

Conference Paper

Environmental performance studies on educational institutions

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ABSTRACT

Sustainable development is widely used these days by the policy makers, academia, governments in all areas including developmental projects, and in many verticals. Sustainability is not only spoken in various levels but also practiced by industries and organizations to optimize their resource utilization and make them environmental friendly. Sustainability is the need of the hour for our country to provide our future generation a cleaner, safer environment, to achieve it there are many paths, one should be able to identify the best path related to their industry or organization to achieve sustainability. Various models and tools are already developed by researchers working on this domain which helps them to identify the focus areas where the optimization is possible to improve the environmental performance of the industry. Ecomap is one of such potential tool which can be used effectively used by any SME (small and medium enterprises) and industries for resource usage identification and optimization. It is highly versatile, applicable to many industries which enable them to optimize their resources and making them sustainable. In our country industrial development and blooming job market puts thrust to the increase in number of educational institutions, we have more than 7,00,000 educational institutions operating all over India. Educational institutions consume more natural resources than any SME's, a developing University consumes about 8,00,000 liters of water and uses about 5,333, KWH of electricity per day for their operations. Thus educational institutions should also be focused with industries to preserve our natural resources and methods are to be developed to improve their environmental performance. Ecomap is not only applicable to industries but can also be employed in educational institutions for resource mapping and optimization. Ecomap if properly deployed will increase the sustainability of the institutions and reduce their resource consumption, which will benefit the institutions and the nation in many ways. This paper provides insight into Ecomapping, its principles, applications and methods to arrive the Ecomap for educational institutions with detailed case studies and applications. The environmental problems associated with educational institutions also discussed with the methods to map them in Ecomap.

Keywords: Environmental performance, Sustainability, resource utilization, Optimization.

1. Introduction

Sustainable development is widely used these days by the policy makers, academia, governments in all areas including developmental projects, and in many verticals. Sustainability is not only spoken in various levels but also practiced by industries and organizations to optimize their resource utilization and make them environmental friendly. Sustainability is the need of the hour for our country to provide our future generation a cleaner, safer environment, to achieve it there are many paths; one should be able to identify the best path related to their industry or organization to achieve sustainability. Various models and tools are already developed by researchers working on this domain which helps them to identify the focus areas where the optimization is possible to improve the

environmental performance of the industry. Sustainability had become the key word of developing world and it's evident in many issues, the growing economy is facing nowadays. Ecology is being associated with the growth of any industry, organization or even a nation and it's not still a low key issue. A nation's growth starts from its educational institutions, where the ecology is thought as a prime factor of development associated with environment. Educational institutions nowadays are becoming more sensitive to environmental factors and more concepts were being introduced to make them eco friendly. To preserve the environment within the campus, there are various viewpoints that several Universities are applying in order to tackle with their environmental problems such as promotion of the energy savings, recycle of waste, water reduction, etc. Eco- Campus is one such concepts or principles introduced to make the Universities environmentally sustainable.

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1.2 Eco campus

Eco-campus or Ecological Campus has its meaning in itself. The meaning of eco-campus has been expressed in its targets and objectives. By all means, eco-campus means "environmental sustainability within the school". School is a center for generating of education; moreover, it is also a research center where the students and teachers are attempting to develop the best strategy for achieving their purposes. Due to this reason, the development of eco-campus has been pointed out and established recently. Eco-campus concept mainly focuses on the efficient uses of energy and water; minimize waste generation or pollution and also economic efficiency.

Eco-campus focuses on the reduction of the University's contribution to emissions of green house gases, procure a cost effective and secure supply of energy, encourages and enhance staff and student energy issues, also promotes personal action, reduce the University's energy and water consumption, reduce wastes to landfill and integrate environmental considerations into all contracts and services considered to have significant environmental impacts. While these various measures are promoted synthetically and systematically, an "Environmental Management System" is introduced, in order to realize certainly the "Eco-campus" which considered environment, and clarifying the posture of a University to society. It aims at establishing the organization which may be evaluated objective. Most recently, the concept of cleaner production (CP) has entered the global environmental arena. CP fits within pollution prevention's broader commitment toward the prevention rather than the control of pollution.

Cleaner production means the continuous application of an integrated preventive environmental strategy to processes and products to reduce risks to humans and the environment. For production processes, cleaner production includes conserving raw materials and energy, eliminating toxic raw materials, and reducing the quantity and toxicity of all emissions and wastes before they leave a process.

Pollution prevention is an approach which can be adopted within all sectors, whether it is a small service operation or a large industrial complex. CP, on the other hand, directs activities toward production aspects. Unlike in the past when pollution was simply controlled, P2 and CP programs attempt to reduce and/or eliminate air, water, and land pollution. Therefore, the P2 and CP approaches benefit both the environment and society. Economically, P2 and CP can actually reduce costs and in some cases, generate profit. Both approaches are practical and feasible, and can consequently contribute to a sustainable future.

Cleaner production, pollution prevention, etc. are all subsets of the concept of sustainable development, which states the basic problem that the other concepts attempt to address: There are limits to what the environment can tolerate, and society needs to ensure that development today does not cause environmental degradation that prevents development tomorrow. There are many issues here but the role of industry and industrial pollution is obvious. Industrial systems and individual companies will need to make changes in order to prevent future generations from being unable to meet their own needs. Sustainable development is thus the long-term goal of individual companies rather than a business practice.

Eco-campus approaches must be implemented step by step. First of all, data collection has to be conducted in order to find out what the status of the campus is. After collecting all information and data, the next step is determining of problematic areas and find out what the reasons are. Finally, proposing the way that can solve the issues, in order to achieve the sustainable development. In this study, Cleaner Production is an option that is selected for implementing of eco-campus development.

1.3 Need for the present study

India with the second largest population in the world is now one of the fastest growing economies with a rapid growth in GDP. In the past few decades the need for trained people is rapidly increasing in the industrial and other fields to support our countries technological growth. This has lead to the establishment of more and more technological and educational institutions in India. India has a large number of Universities, colleges, and other institutions and the number is growing rapidly in the past few decades. In Tamilnadu itself there are more than 2000 educational institutions are now operating to cater to the needs of students from various areas of study for more than 2 million students.

It is well known that educational institutions consume resources like water, electricity; forest product's and generates wastes like many industries. Establishment and operating of Universities are not covered by any of the environmental laws in India. As a result, the importance of making the Universities operate with self consciousness in the utility of resources inside the campus is least understood. Eco campus is a concept implemented in many Universities across the globe to make them sustainable because of their mass consumption of resources and creation of waste. Waste minimization plans inside the Universities for solid and wastewater is now mandatory to maintain the cleanliness inside the Universities. The number of Universities in the near future will be doubled and it is ripe time to emphasis the creation of Eco campuses and its implementation for making the Universities sustainable.

1.4 Studies conducted

To find out the environmental performance of the educational institutions and to analyse the possible solutions for converting the educational campus as ecocampus the following studies are conducted

- Energy consumption pattern in the University.
- Water audit and to give sustainable solutions for usage.
- Effect of noise inside the campus at various locations.
- Prepare an Ecomap for the University campus.
- Environmental performance analysis of the educational institution.

The studies were conducted at College of Engineering, Anna University, Guindy, Tamilnadu Campus in which all the areas including administrative locations, class rooms, residential areas, Sports facilities, canteen, library and recreational areas are studied for environmental performance. In the study area various environmental components were studied for improving the sustainability inside the campus and to reduce the resource utilization in various day to day activities of the University. Ecomap is drawn using GIS after calculating various data necessary to prepare the map. Ecomapping is not only applicable to industries but also to educational institutions since educational institutions consume natural resources equivalent or more than any SME these days. A study was conducted aimed to predict the possibilities of maintaining the greener environment inside the University campus which is main concept of environmental sustainability within the campus called as Eco Campus. To preserve the environment within the campus, there are various viewpoints that several Universities are applying in order to tackle with their environmental problems such as promotion of the energy saving, resource savings, recycle of waste, water reduction, etc.

2. Methodology of study

To study the concepts of converting the campus into Eco campus and to apply the principles of sustainable utilization of resources, analysis of resources calculation was done. The total resources including water, electricity, consumables, was studied to calculate the various details. The primary data collection was done for the areas of electricity consumption pattern, water usage, noise level analysis, sustainability concepts. Data available from the previous studies conducted inside the University which is useful for analysis is incorporated. With the calculated data on field and the secondary data an Ecomap was drawn to the Anna University campus to identify the resource utilization on various areas of University.

2.1 Energy audit

Energy audit primarily is focusing on having efficient campus electricity consumption. The actions that will have significant electricity savings, reduction in the power factor and also providing a more efficient refrigerating system, as well as water distribution will be determined. The following actions was carried out, real time readings of electrical energy consumption will be taken in energy meters installed inside the campus at various locations, refrigerated water system operation wherever necessary (Ductable split A/C's and other cooling units inside the campus) was studied for the emission of CFC's Lighting concepts in class rooms, laboratories, Computer rooms, Conference halls, Libraries, and other utility areas was be studied for the luminance and the comfort of the user by various methods

and the techniques for lower power consumption will be arrived by comparing it with literatures and brain storming session. : i.e. substitution of lower power consumption methods instead of high power consumption techniques in all areas of the campus. Meter reading, campus electricity consumption details were utilized for the calculation. Each selected buildings were monitored for their power consumption rate on three separate periods; (1) examination period, (2) weekend, and (3) semester break period and the results were tabulated. Universities main power is coming from electricity board power supply and it has two main power grids supplying power to all parts of the Universities. After detailed calculation it was found that the energy is mostly consumed by the air conditioners inside the campus, laboratory equipments and computers.

Table 1: Energy consumption inside the University campus

S. NO	MONTH	HT5 (kWh)	HT547(kWh)	TOTAL (kWh)
1	May	70500	25010	95510
2	June	73950	31690	105610
3	July	75839	28200	104039
4	August	75730	29940	103670
5	September	81730	31890	113620
6	October	71730	25010	96740

The above tables clearly prove the way the energy is utilized inside the campus for its operations and the amount spend on each department. With the calculated data the per capita consumption of electricity is found to be $(25050 + 71730 = 96730 \text{ Units}) = 10\text{-}13$ units per capita per month which is to be reduced drastically. The amount spend on electricity is also to be reduced since its more than greater than amount spend on any other resources. Special measures are to be provided to prevent energy loss and wastage, guidance for the students is to be given by authorities to use electricity effectively. With the collected information it's also evident that the major electricity usage is by air conditioners inside the campus which is also the potential source of CFC emission, which is to be controlled to make the campus a Green campus. It's advised to use the air conditioners more effectively and only in areas of necessity so that the power utilization is saved primarily for other major operations of the University.

2.2. Noise Audit

The noise pollution inside the campus will affect the serenity of the campus and will create distraction among the students which will directly affect the teaching learning process. The noise pollution is mainly due to the vehicular movement, anthropogenic sounds, laboratory works, operation of generator's, machineries etc. The comprehensive study was done inside the campus to calculate the noise level at various important locations such as class rooms, pavements, laboratories, library location and the data will be interpreted for solutions. Noise meter readings were taken at various locations and near the sound sources such as generators, class rooms, canteen blocks, vehicular movement areas, hostel blocks, main building, conference halls, etc. The data available (secondary data) if any was utilized

for the study noise pollution inside the campus. Noise level readings (db) was taken using noise meter and the readings were given in table 1

Table 2: NOISE AUDIT

Serial No	Location	Noise level (db)
1	Classrooms, Main Building, Other study areas	53.7 – 76.4
2	Near hostel buildings	54.5- 67.2
3	Near running machineries, laboratories	58.6 – 78.2
4	All other utility areas	67.2 – 82.6

Noise level readings were taken both indoor and outdoor of the classrooms, verandah, main noise sources such as generators, canteen, road sides (vehicle traffic), front side entrance, side entrance of the campus, near hostel blocks. The readings were taken in certain period of interval and specific timings such as mornings, evenings, afternoon, leave days, working days and specific readings were tabulated. With the calculated readings in was clearly evident that Anna University campus is not much affected by the noise pollution but in certain areas standard measures are to be taken to bring down the noise level to ambient level. Areas such as Power house, Canteens, etc were to be isolated from the main utility areas such as class rooms, laboratories, library etc and special noise barricades are to be provided over the front side entrance or the wall height can be increased to a certain level so that the impact of noise in minimized. Vehicular traffic inside the campus is to be banned completely to preserve the noise pollutions inside the campus and the classrooms are to be provided with proper sound facilities such as noise absorbents inside the class rooms. When building new hostel blocks or class room's special care is to be taken to locate them in an area where the noise level is minimum

2.3 Water audit

Water is biggest over head in any industry, process or operations and its essential for any business. A water audit can identify productive use and needless waste such as leaks prevention, reduced consumption, and money savings. A comprehensive water audit will be done to uncover any costly inefficiency in the water distribution, utilization system that results in money literally pouring in drains. The water audit will eliminate the flaws in the unwanted utilization, wastage of water inside the University campus. The water audit was done on total water consumption, cost, consumption per capita, and other usage of water inside the campus. A comprehensive waste water characterization was done or the available reliable data will be used for the calculations and analysis. This was done by calculating the following

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- Real time water source finding – University water supply data was taken from the Estate office or from the different departments and the storage methods was analyzed.
- Trends of water usage for Gardening, Laboratory, Canteen, official purposes was calculated by taking real time reading with the departments of the University and with secondary data available in Estate office.
- Per capita water consumption for the University for the past one decade was arrived with the data calculated and secondary data.
- Water sampling will be done at collection point and at water outlet to characterize the water. Waste water sampling was done to at the treatment plant available inside the campus.

Water Audit is done with the following method

Water Lost = Water supply – Wastewater discharge*Wastewater discharge:

$$= (\text{operational time of the pumps, h/day}) \times (\text{pumps' capacity, m}^3/\text{h}) \quad (1)$$

To find out the usage of water for the university activities the detailed water audit was conducted and the flow of water from the starting point is analysed. Anna University's daily water consumption is found to be 7 - 8,00,000 liters per day including hostels, gardening, canteen and other usages. The only source of water is corporation supply of 8, 00,000 liters per day provided as continues supply. The internal water sources like bore well are stopped temporarily and the main water supply is used all over the campus. The incoming water is connected in the main sump and distributed to other sumps and over head tanks for distribution. The main water usage inside the campus is found to be hotels, canteens and main buildings owing to the number of dwellers and this accounts more than 65% of the total water usage. The water flow diagram is given in fig 1 and it was found that the

Total in flow = 8,10,000 litres per day.

Water available at end point = 7, 70,000 litres per day.

Net loss = 35 – 40,000 litres per day in the form of loss, wastage, unaccounted.

This is evident from the readings taken from all over the campus for the water audit and in most of the areas of the University it's found that the water usage is mostly unaccounted or wasted. The method of pumping adapted now by the authorities is crude and there is no standard procedure for the pumping as of now. With this pattern of pumping it's found that calculating the water usage requirements for each and every building or usage is difficult. To eliminate this a standard method of pumping is to be adopted throughout the campus and the total water supply is to be exactly equal to the water need of the University campus since water is one of the prime resource which is to be effectively used.

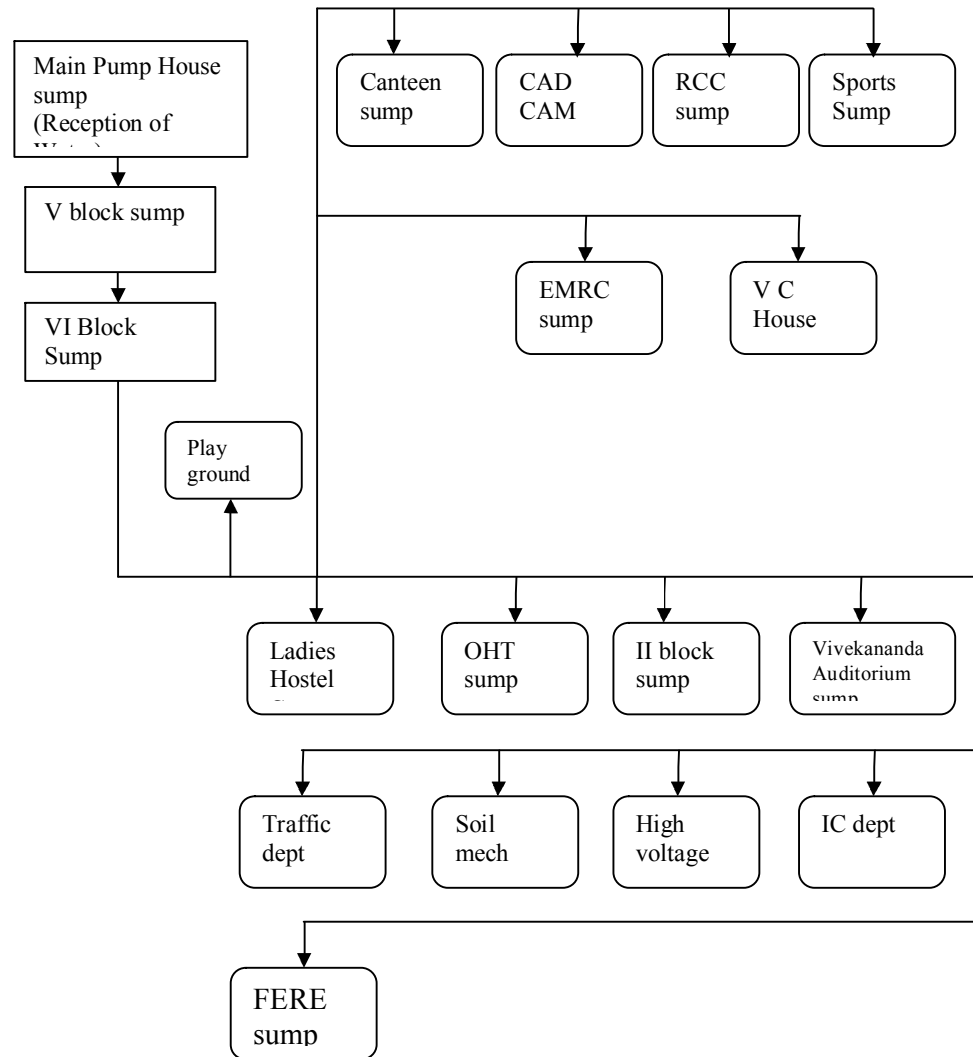


Fig 1: Pumping details in the University campus

It was found that effective usage of water inside the campus is the need of the hour, to achieve this both social and technological approach is to be followed to avoid wastage of water, effective point to point utilization. The major source of water inside the campus is found to be corporation water supply and saving water aims at economical point of view also it is needed to find local water supply to give water surety.

2.4 Social impact analysis

Most of the environmental related problems are created owing to the carelessness and laziness of the human beings, it varies from small problems to problems of greater magnitude whatever may be the issue there exist some among of carelessness. This is common also in the environmental performance of the educational institutions where most of the natural resource wastage occurs just because of the unwanted usage of resources where it's not

needed. For an example a classroom running in day time just need only fan but most of the classrooms are found to switch on the lights even in bright daylight, just because of this for the full campus huge amount of electricity is wasted. Also the water consumption inside an educational institution can be minimized just by employing simple methods like turning off the taps when it's not used. To analyze this effects a social impact study is done within the campus by the method of survey among the students and staff members. For social impact analysis a questionnaire was prepared and the data was collected about the awareness among the students about the energy, water and other resources utilization inside the University campus. The details collected were utilized to give suggestion for sustainable usage of resources inside the campus to make the University an Eco-Campus.

Universities were not just bricks and mortar; it's made up of the people using the facilities inside the campus. The maintenance and the resource utilization inside the campus is directly in the hands of the students and staff using the University resources for day to day operations. Most of the resource utilization is by the student community for their study aids such as laboratories, library, classrooms, etc and they play a major role in saving the resource utilization inside the campus. To analyse the awareness among the students about the enormity of the resource utilization in day to day operations of the campus a detailed study was done in the form of questionnaire given to representative sample of the students and the results was calculated. It's found after the study that most of the students are unaware of the magnitude of resource utilization inside the campus for day to day operations and it's mandatory for the University authorities to inculcate knowledge among the student and staff community on the preservation and optimization of resources inside the university. This starts with small posters inside the class rooms for saving electricity and water which are major resources wasted inside the campus, which may directly results in huge savings to the University authorities. Students should be made aware of the total amount of water and electricity usage inside the campus for the operations and they should be well known to the methods of savings it. Posters and hand outs were prepared for distributing to the students to increase the awareness among them about the resource savings that can be done by them using simple methods such as switching off lights and fans while leaving, using water properly without wastage in laboratories, canteens, toilets , etc. It's also suggested to the University authorities to make some simple rules as mandatory for the students to form a team of students in all courses to improve the methods of resource usage while in the University. This will be a major tool for resource optimization since the students will normally used to the conditions soon if it was practiced particularly in the hostel blocks students should be advised about saving electricity and water which are prime resources.

3. Preparation of Ecomap

An Eco Map was drawn indicate the possible and focus areas inside the campus for sustainability by using the calculated data from the studies conducted, fig 2 and fig 3 shows the Ecomap of the University campus. To draw the Ecomap various legends were used to identify the areas where the focus is to be given for preserving the natural resources utilization inside the campus. Since this is an University the main parameters studied was energy, water usage pattern and noise level inside the campus, there are many other allied parameters that can also be incorporated in the Ecomap (i.e. Air pollution level inside the campus). Ecomap is drawn using GIS with the scale of 1:5000 showing necessary areas of focus. Fig.1. shows the initial map of the University where the studies are conducted to prepare the ecomap drawn to scale of 1:1000. With this map and after calculating the

necessary information from various studies conducted inside the campus the necessary ecomapping is done, Fig 2 and fig 3 shows the ecomap drawn to identify the energy utilization pattern and noise level inside the campus, the areas where the focus is to be given for optimization is clearly marked in the map.

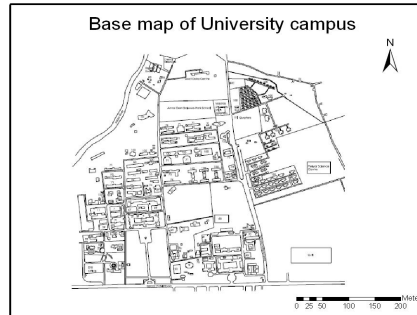


Fig 2: Initial map showing various areas inside the University campus

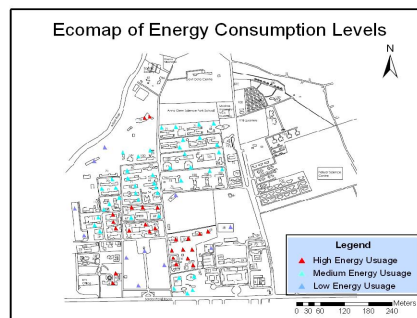


Fig 3: Ecomap showing energy utilization

The maps shows the areas where the energy, water utilization is more, those are the areas where the optimization measures are to be employed to increase the environmental performance of the University. Also the noise ecomap clearly shows the areas where the noise level is more than the ambient standards, necessary precautionary measures are to be taken in these zones to avoid any problems related to noise.

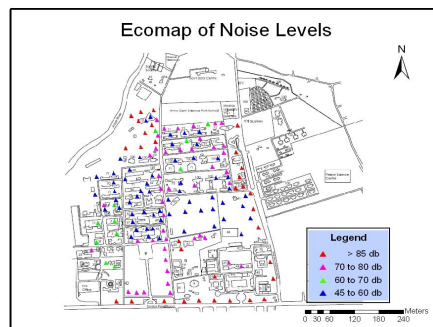


Fig 4: Ecomap for Noise level inside the campus

For large areas manual mapping may be tedious, in that case GIS can be effectively employed from starting stage to map the place, to mark the various points of interest and also to analyse the areas where the resource optimization is to be done.

4. Conclusion

The results found after the studies conducted shows that almost 30% of the material inflow is wasted in various places, this wastage is found both in water, electricity utilization. Noise level inside the campus is also found to be exceeding the ambient norms near educational institutions. To understand these results in a better manner ecomap prepared was found to be the best tool since it's visual, simple and efficient to describe the various problems in different places of the University.

With this case study it's evident that Ecomap can be employed in any industry as an environmental performance enhancing tool and Ecomapping is very easy to understand and a useful support tool for raising the awareness of householders of the environmental impacts of household activities. It also enables more people to be involved at an early stage without needing a huge amount of specialist understanding. Any industry or SME who wants to be environmental friendly can employ Ecomapping for their industry in simple manner to get clear idea about what to do and how to do to increase the environmental performance. Also its found that using GIS to prepare the map will completely computerize the total process and provides better analysis.

Each resource conservation measure should be given top priority inside the University campus and the proposal to conserve resources was to be implemented immediately. Universities being the one of the largest consumer of electricity, water and other consumables main focus are to be given to conserve these resources and to optimize the utilization of resources inside the campus. By doing the same Universities will become Eco-Campus which will be an example for other industries to follow. Noise level inside the campus is found not be a main problem inside the campus even though it seems to be and its evident from the readings taken at various points inside the campus but its suggested that the main source of noise such as generators, heavy equipments are to be isolated from main study areas such as class rooms, library.

Energy being a main commodity is to be saved precisely inside the campus and its main utilization should be on core applications such as laboratory equipments, and other appliances. Air conditioners are consuming more energy and its to be replaced by cost effective solutions wherever viable. Awareness among the students and staff members of the University to conserve the resource utilization is to be improved considerably which will have direct impact over the resource conservation. Thus environmental performance of Universities and other educational institutions are to be analysed properly by conducting studies at least once in a year and measures are to be taken to improve the environmental conditions inside the campus to make them sustainable.

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