** | **5.0** | **7.0** | **De-Rated** |
| 14 | 50 | 65.6 | **0.0** | **0.0** | **0.0** | **De-Rated** |
| **Total** | **400** | | | | | |

**The advantages of Power Factor improvement by capacitor**

- A Reactive component of the network are reduced and so also the total current in the system from the source end.
- I2R power losses are reduced in the system because of reduction in current.
- Voltage level at the load end is increased.
- kVA loading on the source generators as also on the transformers and line upto the capacitors reduces giving capacity relief. A high power factor can help in utilities the full capacity of the electrical system.

## Cost benefits of Power Factor improvement

- Reduced kVA (Maximum Demand) charges in electricity bill
- Reduced distribution losses (kWh) within the plant network
- Better voltage at motor terminals and improved performance of motors
- A high power factor eliminates penalty charges imposed when operating with low power factor
- Investment on system facilities such as transformers, cables, switchgears etc for delivering load is reduced.

# 22.Earthing

The electricity rules clearly specify that two independent earths to the body and neutral should be provided to give adequate protection to the equipment in case if an earth fault, and also to drain away any leakage of potential voltage from the equipment to the earth for safe working.

As there is no standard of earth resistance value, it varies on different type of soil resistivity, ideally it should be Zero but for different kind of soil for electrical equipment it should be better to below .8 Ohm and for electronics equipment it should be below .4 Ohm but best value is .1 Ohm.

**Table 25: Details of Earth Resistance at various locations**

| Sr. No. | Location | Ohm |
|---|---|---|
| 1 | TRANSFORMER -630 | 3.8 |
| 2 | | 4.3 |
| 3 | TRANSFORMER -400 | 4.2 |
| 4 | | 2.7 |
| 5 | TRANSFORMER -630 | 3.9 |
| 6 | | 2.8 |
| 7 | DG SET – 750 KVA (Body) | 4.7 |
| 8 | DG SET – 750 KVA (Body) | 4.5 |
| 9 | DG SET – 750 KVA (NEUTRAL GROUNDING) | 4.6 |
| 10 | DG SET – 380 KVA (Body) | 4.2 |
| 11 | DG SET – 380 KVA (Body) | 2.6 |
| 12 | DG SET – 380 KVA (NEUTRAL GROUNDING) | 2.1 |
| 13 | L.T Panel | 1.4 |
| 14 | L.T Panel | 2.3 |
| 15 | L.T Panel | 3.4 |

# 23.General Tips for Energy Conservation

## 23.1. Electricity

- Schedule your operations to maintain a high load factor
- Minimize maximum demand by tripping loads through a demand controller
- Use standby electric generation equipment for on-peak high load periods.
- Correct power factor to at least 0.99 under rated load conditions.
- Set transformer taps to optimum settings.
- Shut off unnecessary computers, printers, and copiers at night.

## 23.2. Motors

- Properly size to the load for optimum efficiency.
- (High efficiency motors offer of 4 - 5% higher efficiency than standard motors)
- Check alignment.
- Provide proper ventilation
- (For every 10°C increase in motor operating temperature over recommended peak, the motor life is estimated to be halved)
- Check for under-voltage and over-voltage conditions.
- Balance the three-phase power supply.
- (An Imbalanced voltage can reduce 3 - 5% in motor input power)
- Demand efficiency restoration after motor rewinding.

## 23.3. Drives

- Use variable-speed drives for large variable loads.
- Use high-efficiency gear sets.
- Use precision alignment.
- Check belt tension regularly.
- Eliminate variable-pitch pulleys.
- Use flat belts as alternatives to v-belts.
- Use synthetic lubricants for large gearboxes.
- Eliminate eddy current couplings.
- Shut them off when not needed.

## 23.4. Fans

- Use smooth, well-rounded air inlet cones for fan air intakes.
- Avoid poor flow distribution at the fan inlet.
- Minimize fan inlet and outlet obstructions.

- Clean screens, filters, and fan blades regularly.
- Use aerofoil-shaped fan blades.
- Minimize fan speed.
- Use low-slip or flat belts.
- Check belt tension regularly.
- Eliminate variable pitch pulleys.
- Use variable speed drives for large variable fan loads.
- Use energy-efficient motors for continuous or near-continuous operation
- Eliminate leaks in ductwork.
- Minimize bends in ductwork
- Turn fans off when not needed.

## 23.5. Blowers

- Use smooth, well-rounded air inlet ducts or cones for air intakes.
- Minimize blower inlet and outlet obstructions.
- Clean screens and filters regularly.
- Minimize blower speed.
- Use low-slip or no-slip belts.
- Check belt tension regularly.
- Eliminate variable pitch pulleys.
- Use variable speed drives for large variable blower loads.
- Use energy-efficient motors for continuous or near-continuous operation.
- Eliminate ductwork leaks.
- Turn blowers off when they are not needed.

## 23.6. Pumps

- Operate pumping near best efficiency point.
- Modify pumping to minimize throttling.
- Adapt to wide load variation with variable speed drives or sequenced control of smaller units.
- Stop running both pumps -- add an auto-start for an on-line spare or add a booster pump in the problem area.
- Use booster pumps for small loads requiring higher pressures.
- Increase fluid temperature differentials to reduce pumping rates.
- Repair seals and packing to minimize water waste.
- Balance the system to minimize flows and reduce pump power requirements.
- Use siphon effect to advantage: don't waste pumping head with a free-fall (gravity) return.

## 23.7. Chillers

- Increase the chilled water temperature set point if possible.
- Use the lowest temperature condenser water available that the chiller can handle.
- (Reducing condensing temperature by 5.5°C, results in a 20 - 25% decrease in compressor power consumption)
- Increase the evaporator temperature
- (5.5°C increase in evaporator temperature reduces compressor power consumption by 20 - 25%)
- Clean heat exchangers when fouled.
- (1 mm scale build-up on condenser tubes can increase energy consumption by 40%)
- Optimize condenser water flow rate and refrigerated water flow rate.
- Use water-cooled rather than air-cooled chiller condensers.
- Use energy-efficient motors for continuous or near-continuous operation.
- Specify appropriate fouling factors for condensers.
- Do not overcharge oil.
- Install a control system to coordinate multiple chillers.
- Study part-load characteristics and cycling costs to determine the most-efficient mode for operating multiple chillers.
- Run the chillers with the lowest operating costs to serve base load.
- Avoid oversizing -- match the connected load.
- Isolate off-line chillers and cooling towers.
- Establish a chiller efficiency-maintenance program. Start with an Energy & Safety Audit and follow-up, then make a chiller efficiency-maintenance program a part of your continuous energy management program.

## 23.8. HVAC (Heating / Ventilation / Air Conditioning)

- Tune up the HVAC control system.
- Consider installing a building automation system (BAS) or energy management system (EMS) or restoring an out-of-service one.
- Balance the system to minimize flows and reduce blower/fan/pump power requirements.
- Eliminate or reduce reheat whenever possible.
- Use appropriate HVAC thermostat setback.
- Use building thermal lag to minimize HVAC equipment operating time.
- In winter during unoccupied periods, allow temperatures to fall as low as possible without freezing water lines or damaging stored materials.
- In summer during unoccupied periods, allow temperatures to rise as high as possible without damaging stored materials.
- Improve control and utilization of outside air.
- Use air-to-air heat exchangers to reduce energy requirements for heating and cooling of outside air.

- Reduce HVAC system operating hours (e.g. -- night, weekend).
- Optimize ventilation.
- Ventilate only when necessary. To allow some areas to be shut down when unoccupied, install dedicated HVAC systems on continuous loads (e.g. -- computer rooms).
- Provide dedicated outside air supply to kitchens, cleaning rooms, combustion equipment, etc. to avoid excessive exhausting of conditioned air.
- Use evaporative cooling in dry climates.
- Clean HVAC unit coils periodically and comb mashed fins.
- Upgrade filter banks to reduce pressure drop and thus lower fan power requirements.
- Check HVAC filters on a schedule (at least monthly) and clean/change if appropriate.
- Check pneumatic controls air compressors for proper operation, cycling, and maintenance.
- Isolate air conditioned loading dock areas and cool storage areas using high-speed doors or clear PVC strip curtains.
- Install ceiling fans to minimize thermal stratification in high-bay areas.
- Relocate air diffusers to optimum heights in areas with high ceilings.
- Consider reducing ceiling heights.
- Eliminate obstructions in front of radiators, baseboard heaters, etc.
- Check reflectors on infrared heaters for cleanliness and proper beam direction.
- Use professionally-designed industrial ventilation hoods for dust and vapor control.
- Use local infrared heat for personnel rather than heating the entire area.
- Use spot cooling and heating (e.g. -- use ceiling fans for personnel rather than cooling the entire area).
- Purchase only high-efficiency models for HVAC units.
- Put HVAC window units on timer control.
- Don't oversize cooling units. (Oversized units will "short cycle" which results in poor humidity control.)
- Install multi-fueling capability and run with the cheapest fuel available at the time.
- Consider dedicated make-up air for exhaust hoods. (Why exhaust the air conditioning or heat if you don't need to?)
- Minimize HVAC fan speeds.
- Consider desiccant drying of outside air to reduce cooling requirements in humid climates.
- Seal leaky HVAC ductwork.
- Seal all leaks around coils.
- Repair loose or damaged flexible connections (including those under air handling units).
- Eliminate simultaneous heating and cooling during seasonal transition periods.
- Zone HVAC air and water systems to minimize energy use.
- Inspect, clean, lubricate, and adjust damper blades and linkages.
- Establish an HVAC efficiency-maintenance program. Start with an Energy & Safety Audit and follow-up, then make an HVAC efficiency-maintenance program a part of your continuous energy management program.

## 23.9. Lighting

- Reduce excessive illumination levels to standard levels using switching,de-lamping, etc. (Know the electrical effects before doing de-lamping.)
- Aggressively control lighting with clock timers, delay timers, photocells, and/or occupancy sensors.
- Install efficient alternatives to incandescent lighting, mercury vapor lighting, etc. Efficiency (lumens/watt) of various technologies range from best to worst approximately as follows: low pressure sodium, high pressure sodium, metal halide, fluorescent, mercury vapor, incandescent.
- Select ballasts and lamps carefully with high power factor and long-term efficiency in mind.
- Upgrade obsolete fluorescent systems to Compact fluorescents and electronic ballasts
- Consider lowering the fixtures to enable using less of them.
- Consider day-lighting, skylights, etc.
- Consider painting the walls a lighter color and using less lighting fixtures or lower wattages.
- Use task lighting and reduce background illumination.
- Re-evaluate exterior lighting strategy, type, and control. Control it aggressively.
- Change exit signs from incandescent to LED.

## 23.9. DG Sets

- Optimize loading
- Use waste heat to generate steam/hot water /power an absorption chiller or preheat process or utility feeds.
- Use jacket and head cooling water for process needs
- Clean air filters regularly
- Insulate exhaust pipes to reduce DG set room temperatures
- Use cheaper heavy fuel oil for capacities more than 1MW

## 23.10Buildings

- Seal exterior cracks/openings/gaps with caulk, gasketing, weatherstripping, etc.
- Consider new thermal doors, thermal windows, roofing insulation, etc.
- Install windbreaks near exterior doors.
- Replace single-pane glass with insulating glass.
- Consider covering some window and skylight areas with insulated wall panels inside the building.
- If visibility is not required but light is required, consider replacing exterior windows with insulated glass block.
- Consider tinted glass, reflective glass, coatings, awnings, overhangs, draperies, blinds, and shades for sunlit exterior windows.

- Use landscaping to advantage.
- Add vestibules or revolving doors to primary exterior personnel doors.
- Consider automatic doors, air curtains, strip doors, etc. at high-traffic passages between conditioned and non-conditioned spaces. Use self-closing doors if possible.
- Use intermediate doors in stairways and vertical passages to minimize building stack effect.
- Use dock seals at shipping and receiving doors.
- Bring cleaning personnel in during the working day or as soon after as possible to minimize lighting and HVAC costs.

## 23.11 Water & Wastewater

- Recycle water, particularly for uses with less-critical quality requirements.
- Recycle water, especially if sewer costs are based on water consumption.
- Balance closed systems to minimize flows and reduce pump power requirements.
- Eliminate once-through cooling with water.
- Use the least expensive type of water that will satisfy the requirement.
- Fix water leaks.
- Test for underground water leaks. (It's easy to do over a holiday shutdown.)
- Check water overflow pipes for proper operating level.
- Automate blow-down to minimize it.
- Provide proper tools for wash down -- especially self-closing nozzles.
- Install efficient irrigation.
- Reduce flows at water sampling stations.
- Eliminate continuous overflow at water tanks.
- Promptly repair leaking toilets and faucets.
- Use water restrictors on faucets, showers, etc.
- Use self-closing type faucets in restrooms.
- Use the lowest possible hot water temperature.
- Do not use a heating system hot water boiler to provide service hot water during the cooling season -- install a smaller, more-efficient system for the cooling season service hot water.
- If water must be heated electrically, consider accumulation in a large insulated storage tank to minimize heating at on-peak electric rates.
- Use multiple, distributed, small water heaters to minimize thermal losses in large piping systems.
- Use freeze protection valves rather than manual bleeding of lines.
- Consider leased and mobile water treatment systems, especially for de-ionized water.
- Seal sumps to prevent seepage inward from necessitating extra sump pump operation.
- Install pretreatment to reduce TOC and BOD surcharges.
- Verify the water meter readings. (You'd be amazed how long a meter reading can be estimated after the meter breaks or the meter pit fills with water!)
- Verify the sewer flows if the sewer bills are based on them.

## 23.12Miscellaneous

- Meter any unmetered utilities. Know what is normal efficient use. Track down causes of deviations.
- Shut down spare, idling, or unneeded equipment.
- Make sure that all of the utilities to redundant areas are turned off -- including utilities like compressed air and cooling water.
- Install automatic control to efficiently coordinate multiple air compressors, chillers, cooling tower cells, boilers, etc.
- Renegotiate utilities contracts to reflect current loads and variations.
- Consider buying utilities from neighbors, particularly to handle peaks.
- Leased space often has low-bid inefficient equipment. Consider upgrades if your lease will continue for several more years.
- Adjust fluid temperatures within acceptable limits to minimize undesirable heat transfer in long pipelines.
- Minimize use of flow bypasses and minimize bypass flow rates.
- Provide restriction orifices in purges (nitrogen, steam, etc.).
- Eliminate unnecessary flow measurement orifices.
- Consider alternatives to high-pressure drops across valves.
- Turn off winter heat tracing that is on in summer.

# Annex I –Certification

This part shall indicate certification by Accredited Energy Auditor stating that:

**(i)** The data collection has been carried out diligently and truthfully;

**(ii)** All data monitoring devices are in good working condition and have been calibrated or certified by approved agencies authorized and no tempering of such devices has occurred

**(iii)** All reasonable professional skill, case and diligence had been taken in preparing the energy audit report and the contents thereof are a true representation of the facts;

**(iv)** Adequate training provided to personnel involved in daily operations after implementation of recommendations; and

**(v)** The energy audit has been carried out in accordance with the Bureau of Energy Efficiency (Manner and Intervals of Time for the Conduct of Energy Audit) Regulations, 2010.

**(Dr. P.P. Mittal)**

**Accredited Energy Auditor AEA-011**

# Annex II –Certificate of Accreditation

BUREAU OF ENERGY EFFICIENCY

Examination Registration No. : EA-6851

Accreditation Registration No.: AEA-0011

## Certificate of Accreditation

This is to certify that Mr./Ms. Prem Prakash Mittal having its trade/registered office at Delhi has been given accreditation as accredited energy auditor. The certificate shall be effective from 26th day of February 2013

The certificate is subject to the provisions of the Bureau of Energy Efficiency (Qualifications for Accredited Energy Auditors and Maintenance of their List) Regulations, 2010.

This certificate shall be valid until it is cancelled under regulation 9 of the Bureau of Energy Efficiency (Qualifications for Accredited Energy Auditors and Maintenance of their List) Regulations, 2010

On cancellation, the certificate of accreditation shall be surrendered to the Bureau within fifteen days from the date of receipt of order of cancellation.

Your name has been entered at AEA No. 0011 in the register of list of accredited energy auditors. Your name shall be liable to be struck out on the grounds specified in regulation 8 of the Bureau of Energy Efficiency (Qualifications for Accredited Energy Auditors and Maintenance of their List) Regulations, 2010.

Given under the seal of the Bureau of Energy Efficiency, Ministry of Power, this 26th day of May 2014.

Secretary,
Bureau of Energy Efficiency
New Delhi

# ANNEXURE III–Venders List

The details of suppliers/manufacturers of energy efficient technologies are provided below.

| Srl. | Product / Equipment | Agency Name / Address |
|---|---|---|
| **1** | DG Synchronization, Automation and capacitors | SGS Industrial Controls & Solutions Pvt. Ltd.<br>Floor-II, MadanpurKhadar, SaritaVihar,<br>New Delhi Tel. 011-29942516, 41402992 |
| **2** | Eco-Ventilators | Nu Plast Pipes &profilies<br>SCF – 124, Sector – 17 Market,<br>Faridabad - 121002<br>Tel. 0129-6456217, 4070023 |
| **3** | Electrical measurement Instrument | Riken Instrument Ltd.<br>369, Industrial Area, Phase –II,<br>Panchkula Haryana Tel. : 0172-2591651, 2592028<br>www.rikeninstrumentation.com |
| **4** | Energy Management & Control System | Manaco Energy Solutions (P) Ltd.<br>A-6, Shanti Apts. 21 & 22,1st Cross St.TTKRoad,<br>Alwarpet Chennai-18, Tel. 044-42316164<br>www.mesco.co.in |
| **5** | Energy Saving Products | Gautam Enterprises<br>205, VinayIndl. Est.<br>ChicholiBunder Link Road,<br>Malad(W) Mumbai – 6, India |
| **4** | Energy Saving Products | Techmark Engineers & Consultants<br>K-1/28, Ground Floor, Chittaranjan Park,<br>New Delhi – 110019Tel. 011-26238349 |
| **5** | Flue Gas Analyzer/ Oxygen Analyzer | Nevco Engineers Pvt. Ltd.<br>90A, (2nd Floor) Amritpuri B, main Road,<br>East of kailash, Opp. Iskcon Temple,<br>New Delhi – 110 065<br>Tel. 26226328, 26213009 www.nevco.co.in |

| | | |
|---|---|---|
| **6** | Flue Gas Analyzer/ Oxygen Analyzer | ACE Instruments & Controls<br>1 Birandari, Above Kashi Dairy MG Road,<br>Ghatkopar (W) Mumbai – 400 086<br>Tel. 5125153, 5122762 |
| **7** | FRP Blades & Cooling Tower accessories | Eneertech Engineers<br>SCO 144 – 145, Sector – 34A, Chandigarh<br>Tel. 0172-5018077, 9876022225 |
| **8** | HVAC related instruments Thermocouples pipe fittings pressure gauges | Waaree, 36 Damjishamji Industrial Complex, Off Mahakali caves Road, Andheri (E) Mumbai tel. 02266963030, 26874778 |
| **9** | Infrared Temperature Meters (600 $^{o}$C to 1800 $^{o}$C | Toshniwal Industries Pvt. Ltd.<br>Industrial Area MahU.Pupura, Ajmer – 305 002<br>Tel. 91145 2695171, 91145 2695205 |
| **10** | Infrared Temperature Meters (upto 1500 $^{o}$C) | KusamMeco, G-17, Bharat Industrial Area,<br>T.J. Road, Sewree Mumbai – 400015<br>Tel. 02224156638, 24124540 |
| **11** | AC Drives | Rockers Control System<br>SCO 819 2$^{nd}$ Floor, NAC Manimajra,<br>Chandigarh – 160101<br>Tel. 0172-2730900, 5071627 |
| **12** | AC Drives | Allen Bradley India Ltd.<br>C – 11, Industrial Area, Site – IV,<br>Sahibabad, Ghaziabad |
| **13** | AC Drives | Asea Brown Boveri Ltd.<br>Guru Nanak Foundation Building, 15 – 16, Qutab Institutional Area, SaheedJeet Singh Sansnwal Marg,<br>New Delhi 110 067 |
| **14** | AC Drives | Crompton Greaves Ltd.<br>Machine 3 Division, A – 6 / 2, MIDC Area, Ahmednagar |
| **15** | Automation, Panel Meters | Conzerv System<br>44P, Electronic City Phase –II,<br>East Hosur Road, Banglore – 560100 |

| | | |
|---|---|---|
| **16** | Automation, Panel Meters | Selec controls Pvt. Ltd.<br>E-121 Ansa Industrial Estate,<br>Saki Vihar Road, Mumbai 400072<br>Tel.: 022-28471882, 28476443 www.selecindia.com |
| **17** | Building Automation, sensors, twilight Switches | Electro Art<br>Plot No. K-11, MIDC Area, Ambad, Nasik – 422010<br>Tel. 0253-5603954, 2380918,<br>www.electronicswitchesindia.com |
| **18** | Burners | Wesman Engineering (P) Ltd.<br>503-504 Eros Apartments, 56, Nehru Place,<br>New Delhi – 110019<br>Tel. : 26431723, 26434577 |
| **19** | Burners, Furnace RecuperatorsHor air Generation, Heating & Pumping unit Laddle pre-heating | ENCON<br>12/3, Mathura Road,<br>Faridabad – 121003<br>Tel. : 0129-25275454 www.encon.co.in |
| **20** | Capacitors | Asian Electronics Ltd.<br>Plot No. 68, MIDC, Satpur,<br>Nasik – 422 007 |
| **21** | Capacitors | Shreem Capacitors Pvt. Ltd.<br>/39, VikramVihar, Lajpat Nagar-IV,<br>New Delhi – 110024 |
| **22** | Capacitors & APFC Panels | Matrix Controls & Engineers Pvt. Ltd.<br>E-725, DSIDC Industrial Complex, Narela, GT Road, Delhi – 011-27786945 / 46 / 47<br>Rajeev Batra 9811624440, Rajeev@matrixcapacitor.com |
| **23** | Capacitors & APFC Panels | Standard Capacitors<br>B-70/43, DSIDC Complex, Lawrence Road, Industrial Area,, Delhi – 110035Tel: 011-27181490, 27151027<br>www.standardcapacitors.com |
| **24** | Capacitors & APFC Panels | Saif Electronics<br>174, Hira Building, 1st Floor, Carnac Road, Opposite Police Commissioner Officer Mumbai<br>Tel. 022-22064626, 22086613 www.saifel.com |

| | | |
|---|---|---|
| **25** | Insulations | Llyod Insulations (India) Ltd.<br>PB NO. 4321, Kalkaji Industrial Area,<br>Punj Sons Premises, New Delhi<br>Tel. : 26430746-7 |
| **26** | Insulations | Hirnal Supply (India) Ltd.<br>168, Rajagarden, New Delhi – 110015<br>Tel: 011-25438602, 25448602 |
| **27** | Insulations | Technical & Management Consultancy Center<br>SCO – 324, 2nd Floor, Cabin – 203,<br>Sector – 9, Panchkula<br>Ry_tmcc@yahoo.com |
| **28** | LED Lighting | Synergy Solar (P) Ltd.<br>SCO 133, Sector 28D, Chandigarh<br>Tel. : 0172-6451133, www.synergysolars.com |
| **29** | Lighting system | Philips India Ltd.<br>Regional Office-North, 9th Floor Ashoka Estate,<br>24, Barakhamba Road, New Delhi – 110 001<br>Tel. : 3353280, 3317442 |
| **30** | Lighting system | Crompton Greaves Ltd.<br>Lighting Business Group, 405, Concorde, RC Dutt Road,<br>Baroda – 390 007 |
| **31** | Lighting system | Osram India Ltd.<br>Signature Towers, 11th Floor, Tower B, South City-I,<br>Bareilly -122001Tel.: 0124-6526175, 6526178, 6526285 |
| **32** | Lighting system | Asian Electronics<br>Surya Place, First Floor, K-185, Sarai Julena<br>New Friends Colony, New Delhi – 110 025 |
| **33** | Lighting system | Philips India Limited,<br>Technopolis Knowledge Park, Nelco Complex, Mahakali<br>Caves Road, Chakala, Andheri (E) Mumbai – 400 093 Tel |
| **34** | Lighting system | Surya Roshni Ltd.<br>Padma Tower_I, Rajendra Palace,<br>New Delhi – 110 006 |

| | | |
|---|---|---|
| **35** | Lighting system | Wipro Limited<br>SCO – 196-197, Sector – 34-A,<br>Chandigarh – 160 022 |
| **36** | Lighting Voltage Control Systems | Jindal Electric & machinery Corporation<br>C – 57, Focal Point, Ludhiana – 141010<br>Tel. : 2670250, 2676890 |
| **37** | Lighting Voltage Control System | ES Electronics (India) Pvt. Ltd.<br>Plot No. 82, KIADB Industrial Area,<br>Bommasandra – Jigani Link Road, JiganiHobli<br>Banglore – 562 106 |

# ELECTRICAL SAFETY AUDIT


# INVERTIS UNIVERSITY

NVERTIS VILLAGE, BAREILLY–LUCKNOW NATIONAL HIGHWAY,
NH-24, BAREILLY, UTTER PRADESH – 243123

**Conducted By:**

**A-Z ENERGY ENGINEERS PVT. LTD.**

PLOT NO. 12, 4860-62, HARBANS SINGH STREET, KOTHI NO. 24,
WARD NO. II, DARYA GANJ, NEW DELHI-11002
011-23240541, 9811402040 pp_mittal@yahoo.com

# INDEX

# 1. INTRODUCTION

M/s A-Z under the guidance of Dr. P. P. Mittal performed an electrical safety audit at Invertis University,Bareilly with following electrical safety audit team members.

- Mr Vishal Goyal, Team Leader, Electrical safety Audit
- Mr.Pankaj Chauhan, Associate Electrical safety Auditor
- Mr. Sandeep Sain , Team Member

The audit focused on current electrical safety conditions, and selected othersafety measures for School building.

The following were key objectives of Electrical safety audit.

1) Inspection of LT Cables
2) Out-going Bus Duct/ cable from transformer to LT panels
3) Each LT distribution switch as per the requirements for load.
4) The control panels installed in the premises to be as per the standards
5) The installations should confirms as per Electrical standards & suggest changes if required
6) The system connection should be confirmed as per safety standards.
7) The recommendations are to be defined as Critical 1 / Critical 2 so action can be taken accordingly

The audit consisted of: interviews of different employees, observations of employees while working, administration of a safety culture survey; review of training records; review of electrical safety programs; review of safety meeting records; attendance to safety meetings; and inspection of personal protective equipment (PPE).

The scope of the audit consisted of premises of Invertis University, Bareilly.

## 2. Applicable Standards

Determination of compliance is based on following applicable rules and IS standards.

1. CEA guidelines on Electrical safety-2010
2. IS-5216 –Standard for Electrical safety Part-I & Part-II
3. IS : 3043 – *1987. Indian Standard. CODE OF PRACTICE FOR EARTHING*
4. NEC-2011
5. NFPA-70E
6. NFPA-70B

# 3. OVERVIEW OF ELECTRICAL SYSTEM

| Sr. No. | Requirement | | |
|---|---|---|---|
| 1 | Name of Contact Person | Mr. Shantosh Sharma | |
| 2 | Number of Electrical Competent Person | 1 Nos. | |
| 3 | Qualification of Electrical Person | ITI | |
| | | | |
| 4 | **Capacity of Main Transformer** | | |
| | Transformer-1 | 630 | kVA |
| | Transformer-2 | 630 | kVA |
| | Transformer-3 | 400 | kVA |
| | | | |
| 5 | **Capacity of DG SETS** | | |
| | | | |
| i | Capacity of DG Sets-1 | 750 | KVA |
| ii | Capacity of DG Sets-2 | 380 | KVA |
| | | | |
| 6 | **IF APFC Panel is installed** | Yes | |
| | | | |
| 7 | **Capacity of APFC panel** | NA | |

## 4. EXECUTIVE SUMMARY

During Electrical safety audit of Invertis University, the following important observationsthat require immediate attention have been made regarding electrical safety.

## Points of Appreciation

1. Lightning, arrester system has been provided in university campus.
2. No present any external damage or corrosion on the Transformer.

## Points of Concern

- ✓ A lot of junk and removed electrical material is strewn in all areas where electrical equipment are installed. It is causing un-hygienic, unsafe and hazardous condition. This should be disposed off regularly.
- ✓ SOP for preventive/predictive maintenance team is required to be prepared and schedule is required to be followed
- ✓ Awareness of Personnel connected with Electrical Maintenance is required to be enhanced through electrical safety training
- ✓ No PVC Mats have been provided in front and rear of various LT panels.
- ✓ Transformer-2 Name Plate not clearly visible
- ✓ Transformer-1 Breather not present
- ✓ Transformer-3 Foundation is not good condition
- ✓ Out Side LT Panel - 2 - some doors opened
- ✓ Out Side LT Panel - 2 - some cables terminated without glands
- ✓ NOC from fire authority is not available
- ✓ LT Panel is made out of sheet Metal and the ambient conditions are very hot. Ventilation is not provided as per standard requirement. The walls and roof of LT panels should be provided thermal insulation and also ventilation be provided.
- ✓ Fire extinguishers installed are with expired dates. Action has to be initiated. Advance action should always be taken for re filling of fire extinguishers in phases

- ✓ Complaint register was not maintained and there is no record and SOP for maintenance records for Preventive and predictive maintenance.
- ✓ Shock treatment chart not found in LT panel Room
- ✓ First Aid kit not found in Electrical area
- ✓ Safety signage's has not been provided in Electrical Area
- ✓ Single line diagram is not available should be got prepared and kept updated always
- ✓ Fire fighting system was not charged
- ✓ DG and transformers were kept in open condition.
- ✓ Earthing system was very high resistance for all kinds of earth pits. These are required to be restored or replaced for effective earth connection to avoid any mishap. It is a very critical risk of high criticality.
- ✓ Neutral grounding pits are found to be with very high resistance as per the schedule of Earth resistance. This can cause system disturbances and may damage equipment due to rising voltage in a phase due to floating neutral.
- ✓ Earth resistance has also been noticed high. This can lead to electrocution/Shock hazard.
- ✓ Lightning arrester system has not been provided in university campus. Earth pits of lightning arrester system are also not maintained for solar PV system.

# 5. Electrical Panel Details

| Electrical Panels & DBs | | | |
|---|---|---|---|
| **S. No** | **Checkpoints** | **Observation** | **Recommendation** |
| 1 | Main Electrical Panel Room is separately provided? | Separate electrical panel room is provided at ground floor but list of authorized entries not pasted.<br><br>It was informed that the main panel & cables are very old (more than 20 years old).<br><br>  | Electrical room shall be restricted to authorized entry and locked. List of authorized persons shall be pasted on the door.<br><br>The expected life time of electrical panels is 20 years. Beyond this period, they are not expected to render their services up to expectation with desired efficiency & safety. Recommended to replace all old panels with new one |
| | | Clearance of around 1m is provided at front side of the main panel. But there is no adequate spacing provided around main breaker & distribution panel. | |

| | | | |
|---|---|---|---|
| 2 | Adequate space has been provided for accessing Main Electrical Panel? |  | Recommended to provide clearance of around 1m to distribution panels. Also maintain cleanliness of system. |

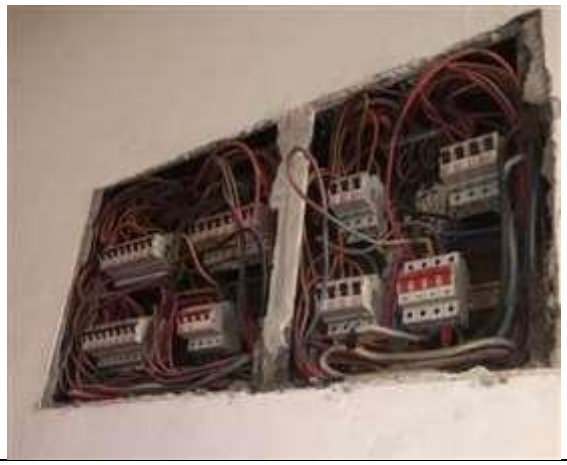
| Electrical Panels & DBs | | | |
|---|---|---|---|
| **S. No** | **Checkpoints** | **Observation** | **Recommendation** |
| 3 | Is there any external damage to electrical fittings & panel? | Panel/ feeders door & cable chamber enclosure alignment was not proper<br>Broken switch socket was observed at many locations inside the labs/ 1nd floor lab)<br>  | It is recommended to align the door properly to avoid gaps between panel cover & breakers to restrict entrance of pests which may cause short circuit.<br>Broken switch sockets shall be replaced with new one. |
| 4 | Is Shock Treatment chart Displayed? | Resuscitation chart was not displayed inside LT room. | (This is reference from CEA – MSES Reg 28, 2010) Resuscitation chart shall be displayed in the panel room in English, Hindi or local language. |
| 5 | Is double body earthing provided to Main Electrical Panel? | Double body earthing was not provided to all electrical panels/ DBs. | Double earthing shall be provided to the body of all electrical panels/ DBs & pump motors. |
| 6 | Are protection devices provided to panel/DBs? | Protection devices viz. MCCB/ MCBs are provided to panels/ DBs.<br>Isolators are provided as incomer of most of theLDB & PDBs in the premises Mostly Every Place. (Ground floor Computer room, 1nd floor of workshop ICP DB etc.) | Isolator is just like as switching device, it doesn't have any protection. Hence, it is recommended to replace all isolator with protection devices viz. MCB, RCCB, RCBO. |

| | | | |
|---|---|---|---|
| | | | |

| Electrical Panels & DBs | | | |
|---|---|---|---|
| **S. No** | **Checkpoints** | **Observation** | **Recommendation** |
| | |   | |
| 7 | Are electrical Three phase supply Indicating lamp in working condition? | Same indication lamp (red) is used for all three phase R, Y & B in main LT panel.  | Indication lamps shall be provided as per the phase colour. |
| 8 | Is voltmeter provided to main panel? | Voltmeter is provided but not working properly but not calibrated.  | All function meters shall be calibrated once in a year. |

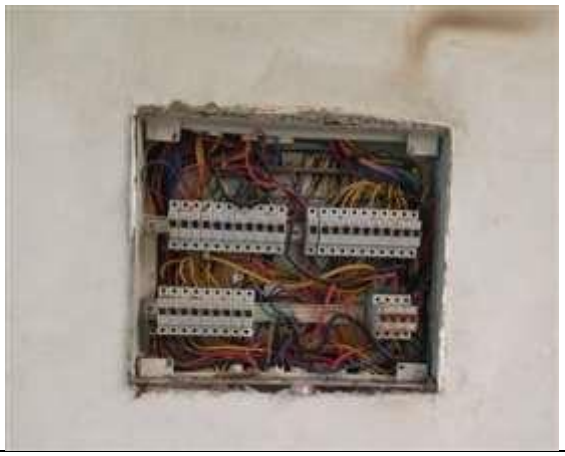
| Electrical Panels & DBs | | | |
|---|---|---|---|
| **S. No** | **Checkpoints** | **Observation** | **Recommendation** |
| 9 | Is ammeter provided to main panel? | Ammeter is provided but not working properly also not calibrated. | All function meters shall be calibrated once in a year. This is applicable to Other panel also. |
| 10 | Area panel/ DB doors/covers properly closed? | Doors of some of distribution boards are not closed properly. Face plate was missing in some of the distribution boards inside the lab. | Panel/ DBs door shall be closed and airtight.<br>Face plate shall be provided to all distribution boards and earth bonding shall be provided to all DBs. |
| 11 | Are Cable termination glands provided? | Cable gland openings are observed in main panel, as well as distribution panels.<br>  | It is recommended to seal gland holes with rubber grummet to restrict the entry of pests inside the panel/ DB. |
| 12 | Is Proper support & dressing provided to cables? | Cables are laid in haphazard manner inside LT room.<br>  | Cables shall be dressed properly and laid through trench/tray to avoid mechanical damages. |

| | | | |
|---|---|---|---|
| 13 | Is Cable tray provided? | Cable tray is not provided and cables are not supported properly in main panel. Overlapping of cables were observed inside the LT room. | Recommended to provide cable tray and supported properly. Overlapping of cables shall be avoided. |

<table>
<tr><th colspan="4">Electrical Panels & DBs</th></tr>
<tr><th>S. No</th><th>Checkpoints</th><th>Observation</th><th>Recommendation</th></tr>
<tr><td>14</td><td>Is there Possibility of any roof leakage or water spillage in this area?</td><td>No water spillage observed room. in electrical</td><td>No Recommendation.</td></tr>
<tr><td>15</td><td>Housekeeping is satisfactory in this area.</td><td>Dust accumulation was observed inside the panels/ DBs.</td><td>Housekeeping shall be maintained in all panels rooms & DG/ transformer area.</td></tr>
<tr><td>16</td><td>Are insulating mats provided in front of panels.</td><td>Old rubber mats are laid in front of main LT panel/ UPS panel.<br>  </td><td>Rubber mats conforming to IS 5424 has been superseded by IS 15652 insulating mats. Thickness of electrical mats according to the voltage level is listed below.
<table>
<tr><th>Class</th><th>Voltage (kV)</th><th>Mat thickness (mm)</th></tr>
<tr><td>A</td><td>3.3</td><td>2.0</td></tr>
<tr><td>B</td><td>11</td><td>2.5</td></tr>
<tr><td>C</td><td>33</td><td>3.0</td></tr>
</table></td></tr>
<tr><td>17</td><td>Labeling on the switchboard for the identification of circuits provided?</td><td>Incomer details and outgoing feeders are not identified in any of the distribution boards.<br>  </td><td>Incomer details and outgoing details shall be identified distribution boards.</td></tr>
</table>

<table>
<tr><th colspan="4">Electrical Panels & DBs</th></tr>
<tr><th>S. No</th><th>Checkpoints</th><th>Observation</th><th>Recommendation</th></tr>
<tr><td>18</td><td>Is danger/caution signage pasted on panel?</td><td>Danger signage as per IS 2551 was not pasted on the panel/ HT & LT rooms and transformer area.</td><td>Danger notice confirming with IS 2551 shall be affixed permanently in conspicuous position in English or Hindi and in local language at all accessible sides.<br>Danger notice shall be as per the dimensions given below:<br>• For HV & EHV installations: 250*200 mm<br>• For MV installations : 200*150 mm.</td></tr>
<tr><td>19</td><td>Is electrical Single line diagram (SLD) available & Pasted in electrical room?</td><td>SLD was not available at site.</td><td>The Single line diagram for distribution system shall be provided in electrical panel room.</td></tr>
<tr><td>20</td><td>Two pairs of Rubber hand Gloves are provided?</td><td>Safety gloves are not available at site.</td><td>Recommended to procure electrical hand glove of type 2 with working potential 1.1kV. Electrical hand gloves shall be replaced annually.<br>Type of rubber gloves are given below for reference.
<table>
<tr><th>Sl No.</th><th>Type of Glove</th><th>Working Voltage (rms) of Gloves, Max</th><th>Proof (Test) Voltage (rms)</th></tr>
<tr><td></td><td></td><td>V</td><td>V</td></tr>
<tr><td>(1)</td><td>(2)</td><td>(3)</td><td>(4)</td></tr>
<tr><td>i)</td><td>1</td><td>650</td><td>5 000</td></tr>
<tr><td>ii)</td><td>2</td><td>1 100</td><td>10 000</td></tr>
<tr><td>iii)</td><td>3</td><td>7 500</td><td>17 000</td></tr>
<tr><td>iv)</td><td>4</td><td>17 000</td><td>25 000</td></tr>
</table></td></tr>
</table>

| Electrical Panels & DBs | | | |
|---|---|---|---|
| **S. No** | **Checkpoints** | **Observation** | **Recommendation** |
| 21 | Are Smoke detectors provided? | Smoke detectors are provided in the vicinity but spacing / location of detectors were not appropriate. | Fire detection system to be provided as per IS 2189. Spacing of the detectors shall be as per IS 2189. Spacing of the detectors shall be as per IS 2189. The horizontal distance between any point in a protected area & the detector nearest to that point shall not excess 3.5 m & distance between two detectors shall not be more than 7.5 m |
| 22 | Are Emergency lights provided? | Emergency lights are not provided in LT room. | All emergency light shall be marked properly. Emergency lights shall be provided and maintained for easy access during any power failure. |
| 23 | Alarm/trip circuit (switches or MCCB) are working. | All circuits are in working condition. | No Recommendation |
| 24 | Adequate number of CO2 fire extinguishers is provided. | Portable fire extinguishers are adequate. | No Recommendation. |
| 25 | Is Work permit system followed at site? | Work permit system was not developed at site. | Work permit system shall be developed and followed. |
| 26 | Is Authorized entry Provided to the MV panel room? | Authorized entry was not provided for the main distribution panel room. | Entry to panel room shall be restricted and list of authorized persons list shall be displayed outside the panel room. |

| Electrical Panels & DBs | | | |
|---|---|---|---|
| **S. No** | **Checkpoints** | **Observation** | **Recommendation** |
| 27 | Are incoming and outgoing cables from MV panel feeders coated with fire retardant coating? | Cables were not coated with fire retardant compounds.  | Cable terminations into panel shall be coated with flame retardant compound up to 1 m length to prevent spreading of fire from the panel. |
| 28 | Are DB doors bonded to Earthing? | Earth bonding was found to be missing between door and panel in some DBs.  | Earth bonding shall be provided between door and panel shall be connected in all DBs. This recommendation shall be followed to all DBs. |
| 29 | Are the cable entry points are sealed using fire sealants or stops? | Cable passing were found to be not sealed from the main panel to that of the Computer room,lab,office.  | It is recommended to seal the cable sealing with fire retardant sealant. |

| Electrical Panels & DBs | | | |
|---|---|---|---|
| **S. No** | **Checkpoints** | **Observation** | **Recommendation** |
| 30 | Are safety interlock provided between transformer incoming breaker and DG sets breakers? | Electrical interlock has not been provided between Transformer incoming breaker and incoming ACBs of DG set (750 kVA). | Healthiness of interlocks shall also be tested periodically.<br>Control wiring circuit diagram for interlock between feeders are available in the site.<br>Interlock between different feeders shall be clear and conspicuously marked in the SLD shall be available in the site for reference. |
| 31 | Is LOTO implemented for isolation of electrical energy? | Electrical panels are more than 20 years old and LOTO (Lockout Tagout) provision is not available for the panel. | LOTO system shall be implemented to avoid the accident due to unexpected release of energy due to the inadvertent operation of isolation device which is under maintenance. It shall be done by placing Lock / warning tag on isolation device.<br>It is recommended to provide a mechanical arrangement for locking thepanel door (for preventing opening) as shown below.<br>Or OEM manufacturer can be contacted for any retrofitting or change of switch.<br>LOTO shall be integrated with workpermit system and separate register shall be maintained for implementing fullyfledged LOTO system and to ensure release of stored energy at check points.<br>Sample image for LOTO is givenbelow:<br>  |
| 32 | Is localized protective device provided to ACs/ water cooler etc.? | Localized protective device/MCB was provided to electrical appliances. | No Recommendation. |

## 6. Transformer

| **Transformer Specifications:** Very old transformer, 11/0.415kV installed above man operatable height | | | |
|---|---|---|---|
| **Sr. No.** | **Checkpoints** | **Observation** | **Recommendation** |
| 1 | Oil leakage | There was minor oil leakage observed from gasket during the audit.  | If Oil leak is found then it shall be arrested immediately as it will bring down BDV value of the insulation property and may also possess risk for the spread of fire during accident. Signs of Oil leakage should be checked on daily basis. |
| 2 | Oil level | Not visible. Since, transformer is installed above man operator height and, it's body part is rusted, it is difficult to identify the rating & oil level of the transformer during audit. | It was informed that the transformer is more than 20 years old. Need to Maintained properly |
| 3 | Condition (colour) of silica gel | Silica gel in breather was observed to be in white colour.  | Silica gel shall be maintained in dark blue condition. |

<table>
<tr><th colspan="4">Transformer Specifications: Very old transformer, 11/0.415kV installed above man operatable height</th></tr>
<tr><th>Sr. No.</th><th>Checkpoints</th><th>Observation</th><th>Recommendation</th></tr>
<tr><td>4</td><td>Is outgoing cable identification provided at both primary & secondary chamber of transformer?</td><td>Outgoing cable identification details are not mentioned on the secondary side of the transformer.</td><td>Transformer cable terminal cover on primary and secondary side shall be painted with description of its identification of voltage level and also with the size & no. of runs mentioned.</td></tr>
<tr><td>5</td><td>OTI & WTI setting?</td><td>NA</td><td>It is recommended that the alarm and trip value of WTI & OTI shall</td></tr>
<tr><td></td><td></td><td></td><td>be set as follows.<table><tr><td></td><td>Alarm</td><td>Trip</td></tr><tr><td>OTI</td><td>75°C</td><td>85°C</td></tr><tr><td>WTI</td><td>85°C</td><td>95°C</td></tr></table>There is always a thermal gradient between the transformer insulating oil and the transformer winding.<br>Hence there should be 10-degree difference between both settings.</td></tr>
<tr><td>6</td><td>Is emergency push button station provided for isolation of Transformer during emergency conditions?</td><td>Emergency push button station is not provided for isolation of Transformer during emergency conditions.</td><td>Emergency push button station shall be provided at the fence of the transformer yard to isolate the transformer without entering the panel room in case of transformer fire.<br>A clear warning/display is to be provided so that any responsible person can isolate the transformer during any emergency.</td></tr>
<tr><td>7</td><td>Grounding connections of the transformer is OK</td><td>Dissimilar metals have been used in the main earthing with the other parts of the transformer.</td><td>Recommended to use a special Al/Cu copper connectors or bimetallic washer overcome the thermal effects due to fault current.</td></tr>
<tr><td>8</td><td>Is transformer yard/ switchyard provided to authorised entry?</td><td>Authorized list of persons is not affixed in the fence of transformer yard/ 11kV switchyard.<br>Switch yard Entry permit system (even for entering into switch yard) is not available.</td><td>List of employees with supervisory license / wiremen license shall be displayed in switchyard, transformer yard HT & LT panel rooms along with</td></tr>
</table>

| Transformer Specifications: Very old transformer, 11/0.415kV installed above man operatable height | | | |
|---|---|---|---|
| **Sr. No.** | **Checkpoints** | **Observation** | **Recommendation** |
| | | | their license number, expiry date and for the jobs for which they area authorized to work. |
| 9 | I s transformer yard/ switchyard provided to authorized entry? | Authorized list of persons is not affixed in the fence of transformer yard/ 11kV switchyard.<br>Switch yard Entry permit system(even for entering into switch yard) is not available.<br>  | List of employees with supervisory license / wiremen license shall be displayed in switchyard, transformer yard HT & LT panel rooms along with their license number, expiry date and for the jobs for which they are authorized to work.<br>A sample image is as below<br>  <br><br>It is suggested to formulate.<br>"Switchyard Entry Permit" even for entering Switchyard. |
| 10 | Cleanliness and housekeeping | Dust accumulation and oxidation of transformer body was observed.There is no maintenance record foundduring audit.<br>  | Maintenance shall be carried out at periodical time intervals mentioned in IS 10028 part 3. |
| 11 | External damage on transformer? | No external damage is noticed. | No Recommendation. |
| 12 | Condition of cable end sealing and terminal boxes | Dust deposition was observed on HT cable terminals. | Dust deposit on terminals/ insulators may provide a conductive path which |

| | | | |
|---|---|---|---|
| | | | results in flash over. |

| **Transformer Specifications:** Very old transformer, 11/0.415kV installed above man operatable height | | | |
|---|---|---|---|
| **Sr. No.** | **Checkpoints** | **Observation** | **Recommendation** |
| 13 | Earth pit condition | Earth pits were not identified for switchyard/ transformer. | Earth pit drawing helps in locating the earth pit easily and also help to identify the transformer and generatorearth pits which should not be opened when they are in energized condition. |
| 14 | Lighting in the transformer yard | No Lighting system | Recommended to provide proper lighting |
| 15 | Availability of adequate portable fire extinguishers | PFEs are available close to transformer yard/ area. | No Recommendation. |
| 16 | Lock arrangements is available at transformer yard. | Transformer/ switchyard is not locked. It is also not identified.  | Gate shall be locked and the key shall be maintained with authorized electrical person or security in order to avoid unauthorized access for personnel and any animal to enter inside switchyard.<br>Each substation Transformer shall be named and numbered for unique identification, which will be helpful during maintenance and recording discrepancies.<br>Danger notice shall be affixed permanently in a conspicuous position at the fence (or gate) of transformer/ switch yard in Hindi or English and the local language of the district(Marathi), with a sign of skull and bones of a design as per the relevant IS 2551. |

| | | | | |
|---|---|---|---|---|
| | | | | |

## 7. Diesel Generator Sets

| Sr. No. | Checkpoints | Observation | Recommendation |
|---|---|---|---|
| 1. | Diesel Generator Set is provided for emergency supply. | 380kVA Cummins make DG set*1no. is provided for emergency supply.   | No Recommendation. |
| 2. | General cleanliness surrounding Diesel Generator set is OK. | No    | Need to be clean dust and oil. |
| 3. | Diesel Generator has been provided with noise reduction enclosure | Yes | No Recommendation. |
| 4. | Condition of cable sealing and terminal boxes is OK | Yes | No Recommendation. |

| Sr. No. | Checkpoints | Observation | Recommendation |
|---|---|---|---|
| 5. | Guards are provided on moving parts. | Yes | No Recommendation. |
| 6. | Neutral point of Diesel Generator set panel is earthed. | Yes . | No Recommendation. |
| 7. | Body earthing connections are provided. | Two body & two neutral earth pits are provided to DG set but earth pits were not identified. | Earth pits shall be identified and maintained as per IS 3043.<br><br>Earth pits shall be maintained in good condition, by painting the earth pit name, date of last testing and earth pit value on the non-removable part. |
| 8. | Regular servicing & maintenance is being carried out. | Regular servicing & maintenance is carrying out by Deo Engineers (authorized vendor of Kirloskar) | No Recommendation. |
| 9. | Adequate number of fire extinguishers is provided in the Diesel Generator. | Yes | No Recommendation. |

# Annexure-A-Earth test results

| | Annexure-A | | |
|---|---|---|---|
| | **Schedule of Earth resistance measurement during electrical safety audit.** | | |
| **S No.** | **Location** | **Earth-1-Ohms** | **Earth-2-Ohms** |
| **1** | TRANSFORMER – 630 | 3.8 | 4.3 |
| **2** | TRANSFORMER - 400 | 4.2 | 2.7 |
| **3** | TRANSFORMER – 630 | 3.9 | 2.8 |
| **4** | DG SET – 750 KVA (Body) | 4.7 | |
| **5** | DG SET – 750 KVA (Body) | 4.5 | |
| **6** | DG SET – 750 KVA (NEUTRAL GROUNDING) | 4.6 | |
| **7** | DG SET – 380 KVA (Body) | 4.2 | |
| | DG SET – 380 KVA (Body) | 2.6 | |
| **8** | DG SET – 380 KVA (NEUTRAL GROUNDING) | 2.1 | |
| | L.T Panel | 1.4 | |
| **9** | L.T Panel | 2.3 | |
| **10** | L.T Panel | 3.4 | |

# Annexure-B-Lux level measurement

| S No. | Loction | Lux Level | Remark |
|---|---|---|---|
| 1 | TEACHING BLOCK NEW | 300-320 | Satisfactory |
| 2 | TEACHING BLOCK OLD | 300-320 | Satisfactory |
| 3 | CANTEEN(NEW) | 200 | Satisfactory |
| 4 | LABORATORY | 500 | Low-Need to Improved |
| 5 | AUDITORIUM | 480-500 | Satisfactory |
| 6 | HIMALAYA | 250-300 | Satisfactory |
| 7 | KAVERI | 250-300 | Satisfactory |
| 8 | SHIVALIK | 250-300 | Satisfactory |
| 9 | HIMGIRI | 250-300 | Satisfactory |
| 10 | GODAVARI | 250-300 | Satisfactory |
| 11 | ANNAPURNA | 250-300 | Satisfactory |
| 12 | WORKSHOP | 300-400 | Satisfactory |
| 13 | COMPUTER ROOM | 300-400 | Low-Need to Improved |
| 14 | OFFICE | 250-300 | Low-Need to Improved |
| 15 | LIBRARY | 200 | Low-Need to Improved |
| 16 | GIRLS HOSTEL | 250-300 | Satisfactory |
| 17 | DIRECTORS HOUSE | 250-300 | Satisfactory |
| 18 | ENGINEERING BLOCK | 300 | Satisfactory |
| 19 | STAFF OTRS. | 250 | Satisfactory |
| 20 | NEW GIRL'S HOSTAL | 250-300 | Satisfactory |
| 21 | PHARMACY BLOCK | 400 | Satisfactory |
| 22 | CANTEEN NEW | 200 | Satisfactory |

# Annexure-C-Temperature recorded in LT Panels

| | INDEX | | | | |
|---|---|---|---|---|---|
| **Sr. No.** | **Picture Location** | **PIC. No.** | **Hot Temp** | **Cold** | **Remark** |
| | **Main L.T Panel-1** | | | | |
| 1 | Auditorium | IR_000136 | 39.9°C | 34.7°C | Okay |
| 2 | APFC | IR_000137 | 41.9°C | 35.6°C | Okay |
| 3 | Kitchen | IR_000138 | 67.4°C | 36.2°C | Need Action |
| 4 | Lab | IR_000139 | 38.1°C | 34.8°C | Okay |
| 5 | Change Over | IR_000140 | 35.6°C | 31.3°C | Okay |
| 6 | Computer Lab | IR_000141 | 48.9°C | 34.1°C | Okay |
| 7 | Spare | IR_000142 | 36.3°C | 34.6°C | Okay |
| 8 | Motor | IR_000143 | 36.2°C | 34.6°C | Okay |
| 9 | B. Tech | IR_000144 | 39.8°C | 34.7°C | Okay |
| 10 | Mess & Godavari Hostel | IR_000145 | 60.8°C | 33.4°C | Need Action |
| 11 | Himgiri Hostel | IR_000146 | 39.6°C | 35.3°C | Okay |
| 12 | Bus Bar | IR_000147 | 36.0°C | 34.1°C | Okay |
| 13 | Kaveri Hostel | IR_000148 | 38.5°C | 35.5°C | Okay |
| 14 | Himalaya & Shivalik | IR_000149 | 47.5°C | 35.3°C | Okay |
| 15 | Library | IR_000150 | 39.7°C | 34.3°C | Okay |
| 16 | Management Block | IR_000151 | 38.1°C | 34.2°C | Okay |
| 17 | Work shop | IR_000152 | 38.1°C | 33.3°C | Okay |
| | **Main L.T Panel-2** | | | | |
| 18 | MCCB (Bus Bar) | IR_000153 | 60.2°C | 33.2°C | Need Action |
| 19 | Change Over | IR_000154 | 52.0°C | 33.5°C | Okay |
| 20 | Main Incomer (ACB) | IR_000155 | 47.5°C | 33.4°C | Okay |
| 21 | University Building | IR_000156 | 91.3°C | 36.7°C | Need Action |
| 22 | Auditorium (A.C) | IR_000157 | 36.4°C | 32.7°C | Okay |
| 23 | Lab | IR_000158 | 35.7°C | 33.4°C | Okay |
| 24 | Faculty Quater | IR_000159 | 35.1°C | 31.9°C | Okay |
| 25 | B. Tech (A.C) | IR_000160 | 39.9°C | 33.0°C | Okay |
| 26 | Nilgiri | IR_000161 | 38.5°C | 34.0°C | Okay |
| 27 | Lab (Seminar) New Building | IR_000162 | 37.0°C | 32.2°C | Okay |
| | **New Building** | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 28 | Main Incomer | IR_000163 | 42.7°C | 33.7°C | Okay |
| 29 | Outgoing Supply | IR_000164 | 37.4°C | 34.2°C | Okay |
| 30 | Outgoing Supply | IR_000165 | 38.1°C | 32.7°C | Okay |
| | **Engineering Block** | | | | |

| | INDEX | | | | |
|---|---|---|---|---|---|
| 31 | Main Incomer | IR_000166 | 39.8°C | 33.7°C | Okay |
| 32 | Outgoing Supply | IR_000167 | 37.4°C | 33.8°C | Okay |
| 33 | Outgoing Supply | IR_000168 | 47.5°C | 31.5°C | Okay |
| | **Management Block** | | | | |
| 34 | Outgoing Supply | IR_000169 | 39.9°C | 33.3°C | Okay |
| 35 | Outgoing Supply | IR_000170 | 41.8°C | 32.7°C | Okay |
| 36 | Outgoing Supply | IR_000171 | 40.2°C | 32.5°C | Okay |
| | **Computer Block** | | | | |
| 37 | Outgoing Supply | IR_000172 | 36.1°C | 32.4°C | Okay |
| 38 | Outgoing Supply | IR_000173 | 35.4°C | 33.1°C | Okay |
| 39 | Outgoing Supply | IR_000174 | 34.8°C | 32.3°C | Okay |
| 40 | Server Room & Lab-4,5&6 | IR_000175 | 69.4°C | 32.2°C | Need Action |
| | **Admin. Block** | | | | |
| 41 | Outgoing Supply | IR_000176 | 81.5°C | 34.6°C | Need Action |
| 42 | Outgoing Supply | IR_000177 | 62.1°C | 36.3°C | Need Action |
| 43 | Outgoing Supply | IR_000178 | 208.1°C | 37.3°C | Need Action |
| | **Work Shop** | | | | |
| 44 | Outgoing Supply | IR_000179 | 44.8°C | 35.2°C | Okay |
| 45 | Outgoing Supply | IR_000180 | 39.5°C | 34.8°C | Okay |
| 46 | Outgoing Supply | IR_000181 | 38.3°C | 34.3°C | Okay |
| | **University Building** | | | | |
| 47 | Panel-1_Main Incomer | IR_000182 | 35.2°C | 32.4°C | Okay |
| 48 | Outgoing Supply | IR_000183 | 35.3°C | 32.6°C | Okay |
| 49 | Outgoing Supply | IR_000184 | 34.6°C | 31.5°C | Okay |
| 50 | Panel-2_Main Incomer | IR_000185 | 40.3°C | 32.4°C | Okay |
| 51 | Outgoing Supply | IR_000186 | 36.0°C | 32.6°C | Okay |
| 52 | Outgoing Supply | IR_000187 | 35.7°C | 32.3°C | Okay |
| 53 | Panel-3_Main Incomer | IR_000188 | 34.1°C | 32.3°C | Okay |
| 54 | Outgoing Supply | IR_000189 | 34.6°C | 32.6°C | Okay |
| 55 | Outgoing Supply | IR_000190 | 34.2°C | 32.5°C | Okay |
| | **Guest House-1 & 2** | | | | |
| 56 | Guest House-1_Main Incomer | IR_000191 | 36.2°C | 32.0°C | Okay |
| 57 | Outgoing Supply | IR_000192 | 36.2°C | 33.4°C | Okay |
| 58 | Guest House-2_Main Incomer | IR_000193 | 38.0°C | 32.2°C | Okay |
| 59 | Outgoing Supply | IR_000194 | 35.2°C | 32.3°C | Okay |

| | | | | | |
|---|---|---|---|---|---|
| | **Girls Hostel** | | | | |
| 60 | Godavari_Main incomer | IR_000195 | 41.2°C | 33.2°C | Okay |
| 61 | Outgoing Supply | IR_000196 | 41.2°C | 33.6°C | Okay |
| 62 | Kaveri_Outgoing supply | IR_000197 | 35.6°C | 33.4°C | Okay |

# WATER AUDIT


# Invertis UNIVERSITY

INVERTIS VILLAGE, BAREILLY–LUCKNOW NATIONAL HIGHWAY,
NH-24, BAREILLY, UTTAR PRADESH - 243123

**Conducted By:**

**A-Z ENERGY ENGINEERS PVT. LTD.**

PLOT NO. 12, 4860-62, HARBANS SINGH STREET, KOTHI NO. 24,
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# 1. Water Use Study

During audit, it has been seen that a no work for conservation of water has been taken. However, It has been observed that annual water used in university is near the limits as per National Building code in vogue. After going through detailed use pattern it has been found that NBC-2016 standard use pattern are not only met but there is significant reduction of water use to the extent of 24.81 % as per available data. This can be further reduced with complying with recommendations of water audit findings.

There are no water bills for the premise and it is extracting ground water. The following points need attention and required to address. The saving targets should befixed for next 12 months and practice of recording and reviewing of water use on day-to-day basis for pointing out any sudden variation.

- There is no metering system in the premises. Water meters to be installed immediately to account the pattern of water requirement.
- All plumbing fixtures should be regulated from valves for reduction of flow. After end of life with water efficient fixtures as per plan and the plumbing fixtures in frequently used area should be replaced on priority.
- All cisterns be replaced with dual mechanism low flow cisterns so that water can be used efficiently as per requirement as and when these become due for replacement.
- Awareness programs should be conducted and these should be organized for staff as well as students through seminars and workshops with increased frequency for reduction of water foot print.
- Rain Water harvesting pits system should be provided to recharge the ground water and to avoid runoff water during raining season. However, few pits are there to collect water from the rain.

- **Water Meters should be provided for individual uses for monitoring of different water use in order of priority.**
  - **a.** Canteen
  - **b.** Individual Hostels
  - **c.** Mess
  - **d.** Individual Blocks
  - **e.** Chemistry Lab and other Lab.
  - **f.** Water from for Horticulture use.
- **Water Meters should be provided for individual bore wells for monitoring of different water extraction source to capture track on ground water extracted.**
- Water conservation target over the present consumption should be fixed by top management and action for meeting these reductions be initiated.
- There should be stickers and bills for water conservation pasted in university premises.
- Students should also be involved along with all stake holders for water conservation.
- STP/ETP and rainwater harvesting pits should be provided to make premises zero discharge and use same water for horticulture.

**Note: Facility does not have any metering system or log book system to quantifythe water requirement of the premises. Audit team adopted technique of discuss with concern persons and management, running hours, design flow values etc to quantify the water requirement of the premises.**

## 2. Auditing for Water Management

Water is a natural resource; all living matters depend on water. While freely available in many natural environments, in human settlements potable (drinkable) water is less readily available. We need to use water wisely to ensure that drinkable water is available for all, now and in the future.

**A small drip from a leaky tap can waste more than 180 liters of water to a day**; that is a lot of water to waste - enough to flush the toilet eight times! Aquifer depletion and water contamination are taking place at unprecedented rates. It is therefore essential that any environmentally responsible institution should examine its water use practices. Water auditing is conducted for the evaluation of facilities of raw water intake and determining the facilities for water treatment and reuse. The concerned auditor investigates the relevant method that can be adopted and implemented to balance the demand and supply of water. It is therefore essential that any environmentally responsible institution examine its water use practices.

## Water Audit

There is little awareness of management of university campus towards sustainability. Management of university should spearhead the movement of sustainable practicesin running of university and also facilitating dissemination of these practices to all students studying in this campus. It is through support of management and active involvement of other stake holders and staff members that this university has many accolades to be a matter of pride for all concerned.

In all matters of resource use, there is effective implementation of 3R's. Reduction of resource use, Recycling of resources and also re-use. It is for attaining objectives of sustainability.

# Introduction to water management

## Why conserve water:

Water is the most precious of all resources, to sustain it, is to preserve life. However,the careless attitude towards the misuse of fresh water linked with its growingscarcity caused by population growth and climate change, suggests that rational use of water and the adoption of conservation measures are urgently needed.

To sustain this valuable resource, it is imperative to first understand how and where water is used in university buildings and compare this consumption withbenchmarks. This would enable the sector to realize the water saving potential that exists and help in devising effective strategies to achieve it.

For years freshwater supplies have been assumed to be an inexhaustible resource, strongly depending on its regenerative capacity offered by the naturally occurring water cycle. Our planet contains a finite quantity of water, where 97.5% of the supply can be found within the oceans in the form of saltwater and only 2.5% isfresh.

Most of this freshwater is difficult to access, in the form of ice within the Polar Regions and mountains or groundwater. Only 0.01% of all water on Earth is useable by ecosystems and humans

There are also a number of human-induced factors which are affecting the qualityand quantity of global freshwater resources.

- Increase in demand due to population growth leading to over exploitation of water sources.
- Degeneration of water quality due to human activities such as deforestation, urban growth, industrial and agricultural practices.
- Change in rainfall patterns due to global warming and climate change.

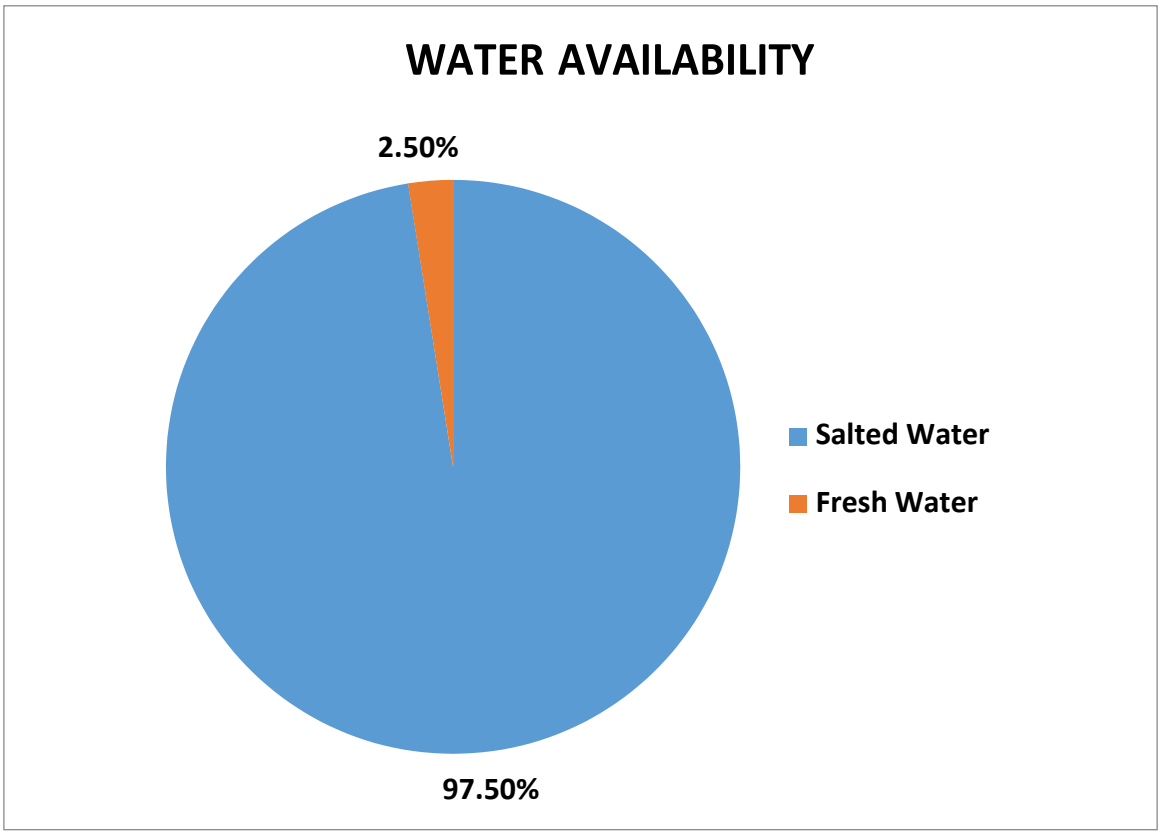



**Figure 1: Fresh Water in Percentage**

***Why consider water conservation in university buildings?***

- Environmental conservation: Reducing dependence on mains water supply can reduce the strain on an increasingly scarce resource.
- Future legislation: The government is currently reviewing its policy for setting targets for water consumption. It is only a matter of time before mandatory regulations are introduced.
- Social responsibility: University's have a role to play and can lead by example.
- Reduced water bills: Efficient use of water within university buildings will lead to reduced water bills as well as low energy bills.

**Hence, all new and existing university buildings/university campus should attempt to close the loop within the water cycle.**

- Precipitation falling on sites should in theory re-charge aquifers and natural waterways.

- Water entering a university building should be used efficiently, in order not to diminish its source, and returned to the natural environment in a state that enhances aquatic habitat.
- If contamination occurs, the building should provide the necessary treatment to remove pollutants. To achieve the above objectives, it is essential to understand where and how much water is used within the university buildings.

The maximum conservation opportunities lie in these areas. Special attention should be given in Hostel and there should be regular water leak audits conducted and reportshould be documented.

**As presently data for extraction of water is not available, it is recommended that all input source of water should be metered and the consumption pattern should be reviewed daily/weekly and monthly and any significant deviation in consumption should be immediately addressed. It has been estimated from estimated flow and running hours of pumps as per details provided.**

# 3. Premises and Turf Area

University has total area of 59351 sq mtr which is spread in various blocks like:

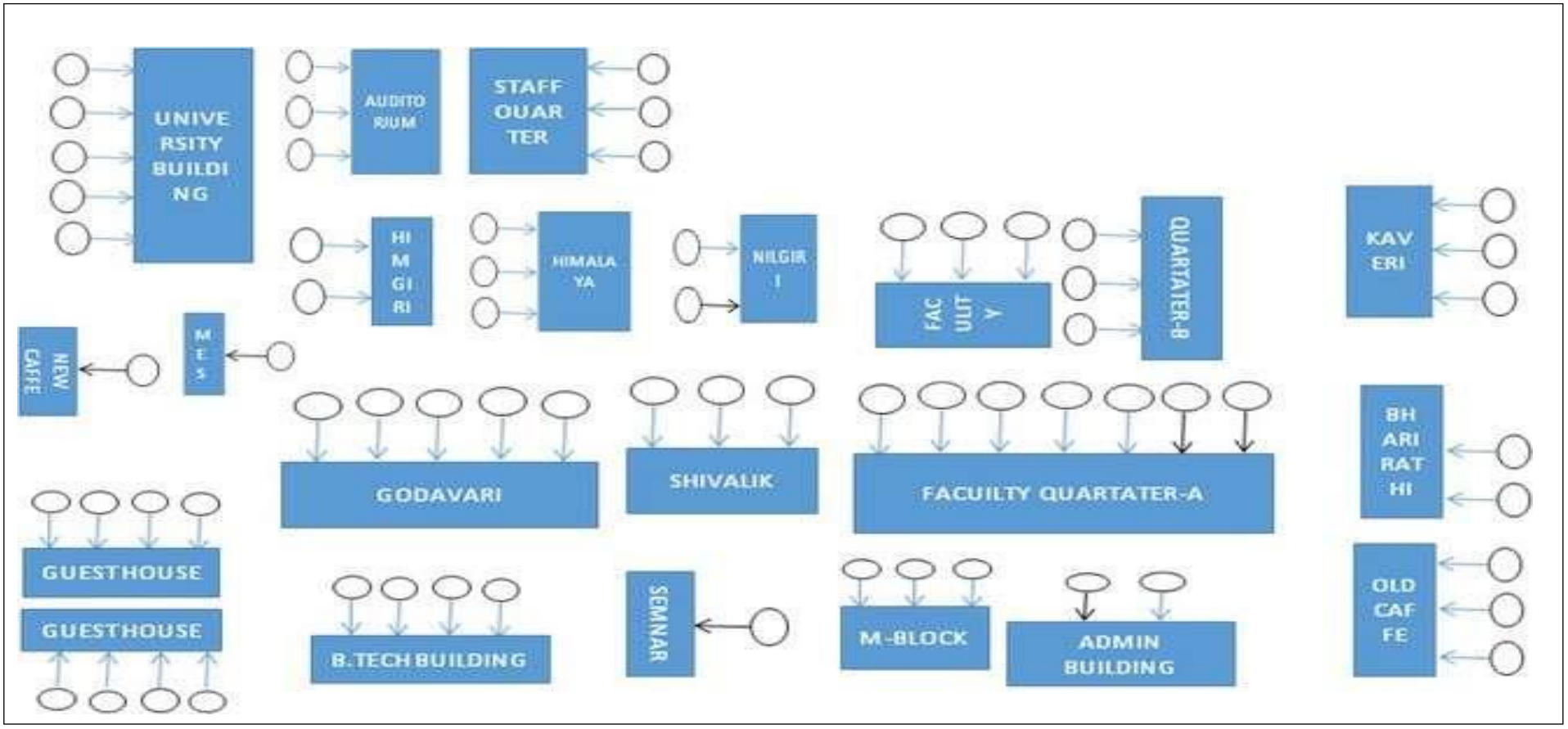
**Table 1: Total Spread Area – Invertis University**

| No. | Specifications | Area (Sq. Mtr) |
|---|---|---|
| 1 | Technical Block New | 4328 |
| 2 | Technical Block Old | 4953 |
| 3 | Canteen (New) | 472 |
| 4 | Laboratory | 4475 |
| 5 | Auditorium | 1725 |
| 6 | Himalaya | 1361 |
| 7 | Kaveri | 1361 |
| 8 | Shivalik | 1815 |
| 9 | Himgiri | 2618 |
| 10 | Godavari | 2378 |
| 11 | Annapurna | 1010 |
| 12 | Workshop | 1862 |
| 13 | Computer Room | 2200 |
| 14 | Office | 1740 |
| 15 | Library | 1197 |
| 16 | Girls Hostel | 4486 |
| 17 | Director House | 1808 |
| 18 | Engineering Block | 14714 |
| 19 | Staff Quarters | 113 |
| 20 | Petrol Pump | - |
| 21 | Diesel Tank | - |
| 22 | Generator Platform | - |
| 23 | T.F Platform | - |
| 24 | New Girls Hostel | 1180 |
| 25 | Pharmacy Block | 3245.66 |
| 26 | Canteen New | 310 |
| 27 | Total Area | 59351.66 |

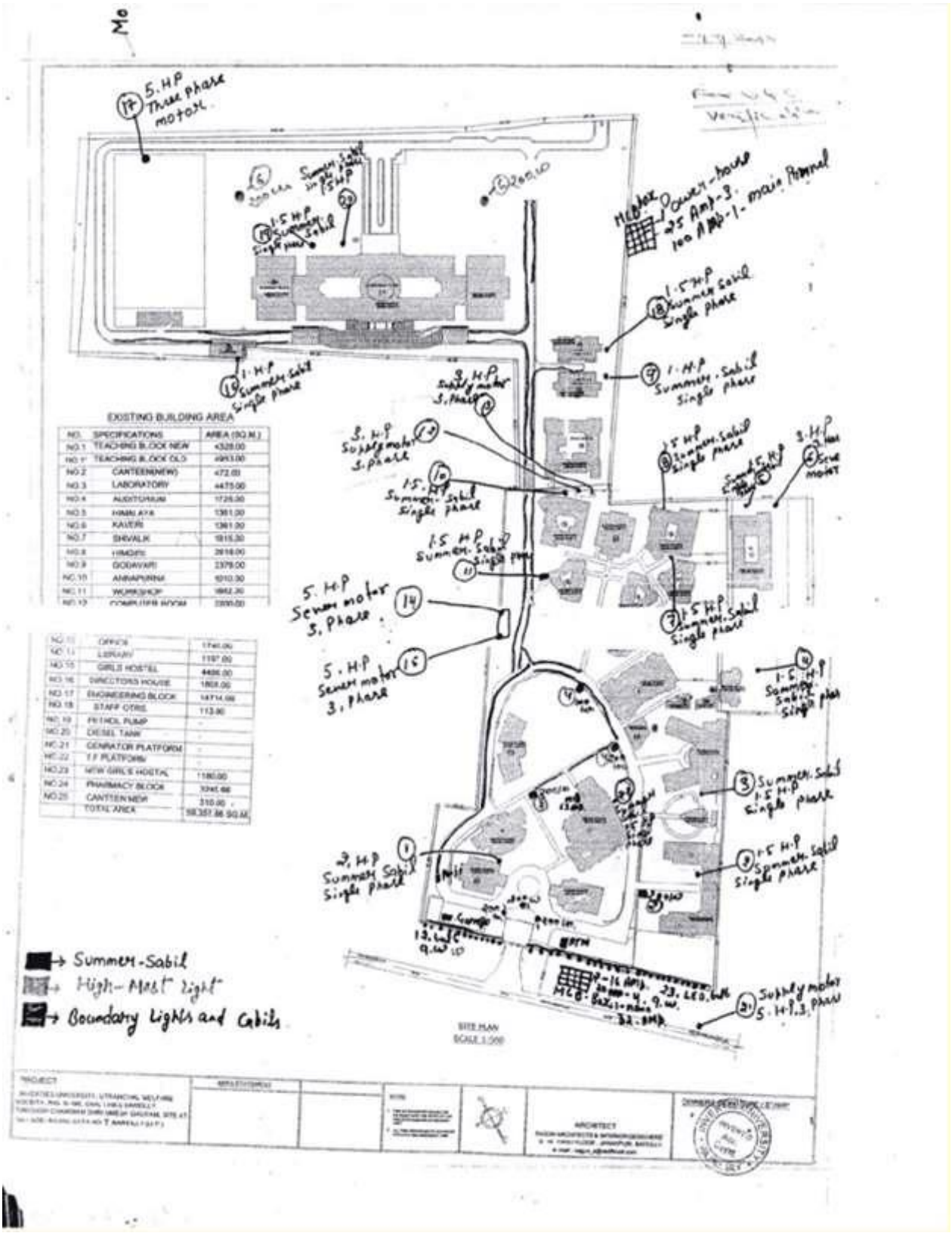
**Table 2: Turf Area - Invertis University**

| Description | Area -Sq. Mts | Water requirement per day per sq.mts. | No. of Days | Annual Water requirement |
|---|---|---|---|---|
| **Total Area in sq mtrs** | **11870** | **5** | **250** | **14837** |

## 3.1 Water Flow Diagram



## 3.2 Facility Layout



# 4. Water Usage Pattern in Campus

**Table 3: Water Usage Pattern in Campus**

| Sl. No. | Name of building | Capacity of Motors (HP) | Estimated flow -LPS | No. of Pumps | No. of Days | No. of Hours | Water drawal-kL |
|---|---|---|---|---|---|---|---|
| 1 | Admin office | 2 | 1.2 | 1 | 300 | 3 | 3888 |
| 2 | M-Block | 1.5 | 1.2 | 1 | 200 | 3 | 2592 |
| 3 | B-Tech building | 1.5 | 1.2 | 1 | 200 | 3 | 2592 |
| 4 | Seminar building | 1.5 | 1.2 | 1 | 200 | 3 | 2592 |
| 5 | faculty quarter A | 1.5 | 1.2 | 1 | 200 | 3 | 2592 |
| 6 | faculty quarter B | 1.5 | 1.2 | 1 | 200 | 3 | 2592 |
| 7 | Nilgiri hostel | 1.5 | 1.2 | 1 | 250 | 4 | 4320 |
| 8 | Shivalik hostel | 1.5 | 1.2 | 1 | 250 | 3 | 3240 |
| 9 | himgiri hostel | 1.5 | 1.2 | 1 | 250 | 3 | 3240 |
| 10 | Bhagirathi hostel main tank | 3 | 2.4 | 2 | 250 | 10 | 43200 |
| 11 | Bhagirathi hostel | 1.5 | 1.2 | 2 | 250 | 4 | 8640 |
| 12 | university building | 1.5 | 1.2 | 2 | 250 | 5 | 10800 |
| | | 5 | 6 | 1 | 150 | 10 | 32400 |
| 13 | caffee | 1 | 1 | 1 | 250 | 3 | 2700 |
| **Total Water Drawn from Pumps** | | | | | | | 125388 |

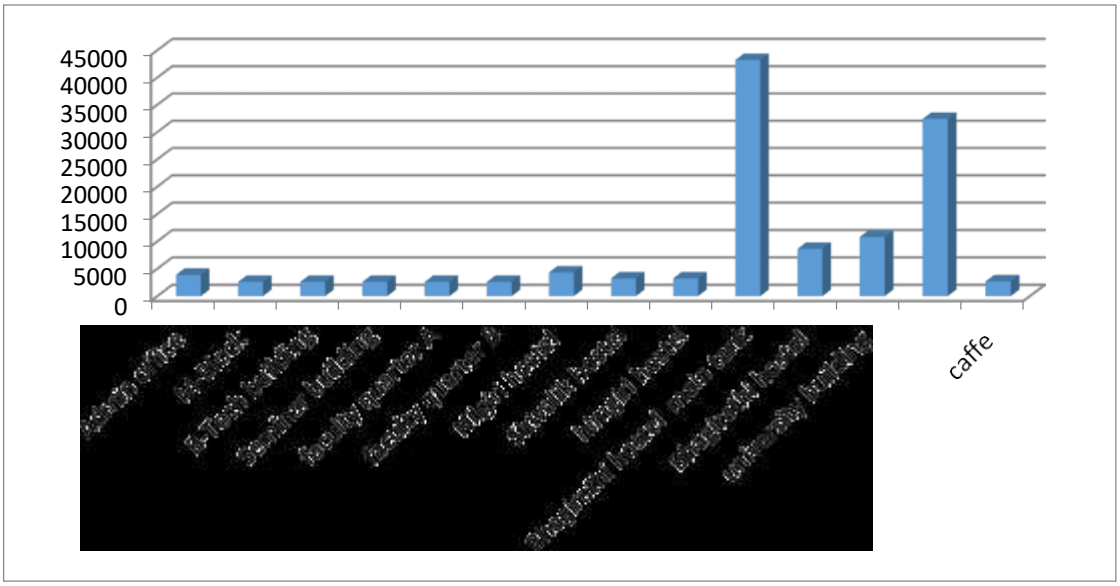



**Figure 2: The consumption trend at various Locations**

# 5. Water Tank Capacity and Pumps Details

Premises have various water tanks ranging from 500 kL to 5000 kL. Details are shown below:

**Table 4: Water Tank Capacity & Pumps Details**

| Sl. No. | Name of building | No. of water tank | capacity of water tank (Ltr) | Total Tank Capacity | sources of water | capacity of motors (HP) | Phase | No. of motor |
|---|---|---|---|---|---|---|---|---|
| 1 | Admin office | 2 | 1000 | 2000 | submersible pump | 2, H.P | single phase | 1 |
| 2 | M-Block | 3 | 5000 ltr./ 3000 ltr./ 1000 ltr. | 9000 | submersible pump | 1.5 H.P | single phase | 1 |
| 3 | B-Tech building | 4 | 500 ltr. / 500 ltr. / 500 ltr. /1000 ltr. | 2500 | submersible pump | 1.5 H.P | single phase | 1 |
| 4 | Seminar building | 1 | 1000 | 1000 | submersible pump | 1.5 H.P | single phase | 1 |
| 5 | faculty quarter A | 8 | 1000 | 1000 | submersible pump | 1.5 H.P | single phase | 1 |
| 6 | faculty quarter B | 8 | 1000 | 8000 | submersible pump | 1.5 H.P | single phase | 1 |
| 7 | Nilgiri hostel | 2 | 5000 | 10000 | summer sabil / sever motor | 1.5 H.P / 3 H.P | single phase / Three phase | 2 |
| 8 | Shivalik hostel | 3 | 5000 ltr. / 2000 ltr. / 2000 ltr. | 9000 | summer sabil | 1.5 H.P | single phase | 1 |
| 9 | Himalaya hostel | 3 | 2000 | 6000 | | | | |
| 10 | himgiri hostel | 2 | 1000 | 2000 | summer sabil | 1.5 H.P | single phase | 1 |
| 11 | Bhagirathi hostel main tank | 2 | 5000 | 10000 | summer sabil / supply motor | 3 H.P / 3 H.P / 1.5 HP / 3 H.P | | 4 |
| 12 | Bhagirathi hostel | | | | summer sabil | 1.5 hp / 1.5 hp | | 2 |
| 13 | godavari | 6 | 1000 | 6000 | | | | |
| 14 | kaveri | 3 | 2000 | 6000 | | | | |
| 16 | mess | 1 | 5000 | 5000 | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 17 | old cafe | 2 | 1000 | 2000 | | | | |
| 18 | guest house right side | 4 | 1000 | 4000 | | | | |

| Sl. No. | Name of building | No. of water tank | capacity of water tank (Ltr) | Total Tank Capacity | sources of water | capacity of motors (HP) | Phase | No. of motor |
|---|---|---|---|---|---|---|---|---|
| 19 | guest house left side | 4 | 1000 | 4000 | | | | |
| 20 | university building | 6 | 2000 ltr./2000 ltr./5000 ltr./5000 ltr./500 ltr. /500 ltr. | 15000 | summer sabil / sever motor | 1.5 H.P / 1.5 H.P/ 5 H.P | single phase | 3 |
| 21 | cafe | 1 | 500 | 500 | summer sabil | 1. H.P | single phase | 1 |
| 22 | auditorium | 3 | 1000 | 3000 | | | | |
| 23 | staff quarter | 3 | 500 | 1500 | | | | |

**Table 5: Pump Flow Data estimated**

| Sl. No. | Name of building | Capacity of Motors (HP) | Estimated flow -LPS | No. of Pumps | No. of Days | No. of Hours | Water drawal-kL |
|---|---|---|---|---|---|---|---|
| 1 | Admin office | 2 | 1.2 | 1 | 300 | 3 | 3888 |
| 2 | M-Block | 1.5 | 1.2 | 1 | 200 | 3 | 2592 |
| 3 | B-Tech building | 1.5 | 1.2 | 1 | 200 | 3 | 2592 |
| 4 | Seminar building | 1.5 | 1.2 | 1 | 200 | 3 | 2592 |
| 5 | faculty quarter A | 1.5 | 1.2 | 1 | 200 | 3 | 2592 |
| 6 | faculty quarter B | 1.5 | 1.2 | 1 | 200 | 3 | 2592 |
| 7 | Nilgiri hostel | 1.5 | 1.2 | 1 | 250 | 4 | 4320 |
| 8 | Shivalik hostel | 1.5 | 1.2 | 1 | 250 | 3 | 3240 |
| 9 | himgiri hostel | 1.5 | 1.2 | 1 | 250 | 3 | 3240 |
| 10 | Bhagirathi hostel main tank | 3 | 2.4 | 2 | 250 | 10 | 43200 |
| 11 | Bhagirathi hostel | 1.5 | 1.2 | 2 | 250 | 4 | 8640 |
| 12 | university building | 1.5 | 1.2 | 2 | 250 | 5 | 10800 |
| | | 5 | 6 | 1 | 150 | 10 | 32400 |
| 13 | Cafe | 1 | 1 | 1 | 250 | 3 | 2700 |
| **Total Water Drawn from Pumps** | | | | | | | 125388 |

| Break up of Water consumption | kL |
|---|---|
| Annual Water drawn from Bore wells | 1,25,388 |
| Water from Municipality | Nil |

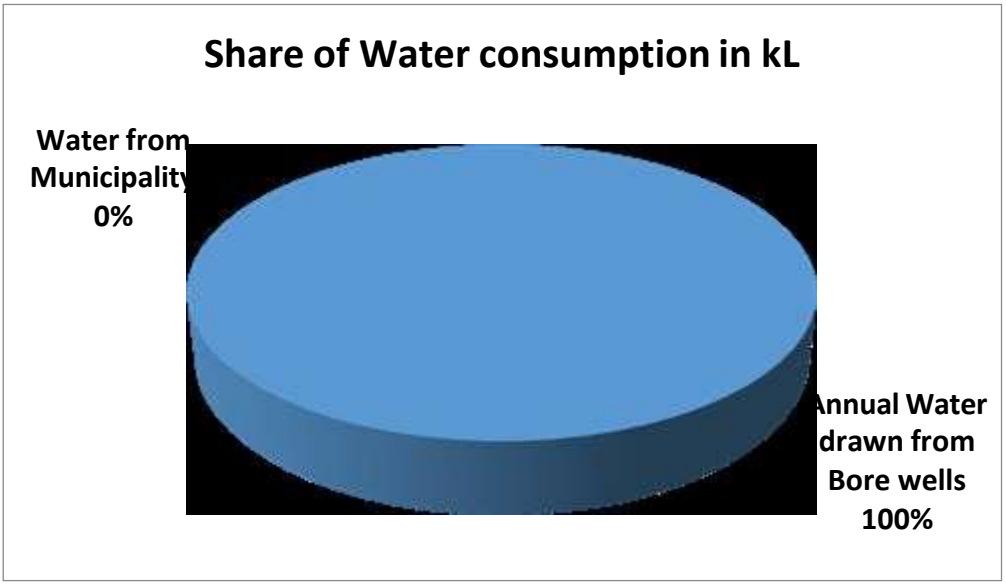



**Figure 3: Share of Water consumption in kL**

**Table 6: Theoretical Water Consumption as per NBC-2016**

| Sr. No. | Description | No. of Hours stay | Nos. | No. of days | Requirement of water /Day (Ltr) | Annual Requirement- |
|---|---|---|---|---|---|---|
| 1 | Students-Day Time | 8 | 4100 | 200 | 45 | 36900 |
| 2 | Students in hostel | 24 | 1200 | 250 | 145 | 43500 |
| 3 | Teaching and Non-Teaching staff | 8 | 290 | 250 | 45 | 3262.5 |
| 4 | Sweeper, Mess Staff, Gardner | 8 | 110 | 250 | 45 | 1237.5 |
| 5 | Vendors staff | 8 | 32 | 365 | 45 | 525.6 |
| 6 | Visitors/Exams etc.-Average | 2 | 20 | 225 | 45 | 202.5 |
| 7 | Horticulture | - | 11870(Area in Sq. Mtr) | 250 | 5 | 14837.5 |
| **Total Annual Water Requirement-Theoretical (kL)** | | | | | | **100466** |

It has been informed during audit that all water required for horticulture use is managed from ground water.

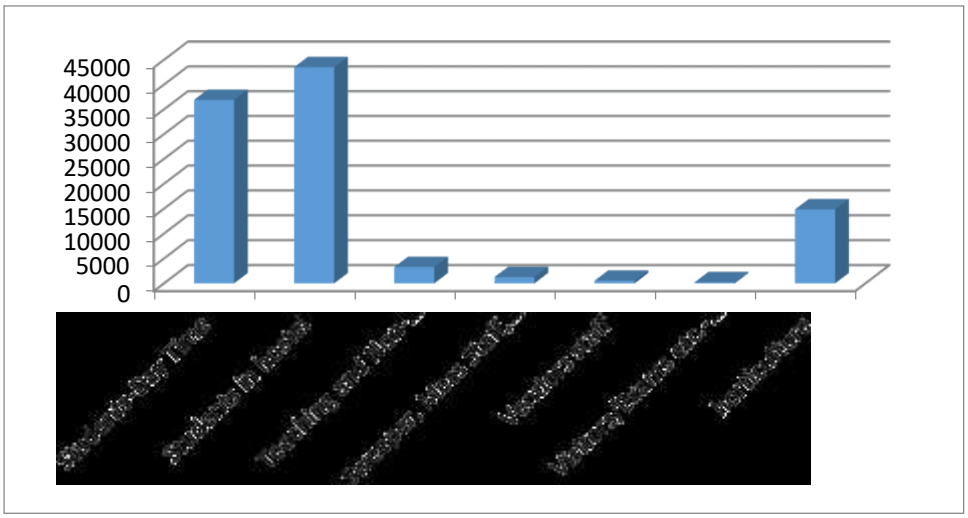



**Figure 4: Annual Requirement of Water for Human use**

**Table 7: Water Balance of Premises**

| Sr. No. | Description | Total Water drawn from Bore well-kL | From Municipality-kL | Total Water Consumption |
|---|---|---|---|---|
| 1 | Actual Water use | 1,25,388 | 0 | 1,25,388 |
| 2 | Theoretical Water Requirement | | | 1,00,466 |
| **3** | **Savings** | | | **24,922** |

| S.No. | Water use | Quantity-kL |
|---|---|---|
| 1 | Water for Horticulture use | 45360 |
| 2 | Water for human use | 80028 |

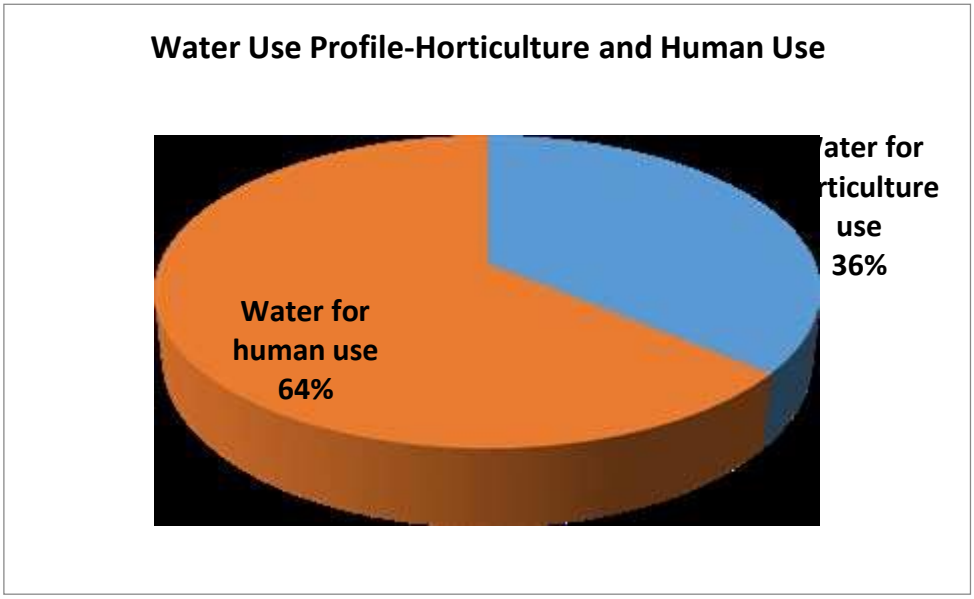



**Figure 5: Water Use Profile-Horticulture and Human Use**

# 6. Water Saving Potential

Total Annual Water Requirement-Theoretical (kL) – 1,00,466 kL /yearly

Total Water Drawn from Pumps (kL) – 1,25,388 kL/yearly

Water Saving Potential – 24,922 kL/yearly Water

Saving Potential % = 24 % approximately

**Note: Facility does not have any metering system or log book system to quantify the water requirement of the premises. Audit team adopted technique of discuss with concern persons and management, running hours, design flow values etc to quantify the water requirement of the premises.**

# 7. Detailed Observations

| Sr. No. | Observation/Parameters | Yes/No | Recommendations |
|---|---|---|---|
| 1 | Is there any bench mark for water use | No | But Consumption of water for human consumption is higher than NBC Bench Mark and the water use is not managed effectively. |
| 2 | Is the water conservation opportunities identified | Yes | Low flow fixtures and Cisterns with double plug mechanism should be provided. Flow of pipes can be reduced by use of water flow reduction accessories. |
| 3 | Are there any signs, postersor stickers in university premises to encourage water efficiency and remind students to report leaks? | No | Suitable water conservation stickers and bills should be displayed conspicuously for creating awareness |
| 4 | Is there any water management team to review water use? | No | Establish a water management team and meet regularly to review use and identify water saving opportunities. Consider involving students, teachers, administrative staff and even parents, visitors and volunteers. |
| 5 | Have you installed meters in high water using areas? | No | Meters in high water using areas should be got installed and monitor regularly to know accurately where water is used and identify any problems |
| **S.No.** | **Observation/Parameters** | **Yes/No** | **Recommendations** |
| | **Amenities** | | |

| | | | |
|---|---|---|---|
| **1** | Are the taps in hand basins are water efficient ? | No | Install flow regulators to reduce flow to at least 4.5L/min: If taps are used only for hand washing, consider a flow rate as low as1.7L/min for super efficiency. Consumption is priestly reduced by closing of valves. |

| | | | |
|---|---|---|---|
| | | | |
| **h** | Do cleaners hose down amenity areas? | No | If you must use a hose ensure it has a water efficient trigger nozzle. |
| **3** | Does University have single flush toilets? | Yes | Consider replacing single flush toilets with 6/3L or 4.5/3 L dual flush models, when these become due for normal replacement. |
| | | | |
| **S.No.** | **Observation/Parameters** | **Yes/No** | **Recommendations** |
| | **Canteen, Mess, Hand Wash Area** | | |
| **1** | Are taps in kitchens water efficient? | No | If No, install 7.5L/min flow restrictors on kitchen/art room sinks **. Tip: Pre-rinse spray nozzles in kitchens can use less than 6L/minute and make it easier to rinse and clean dishes.** |
| **2** | Do staff leave taps running while they are cooking and cleaning? | No | Still , install stickers to remind staff to turn off taps. Consider installing sensor taps. |
| | **DNA : Data not available** | | |
| | **Outdoor areas** | | |
| **1** | Has appropriate staff completed the Water Conservation training | No | Ensure appropriate staff complete the Water conservation training. |
| **2** | Do campus sub-meter irrigation water supply? | No | Consider installing sub-meters to determine water use and identify any leaks, and monitor regularly. |
| **3** | Do you use an alternate water source to irrigate your landscape? | yes | Water rejected from RO is stored and used for irrigation purpose. |
| **4** | Do you have Water wise /Water efficient Plants in your garden? | No | A lot of green area has been planted for gardening |

| | | | |
|---|---|---|---|
| **S.No.** | **Observation/Parameters** | **Yes/No** | **Recommendations** |
| | **Training and Awareness** | | |
| **1** | Whether staff in general are aware about importance and need of water conservation | No | The awareness should be created amongst all maintenance and operation staff. |
| **2** | Whether there is a program for sensitizing students through workshop/seminars to educate them regarding scarcity of water and its conservation | No | There is no awareness program to create awareness amongst students through training |
| **3** | Whether there is a program in place to involve students in water conservation targets. | No | There should be regular active involvement of students, they being helpful in university as well as it shall be useful for them during their life time in future. |

# 8. Flow Rate of Fixtures Measured

**Table 8: Water flow Measurement**

| Time taken for filling one litre of measure on sample basis | | | | | |
|---|---|---|---|---|---|
| **Sno** | **Location** | **WC** | **Wash Basin** | **Taps** | **Total Set** |
| 1 | Administrative Building | 8.12 | 9.13 | 9.4 | WC-8 / WB-7 / Taps - 8 |
| 2 | M Block | 3.4 | 3.14 | | WC-12 / WB-16/ Taps - 12 |
| 3 | AUDITORIUM | 9.97 | | | WC-8 / WB-10/ Taps – 8 |
| 4 | SEMINAR BUILDING | 7.4 | 11.47 | | WC-8 / WB-11/ Taps – 8 |
| 5 | B-TECH BUILDING | 1.8 | 5.07 | | WC-9 / WB-8/ Taps – 17 |
| 6 | NILGIRI HOSTEL | 5.07 | 16.15 | | WC-39 / WB-39/ Taps – 158 |
| 7 | HIMALAYA HOSTEL | | | | WC-18/ WB-12/ Taps – 36 |
| 8 | Shivalik | | 5.43 | 4.89 | WC-12/ WB-16/ Taps – 44 |
| 9 | Himgiri | | 7.75 | | WC-36 / WB-28/ Taps – 92 |
| 10 | BHAGIRATHI HOSTEL | | 5.03 | | WC-48/ WB-32/ Taps – 136 |
| 11 | GODAVARI HOSTEL | | | 3.07 | WC-40/ WB-28/ Taps – 116 |
| 12 | KAVERI HOSTEL | | | 3.76 | WC-20/ WB-12/ Taps – 56 |
| 13 | STAFF QUARTER | | | 4.43 | WC-12 WB-8/ Taps – 28 |
| 14 | UNIVERSITY BUIDING | 3.38 | 13.59 | | WC-20 WB-22/ Taps – 42 |
| 15 | FACULTY QUARTER A/B | 3.06 | 6.02 | | WC-12 WB-8/ Taps – 28 |
| 16 | GUEST HOUSE | | | | WC-48 / WB-48 / Taps – 144 |

**It has been observed that flow in liters per minute of taps is very high and with provision of accessories it is required to be brought under 5 Liters and for further optimization it should be targeted to be reduced to 2 Liter per minute.**

| Flow Water From Tap | Submersible Pumps |
|---|---|
|  |  |

**Figure 6: Submersible Pumps and Water Flow from Taps**

**Table 9: Location wise Tap/WC Installations**

| S. N | NAME OF BUILDING | WASH BASIN | WATER CLOSET | TAPS | BATHROOM | TAP |
|---|---|---|---|---|---|---|
| **1** | **ADMIN BUILDING** | 3 | 3 | 3 | | |
| | KITCHEN | 1 | | 1 | | |
| | CHANCELLOR SIR'S OFFICE | 1 | 1 | 1 | | |
| | EXECUTIVE DIRECTOR SIR'S OFFICE | 1 | 1 | 1 | | |
| | VICE CHANCELLOR SIR'S OFFICE | 1 | 1 | 1 | | |
| | ADVISOR ROOM | 1 | 1 | 1 | | |
| **2** | **M-BLOCK** | | | | | |
| | KITCHEN | 1 | | 1 | | |
| | GIRLS WASHROOM STAFF | 1 | 1 | 1 | | |
| | BOYS WASHROOM STAFF | 1 | 1 | 1 | | |
| | GIRLS WASHROOM STUDENT | 3 | 5 | 3 | | |
| | BOYS WASHROOM STUDENT | 6 | 9 | 6 | | |
| **3** | **AUDITORIUM** | | | | | |
| | GREEN ROOM | 3 | 3 | 3 | | |
| | GIRLS WASHROOM | 2 | 2 | 2 | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | BOYS WASHROOM | 3 | 5 | 3 | | |

| S. N | NAME OF BUILDING | WASH BASIN | WATER CLOSET | TAPS | BATHROOM | TAP |
|---|---|---|---|---|---|---|
| **4** | **SEMINAR BUILDING** | | | | | |
| | BOYS WASHROOM | 4 | 6 | 4 | | |
| | GIRLS WASHROOM | 4 | 5 | 4 | | |
| **5** | **B-TECH BUILDING** | | | | | |
| | BOYS WASHROOM | 4 | 3 | 7 | | |
| | GIRLS WASHROOM | 5 | 5 | 10 | | |
| **6** | **NILGIRI HOSTEL** | | | | | |
| | GROUND FLOOR | 10 | 10 | 20 | 2 | 20 |
| | FIRST FLOOR | 10 | 10 | 20 | 2 | 20 |
| | SECOND FLOOR | 10 | 10 | 20 | 2 | 20 |
| | TOP FLOOR | 9 | 9 | 18 | 2 | 20 |
| **7** | **HIMALAYA HOSTEL** | | | | | |
| | GROUND FLOOR | 6 | 4 | 6 | 3 | 6 |
| | FIRST FLOOR | 6 | 4 | 6 | 3 | 6 |
| | SECOND FLOOR | 6 | 4 | 6 | 3 | 6 |
| **8** | **SHIVALIK** | | | | | |
| | GROUND FLOOR | 3 | 4 | 9 | 3 | 2 |
| | FIRST FLOOR | 3 | 4 | 9 | 3 | 2 |
| | SECOND FLOOR | 3 | 4 | 9 | 3 | 2 |
| | TOP FLOOR | 3 | 4 | 9 | 3 | 2 |
| **9** | **HIMGIRI** | | | | | |
| | GROUND FLOOR | 9 | 7 | 16 | 7 | 7 |
| | FIRST FLOOR | 9 | 7 | 16 | 7 | 7 |
| | SECOND FLOOR | 9 | 7 | 16 | 7 | 7 |
| | TOP FLOOR | 9 | 7 | 16 | 7 | 7 |
| **10** | **BHAGIRATHI HOSTEL** | | | | | |
| | GROUND FLOOR | 12 | 8 | 18 | 8 | 16 |
| | FIRST FLOOR | 12 | 8 | 18 | 8 | 16 |
| | SECOND FLOOR | 12 | 8 | 18 | 8 | 16 |
| | TOP FLOOR | 12 | 8 | 18 | 8 | 16 |
| **11** | **GODAVARI HOSTEL** | | | | | |
| | GROUND FLOOR | 10 | 7 | 17 | 6 | 12 |

| S. N | NAME OF BUILDING | WASH BASIN | WATER CLOSET | TAPS | BATHROOM | TAP |
|---|---|---|---|---|---|---|
| | FIRST FLOOR | 10 | 7 | 17 | 6 | 12 |
| | SECOND FLOOR | 10 | 7 | 17 | 6 | 12 |
| | TOP FLOOR | 10 | 7 | 17 | 6 | 12 |
| **12** | **KAVERI HOSTEL** | | | | | |
| | GROUND FLOOR | 5 | 3 | 8 | 3 | 6 |
| | FIRST FLOOR | 5 | 3 | 8 | 3 | 6 |
| | SECOND FLOOR | 5 | 3 | 8 | 3 | 6 |
| | TOP FLOOR | 5 | 3 | 8 | 3 | 6 |
| **13** | **STAFF QUARTER** | | | | | |
| | GROUND FLOOR | 3 | 2 | 5 | 2 | 2 |
| | FIRST FLOOR | 3 | 2 | 5 | 2 | 2 |
| | SECOND FLOOR | 3 | 2 | 5 | 2 | 2 |
| | TOP FLOOR | 3 | 2 | 5 | 2 | 2 |
| **14** | **UNIVERSITY BUIDING** | | | | | |
| | GIRLS WASHROOM STAFF | 5 | 6 | 11 | | |
| | BOYS WASHROOM STAFF | 5 | 2 | 7 | | |
| | GIRLS WASHROOM STUDENT | 5 | 11 | 16 | | |
| | BOYS WASHROOM STUDENT | 5 | 3 | 8 | | |
| **15** | **FACULTY QUARTER A/B** | 16 | 16 | 32 | 16 | 32 |
| **16** | **GUEST HOUSE** | 32 | 32 | 32 | 24 | 48 |

# 9. Observations And Recommendations

| | Action steps for Water management – Design and Construction |
|---|---|
| **A** | Reduce water consumption through efficient fixtures. |
| **1** | Efficient plumbing design. Two stack system design for future to reduce energy consumption and pumped water energy. |
| **2** | Sub metering of water for separate uses |
| **3** | Efficient fixtures such as low flow taps, shower heads and toilets and **Water less urinals as per applicability in Gents Toilet.** |
| **4** | Efficient appliances for catering and other uses with specified water efficiency standards. |
| **5** | **Recycle** water using **Grey Water** systems. Being done–recycled water data be maintained. It is already in practice |
| **6** | **Rain water is captured in rain water harvesting pits- Maintenance of RWHS is required to be done periodically.** |
| **7** | Automatic shut off of Pump should be installed so that there is no wastage of water and Energy. |
| **8** | Log Book for running of Pump to be maintained |
| **9** | Check Leakage through internal audits-Weekly |
| | **OPERATION & MAINTENANCE** |
| **1** | As the building is operational, further reductions in water use can still be Made depending on how efficiently the building is run.<br>Efficient fixtures and fittings reduce the amount of flow of water; however, it is equally important that water use is periodically assessed or audited to detect wastage caused either by the users or due to leakage. This will also help the building management in devising appropriate strategies for water conservation. |
| **2** | There is a potential for reduction and optimization of water simply and inexpensively by internally auditing water use and identifying appropriate water-saving measures |
| **3** | Install push button type individual manual urinal flushing system, Provide dual flushing systems and make users aware of the use of such installed systems. |
| **4** | Repair, replace leaking taps. |

# 10. Rain Water Harvesting system

The following Rain Water harvesting system pits have been installed.

As per the data furnished, there are 3 nos. Rain water harvesting pits have been provided. Presently only one harvesting pit is maintained properly and two of these are clogged and need to be cleaned.

There is requirement of regular maintenance of these pits to clear these of any silt deposit etc. so that capacity and quality of water fed to these pits is not reduced.

Note: Rain water harvesting pits are not to recharge ground water. However, It is being used to use water for gardening.

**Figure 7: Rain Water Pit**

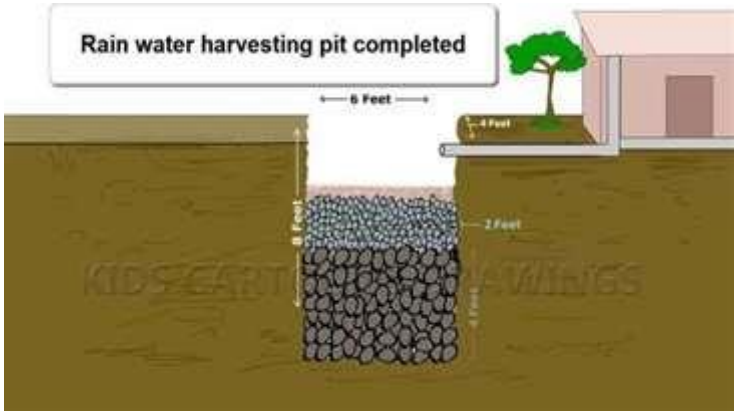



**Figure 8: Proposed Rain Water Harvesting Pit**