Tezpur University
Tezpur

Sustainable Campus Initiatives Policy Document

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Sustainable Campus Initiatives
Policy Document
of
Tezpur University

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1. Introduction

Sustainability means meeting our own needs without compromising the ability of future generations to meet their own needs. The concept of 'needs', in particular, the essential needs of the world's poor, to which overriding priority is required. Sustainability is not just the issue of environment, it also concerns for social equity and economic development. Hence, the concept of sustainability is focused on three domains: environmental, social and economic. Sustainability encourages the actions and decisions in terms of environmental, social, and human impact for long-term, rather than on short-term gains. It is a holistic approach that considers ecological, social and economic dimensions, recognizing that all must be considered together to find solutions. It is now well accepted that climate change will create catastrophic problems, if no actions are taken to mitigate the climate change related issues.

"The incessant search for material comfort and their multiplication is such an evil and I make bold to say that the Europeans themselves will have to remodel their outlook, if they are not to perish under the weight of the comforts to which they are becoming slaves." Gandhiji, Young India 1931
(Reference: https://www.mkgandhi.org/indiadreams/chap01.htm)

*"As the world continues to grapple with how to respond to climate change, biodiversity loss, persistent poverty, and poor health and nutrition, Gandhiji's commitment to what we now call sustainability is perhaps more relevant today than in his own times". **Nature Editorial**, 8th October, 2019.*
Reference: https://www.nature.com/articles/d41586-019-03010-8

A sustainable campus is one that has promoted carbon neutral energy uses, conservation of natural ecosystems, reduce the natural resource consumption and recycle or reuse the wastes into a meaningful manner. A number of Universities around the world have taken initiatives to become sustainable campuses. Sustainable campus communities must be committed to addressing the social and ecological challenges for present and future. Therefore, every individual within the University campus has an important role, directly or indirectly, in making the University campus as sustainable campus. The objectives of sustainable campus are to reduce the ecological footprint beyond benchmark and to do so with an institutional practice that respects and acts to protect the natural resource system. Tezpur University, being a leading higher learning institution, is committed not only towards educating the young minds but also towards providing leadership towards sustaining the natural ecosystems, lowering ecological footprint and adopting mitigation strategies towards

climate change. The University also has societal responsibility to improve the public's understanding towards the concept of sustainability. Quality of life in any residential University is often linked with waste management, energy consumption, water management, natural ecosystems, landscape and building design in order to achieve the well-being of the campus dwellers. More than two-thirds of our carbon footprint is due to fossil fuel based energy consumption. Hence, reducing the fossil fuel based energy consumption, increasing the uses of non-carbon based energy sources, adopting energy efficient technology are an immediate step towards sustainable campus initiative.

Vision

- Tezpur University aims to be a Sustainable Campus that contributes positive environmental, social benefits and engaged in sustainability-related activities.

Mission

- To generated 40 % of total electricity consumption in the University from renewable energy-based systems by 2030
- 40 % green coverage in the University campus by 2030
- 100 % of generated waste is segregated or recycled within the campus before disposal by 2030
- 75 % of movement by bicycle or electric vehicle within the campus by 2030
- Promote sustainability through curriculum and encourage students to purse active research in promoting sustainability

2. Thematic areas

Tezpur University is considering five thematic areas such as (i) **Energy** (ii) **Water** (iii) **Waste management** (iv) **Natural Ecosystems** and (v) **Sustainable buildings** for its mission towards sustainable campus.

3. Measurable Activities

Tezpur University aims to be a Sustainable Campus that contributes positive environmental, social benefits and engages in sustainability-related activities. The way forward for each of the thematic areas is identified to make the University campus a sustainable campus. The identified actions shall be considered through (i) adoption within the University (ii) outreach activities through awareness campaign, competition among students, (iii) offering elective courses on thematic areas and students' project thereon and (iv) augmentation of R&D in the thematic areas. Details of all these

activities will be made available on the website. Yearly activities planning and target achieved will be clearly mentioned in the website.

4. External Agency Audit

Audit will be carried out by domain external agency on the achievement and to identify the gap towards the mission on Sustainable Campus Initiatives after every three years. This will help the University to prioritize the activities and required action plan.

5. Celebration of Days

Students volunteers will be identified from each of the departments to carry out the outreach activities and to celebrate certain important days such as (i) International Sun Day on 3rd May, (ii) Earth Day on 22nd April, (iii) World Bicycle Day on 3rd June (iv) World Environment Day on 5th June, (v) World Ozone Day on 16th September and (vi) National Energy Conservation Day on 14th December to increase awareness among various stakeholders.

Theme I – Energy

(Sadhan Mahapatra, Lead, Barnam J Saharia, Gobinda Kalita)

The University campus is an approximately 262-acre area located at Napam in Tezpur. The University has 25 academic departments with more than 4000 students and most of the students stay in the hostels. More than 400 residential accommodations are available for the Faculty and Staff. Tezpur University draws electricity from State Utility through a 33 KV dedicated transmission line from Dipota. Two 33/11 KV, 2.5 MVA transformers are located at the University main sub-station. Five sub-stations (11/0.43 KV) are located at different locations within the University to provide electricity to the various academic buildings, offices, hostels, residential accommodations, sports complex, street lighting etc. The present connected load of the University is 2 MW. The University has 5 diesel generation units with 500 KVA each capacity to provide power during power cut in the utility grid. The University also installed 1000 kWp rooftop grid-connected solar power plant on the campus in the year 2018. Fig 1 presents the annual electricity consumption at the University during last six years. The maximum electricity consumption was 53.13×10^5 kWh in the year 2019 and the lowest consumption of 34.38×10^5 kWh in the year 2020. This is due to the COVID pandemic, most facilities such as the hostels and academic buildings remained closed for couple of months in the year 2020 and hence electricity consumption dropped. The monthly average electricity consumption in the University is approximately 3.96×10^5 kWh (last three years' average).

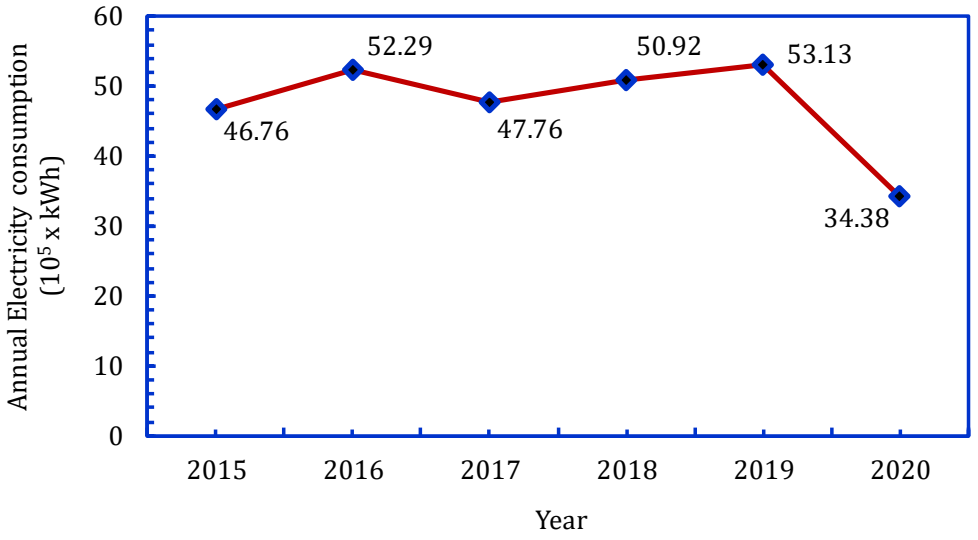


Fig 1 Annual electricity consumption at University

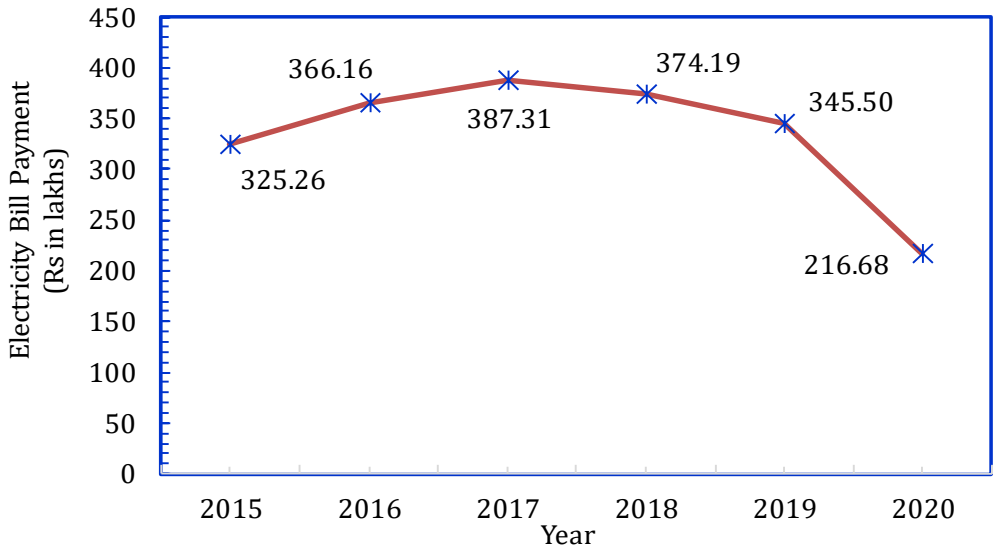


Fig 2 Annual payment for electricity consumption at University

Fig 2 presents the annual cost of the electricity consumption in the University during the last six years. The maximum payment due to electricity consumption was 387 lakhs in the year 2017 and the minimum payment was 217 lakhs in the year 2020. Though the electricity consumption was highest in the year 2019, payment for the electricity consumption is not highest in this year due to solar power injection to the grid. The minimum payment was in the year 2020 because most of the facilities of the University being closed for couple of months due to the COVID. The monthly average payment for the electricity consumption in the University is approximately 26 lakhs (last three years' average). The annual diesel consumption and the cost of the diesel for the last three years is

presented in Table 1. The diesel consumption is increasing due to more power cut duration and also due to the more load being connected with the diesel generation units.

Table 1 Annual Diesel consumption and cost

Year	Diesel consumption (litre)	Diesel cost (Rs in lakhs)
2017	42200	25.38
2018	50400	32.89
2019	63710	41.73

The major share of electricity consumption at the University is in the Academic Departments, Offices, Hostels, Residential accommodation, Street and Sports lighting, etc. Fig 3 presents the share of total electricity consumption in hostels and residential units for the last three years. It is observed that average share of total electricity consumption in the hostel and residential accommodation is 22 % and 10 % respectively. The share for all other units could not be assessed as electricity meters are not installed in all these buildings. It is recommended that an electricity meter be installed at all load points to assess properly the share of electricity consumption.

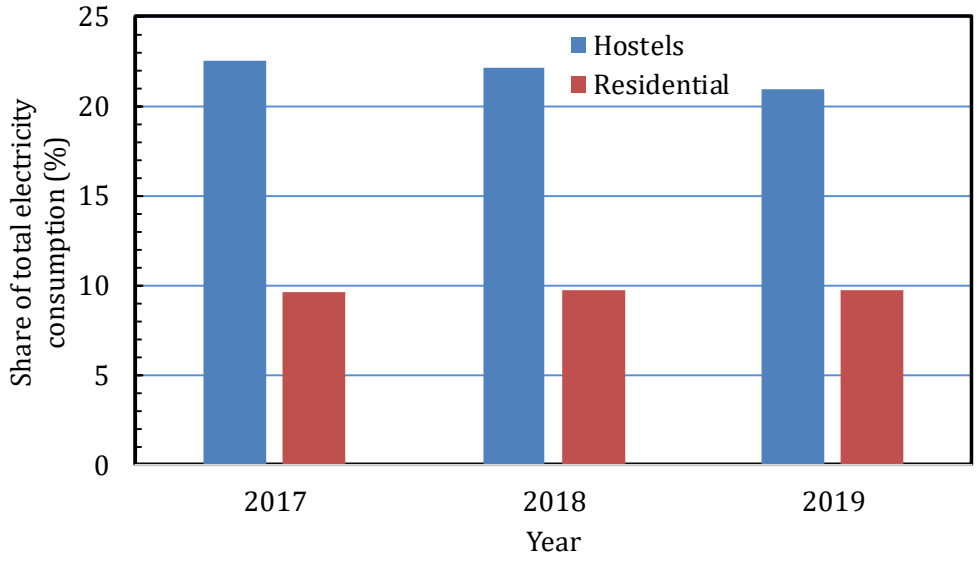


Fig 3 Share of electricity consumption in hostels and residential units

The University is committed to reducing utility electricity consumption by energy efficiency measures and integration of solar power plant generation with the existing infrastructure. Energy efficiency measures can be taken up in Air conditioners and lighting systems. Approximately 700 number standalone Air conditioners with various capacities are in operation within the University. Some of these systems are more than 10 years old and not 5 Star rating. It is recommended that all

these systems be replaced in a phased manner with efficient inverter base 5 Star rating Air-conditioner. The University is also in the process of replacing all existing lights with LED. It is recommended that all the street lighting systems, high mast lighting, and sports lighting systems be replaced with LED-based lighting systems. These measures will reduce a substantial amount of electricity consumption in the University.

Tezpur University installed a 1000 kWp rooftop grid-connected Solar PV Power Plant under the Solar Energy Corporation of India scheme for Government buildings under the Renewable Energy Service Company or RESCO model (Fig 4). The University made a consent agreement with the developer Arunachal Pradesh Power Corporation Private Limited in the month of October 2017 for the installation of the plant. The University made the power purchase agreement with the developer for a period of 25 years at a flat tariff of Rs 2.42/kWh in the month of February 2018. The installation of the plant was started in the month of March and made operational from the month of October 2018. The first installation was at the roof space of the Department of Energy and Community Hall. Vikram solar module of 325 watt-peak and SMA inverter of 50 KVA capacity are used in this plant. A total of 3077 modules and 20 inverters are used in the plant. The monthly average electricity generation from the plant is approximately 90,000 kWh and a total of 27,72,467 kWh of energy has been generated from the plant till April 2021 (Fig 5). The plant is installed on the roof spaces of 15 buildings, out of which in 11 buildings electricity consumption is met by the solar power plant generation. These buildings are known as Electricity Neutral Buildings. Solar power generation on average has replaced 24% of electricity requirement from the utility grid during this period. The generated power from the plant also feeds the utility grid, when demand at the campus was lower than generation. The excess power feed to the utility grid is 1.90 lakhs of units till March 2021. The University is purchasing electricity from Assam Power Distribution Company Limited at the rate of Rs 6.60/kWh, whereas the cost of electricity generated by the solar power plant is Rs 2.42/kWh only. The University is able to save Rs 113 lakhs in electricity bills due to this difference in electricity price till March 2021.

Tezpur University is the first Academic Institution to initiate the installation of Mega-Watt Scale rooftop grid-connected Solar Power plant in the entire North Eastern Region of the country. The electricity generated by the solar power plant also helps in mitigating a substantial amount of carbon dioxide emissions to the environment. The University in in the future shall continue to augment more solar power plants on the campus subject to favorable Government policy.

Fig 4 Solar power plant at University campus

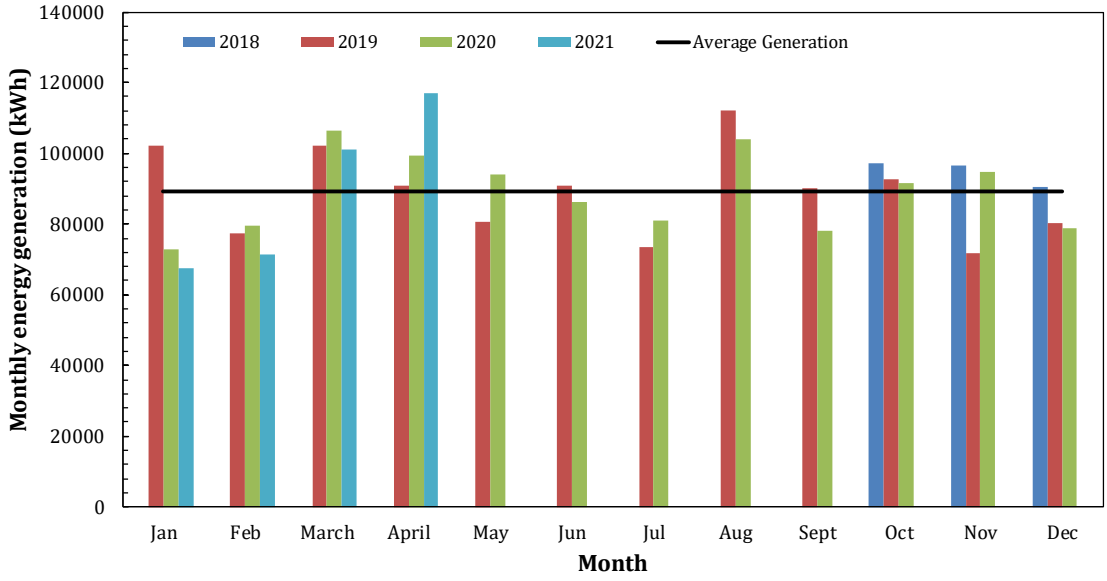


Fig 5 Monthly electricity generation from Solar power plant

Way forward

- To generate 40 % of the total electricity consumption in the University from renewable energy-based systems by 2030.
- To replace all old Air conditioners with energy-efficient inverter base technology with 5 Star rating in phased manner. All new Air conditioners should be 5 Star rating with inverter-base technology.
- To set the temperature of all air conditioners used in office rooms, auditorium, conference hall in the range of 24 -26 ^{0}C.

- To replace all existing metal halide lamps with LED base lamps in street lighting, high mast lighting and sports lighting.
- To replace the existing lighting systems with LED base lamps in Offices, Academic Departments and hostels in a phased manner.
- To promote 75 % of movement by bicycle and/or electric vehicle within the campus by 2030.

Theme II - Waste Management

(D C Baruah, Lead, S S Bhattacharya, Girindra Hazarika)

Waste management is an urgent environmental issue. The case is the same in Tezpur University campus as well. The University duly recognizes that sustainable waste management is indispensable for decreasing ecological vis-à-vis environmental footprints and for providing benign and dynamic work environment for all the inhabitants of the campus including visitors. The University is committed to ensure that all forms of wastes generated are handled based on the RRRR (Reduce, Reuse, Recycle, Recover) principles following appropriate source segregation protocols including safe disposal of bio, medical and hazardous wastes. There are studies time to time to estimate the amount and nature of wastes, particularly the solid waste which indicates the increasing trend of the volume. Daily rate of waste generation has been increasing in the recent time reaching up to an estimated amount of about 7 tons per day (tpd) during peak academic session and minimum amount generated during lean period is about 4 tpd. The wastes generated in the campus include (i) kitchen wastes, (ii) wastes from construction sites, (iii) liquid waste (residential and eateries), (iv) sewage and sludge, (v) biomedical waste, (vi) laboratory chemical wastes, (vi) plastic wastes, (vii) cans and bottles, (viii) damaged or spoiled laboratory glassware, (ix) unused tools and machinery including battery, (xi) papers including packaging materials (xii) electronics waste (xiii) garden leaves and (xiv) sweeping litters etc. Preliminary survey reveals the domination of biodegradable components (volume basis) over the non-biodegradable counterparts in the campus. The students' hostels share the highest amount of solid waste mostly dominated by food/kitchen wastes (substantial amount of papers, plastics, metals are also seen with waste also generated in hostels) followed by residential areas, eateries including shopping complex and offices including academic buildings, construction sites (occasionally), open areas including gardens and roads.

Sustainable Waste Management Plan

The University is in process to formulate Sustainable Waste Management Policy (SWMP) by consolidating various waste management plans and programmes of the University, though a futuristic, dynamic and objective oriented involving all stakeholders of the campus**.** The primary goal

of the policy is to provide clear cut direction for successful implementation of the specific actions concerning waste management (short term, medium term and long term) with true reflections of the national (National Environment Policy 2006) and international (Sustainable Development Goals) aspirations. The delivery of waste management services shall strictly follow the principles of the 'best environmental practice' and 'waste hierarchical approach'. Thus, the University is committed to reduce, reuse, recycle, and recover principles and discourage disposal of raw unsegregated waste materials to the environment. The policy shall emphasize prevention, minimization of waste, comprehensive management system, and use of cleaner technologies through realistic action plan(s). All forms of wastes (solid, and liquid) generated in the campus shall be managed and handled in accordance with the criteria and the procedure laid down in Municipal Solid Wastes (Management and Handling) Rules, 2016.

Work approach

(a) The waste segregation at source and promotion of reuse and recycling in preference to disposal of wastes and encouraging the waste-to-wealth conversion practices such as recycle paper, plastic or kitchen waste as business model.

(b) Adopting a course on 'Sustainable Waste Management' with components of "learning by doing" approach for students as general elective.

(c) Demonstration and awareness programs on best/innovative practices for the benefits of stakeholders.

The following scientific intervention on waste management practices are in place in the campus.

Food waste management

Anaerobic digestion (AD) process is one of the appropriate waste-to-energy conversion technologies that generates biogas. Food waste is considered as a potential AD feedstock because of its biodegradable nature and availability in the hostels of the University. The food waste mostly includes unconsumed food and food preparation leftovers. Anaerobic digestion of food waste has been an economically viable energy conversion route through production of biogas. The university comprises a total of 12 hostels, which generate a good amount of food waste per day. This food waste is used in AD plant in one of the hostel and rest of the waste used as fodder for piggery of the locality. The LPG consumption (number of cylinders) and waste generation of the hostels is presented in Fig 6. The average annual LPG cylinder consumption per boarder and annual waste generation per boarders are 2 cylinder and 87 kg respectively. The annual LPG cylinder consumption in the hostels of the University is approximately 6000 and annual food waste generation from the hostels is approximately 2,50,000 kg. Tezpur University considered the conversion of the food waste into

useful cooking gas (biogas) through anaerobic digestion and installed one 50 m^3 capacity plant in one of the hostel. The biogas plant is a Shakti Surabhi-type biogas digester developed for kitchen waste-based biogas production by Vivekananda Kendra – Natural Resources Development Project (VK-NARDEP), Kanyakumari, India. Fig 7 presents the various stages of the biogas plant installation in the hostel.

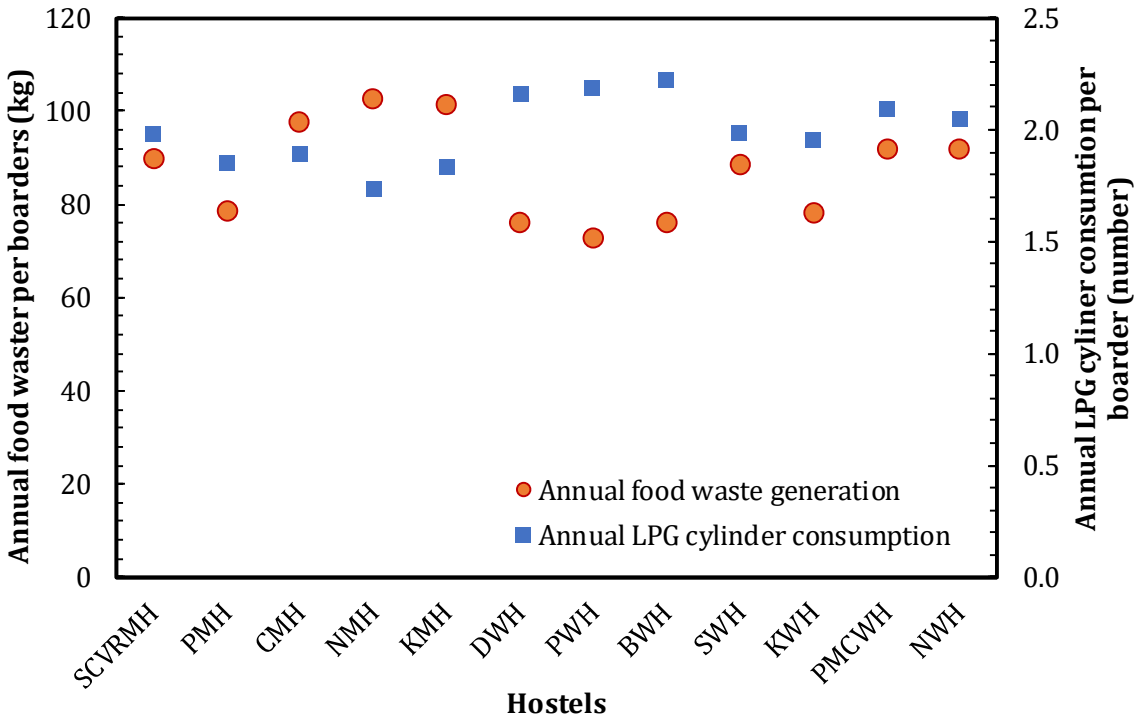


Fig 6 Annual food waste generation and LPG cylinder consumption per boarder

Biogas plant is fed with an amount of 85–90 kg of food waste daily. This is approximately 10 % of total food waste generated in the hostels of the University. The gas production is in the range of 0.2–0.5 m3/kg Total Solid of food waste. It is found during the experimentation stage that the maximum number of LPG cylinder of 14 that could be saved per month. University will install more food waste biogas systems in other hostel based on the performance of the system and user feedback in a phased manner.

Fig 7 Different stages of the construction of the biogas plant

Vermicomposting

Vermicomposting technology relies upon the conjoint action of earthworms and microorganisms to rapidly transform varied types of solid wastes. Considering the simplicity and flexibility of the technology a vermicomposting unit was established in January 2009 in the University under the supervision of Horticulture Section (Fig 8). The prime objectives are to recycle biodegradable waste fractions in a sustainable manner and curtail the cost of purchasing organic manure from market for landscaping ventures. Presently, the unit is running successfully to fulfill the need of organic manure for plantation/gardening works of the University. So far, the ready-to-use vermicompost is produced entirely from garden waste (grass) and leaf litters of the campus. The unit has waste accommodating capacity of about 16.5 m^3, i.e., about 10 quintals (on fresh weight basis) at a given time. On an average, one vermicomposting period (or one batch) takes about 60-90 days depending on the nature of feedstock. Epegeic earthworm species (*Eisenia fetida*, *Eudrilus eugeniae,* and *Perionyx excavatus*) are applied at a rate of 10 worms/kg (approximately) feedstock to carry out the composting process. Approximately 126 quintal vermicompost has been produced in the last five years. The annual production rate is increasing by 3-4 quintal in the stated period. Presently, the cost of production is about Rs. 15/kg only. Approximately 33 quintal vermicompost was produced in the last year and it is used for all sorts of landscaping activities at the University. The total cost of

production was approximately Rs. 49,500/- only. This save about Rs. 25,000/- that was otherwise required in excess to purchase low quality traditional organic manure in larger amount (i.e., 50 quintal) to compensate the benefit of vermicompost application in regard to soil health, productivity, and product quality. The unit is ready for expansion to accommodate various other kinds of bio-degradable solid wastes generated in the University.

Collection of leaf litters

Pre-composting

Processing

Final product

Fig 8 Different stages of vermicomposting process

Bio-waste management

Bio-waste management plant or Bio-incinerator is installed at the University in the year 2017 for scientific management of biohazard generated in the laboratories of academic departments, biomedical waste generated in the University Health Centre and sanitary napkins from Women's hostel (Fig 9). The plant capacity is 25 kg/h and it is an oil fired incinerator. The stack height is 30 m. The plant is operated weekly once based on waste generation and the operation is supervised by the trained faculty members of the Department of Molecular Biology and Biotechnology. The various types of bio-waste generated in the departments such as microbial culture, cell culture media, biological samples like unused blood, plasma, microbes, recombinant DNA waste, recombinant protein waste, cell culture waste, agarose gel waste, SDS-PAGE waste etc. are incinerated in the plant.

Ash generated after incineration is collected at regular intervals and stored in the facility for disposal at Municipality waste dumping site, Tezpur.


Fig 9 Bio waste management facility

Way forward

- To promote the conversion of waste to useful products/process by using available technological solutions
- To adopt holistic approach of waste management in the campus for achieving the goal for 100 % sustainable management of waste before disposal by 2030
- To ensure entire community to participation in the sustainable waste management programme to fulfill the goal of Zero Waste Campus (ZWC) by 2030

Theme III - WATER

(Kamal Uddin Ahmed, Lead, R K Dutta, Jayanta D Bharali, Ratul Ranjan Hazarika)

PART A: Rain Water Harvesting

Water is essential to all forms of life and 70 % of the world is covered with water while only 3 % is fresh and the rest is saline. Only about 0.4 % of the freshwater is easily accessible, while the rest 2.6 % is inaccessible. As water is becoming scarce, there is need to attain self-sufficiency as well as replenish the depleted and polluted ground water sources and water harvesting is one of the innovative and low cost technologies to achieve the same. Water harvesting is the capture and storage of water for beneficial reuse. The use of water should be within the capacity of nature to replenish and sustain. A low cost water harvesting method is the 'Rain Water Harvesting'. Rain water harvesting involves the direct collection of rainwater which can be stored for direct use or can be

used to replenish the ground water sources. The process involves collecting the runoff and using it for beneficial and productive purposes. Rain is one of the primary source of water for us and is the first form of water in the hydrological cycle. The artificial recharge to ground water is a process by which the ground water reservoir is augmented at a rate exceeding that obtained under natural conditions of replenishment.

A rainwater harvesting system would include a harvest source (rain), a collection system, initial treatment for harvested water, storage system, delivery system and a final treatment depending upon the intended use of the water. Some of the benefits of Rainwater Harvesting are (i) environment friendly and low cost method for obtaining fresh water, (ii) helps to increase ground water level, (iii) mitigates the effects of drought and (iv) reduces the runoff, reducing the load on storm water system. The population of Tezpur University has witnessed a year on year growth. The present infrastructure of 2 water treatment plant is catering to the existing population but there is an urgent need to augment the system. Rain water harvesting is an ideal method to supply fresh water for augmenting the existing infrastructure and is capable of meeting future needs in a sustainable way.

A rain water harvesting system typically consists of three elements i.e. (i) collection system or catchment area, (ii) conveyance system and (iii) storage and recharge system. The RWH system has to be designed and installed to capture and store maximum possible rainfall by covering maximum catchment area. The storage area should be connected to network of storm drains wherever possible. Catchment areas is the first point of contact of rainfall where surface water from rain gets collected, drains towards the common outlet and joins storage tanks, recharge pits, reservoirs etc. Potential catchment areas are roof top of all buildings including academic, administrative, hostels, indoor stadium, hospital, schools etc. also from lawns and gardens area. Separate storm water drain should be created to capture the storm water mainly from the rainfall from the catchment areas. It has to be ensured that the sewage water does not seep into storm water drain resulting into contamination of storm water. Periodic maintenance of RWH system is mandatory to ensure its functionality resulting into availability of good collected rain water both in terms of quality and quantity.

The policy regarding rainwater harvesting is applicable to all the buildings including academic departments, administration, health center, hostels, guest house, indoor stadium etc. within the

University campus. The water collected from rain water harvesting (RWH) system shall be used as a secondary source of water and will be used for all other purposes like gardening, cleaning, car washing which does not require drinking water quality.

PART B: Low Cost Drinking Water Treatment

The major concern in the groundwater of the University is the presence of iron in the range of 5-8 mg/L. The groundwater of the University does not contain any other pollutants of concern like fluoride or arsenic, therefore, no special treatment unit is required in the water treatment plant and water from the treatment plant can be directly used to meet the domestic needs. However, groundwater in few places in Assam has a problem of dissolved fluoride and arsenic. University can take up those places and may installed suitable low-cost filtration units, which are developed by the university faculty /research scholars during their research work (Fig 10).

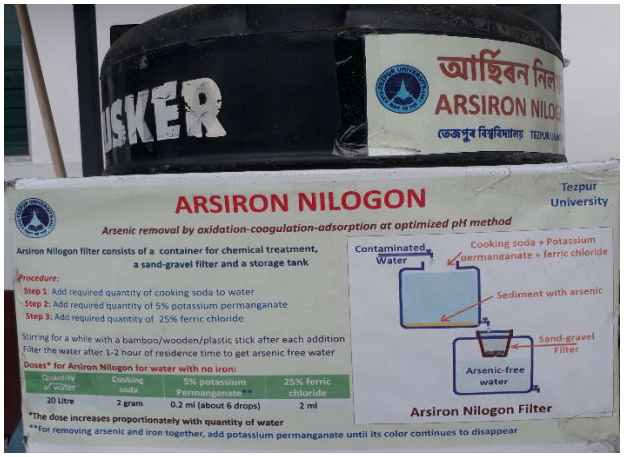


Fig 10 Low cost drinking water tretement facility

PART C: Waste Water Recycling

Environment management in urban and semi urban areas with a high density of population is one the big challenges globally. The water after usage becomes dirty and is discharged out of the household as wastewater. The waste water is filled with dirt and various pollutants and cannot be reused without proper treatment. The cleaning process of the waste water and making it fit for direct or indirect usage is known as waste water recycling. Waste water is of two types i.e. grey water and black water. Grey water is the waste water from the households without the faecal matter or faecal contamination and black water is the waste water from toilets, primarily from flush tanks contaminated with faecal matter. Grey water contributes to 90% of the waste water from a house and is easier to treat while it is harder to recycle black water as it contains more pathogens. The

present infrastructure in the University to treat waste water consist of separate standalone R.C.C septic tanks at each of the establishment like, hostel, academic building, administrative building etc. to treat the black water coming out of the toilets while the greywater is discharged into drains which then discharge the same in the nearby lakes. University at present lacks a proper sewage treatment plant, and the excess water from the septic tanks are allowed to meet ground water after passing through the soak pit. As such for holistic growth and sustainable development, there is an urgent need for a sewage treatment plant which will help maintain the ecological environment in the university.

Way forward

- To promote the installation and periodic maintenance/monitoring of Rain Water Harvesting system in all possible locations/buildings of the University.
- To install sewage treatment plant in the campus to treat the wastewater generated from hostels, residential units etc.
- To promote and install low cost drinking water treatment plants in places where dissolved fluoride and arsenic are present in Assam as an outreach activity.

Theme IV - Natural Eco-system

(Ashalata Devi, Lead, Satya S Bhattacharya, Girindra Hazarka)

The Tezpur University campus located at Napaam, near Tezpur city (26º69′N and 92º83′E) in the Sonitpur district of Assam covers an area of 262 acres (approximately 1060277 sq. m) lying 73 m above mean sea level. The area falls under sub-tropical region and is enriched with ecologically diverse habitats of natural vegetation patches, grassland and water bodies having wide range of biodiversity besides building area. The campus has been the suitable habitat for woody flora as well as dense patches of herbaceous plants including climber and grasses that provides natural habitats for birds, butterflies, insects and snakes. The campus has undergone multiple alternations since its inception. The Sustainable initiative of the University was started as and when a Landscaping Committee was constituted in 1995. There were transformation and redeemed of certain natural vegetation patches for requisite infrastructure development to facilitate the emerging needs for the growth of the university. However, spaces for academic, administrative and recreational areas are delineated in harmony with the landscape to ensure an eco-friendly campus. Horticulture section of the University is looking after the whole green/ sustainable/ horticultural/ landscaping activities within the University campus under the supervision of a Campus Horticultural Committee. This committee member develops strategies for smooth execution of plantation, maintenance and overall protection of the landscape. Therefore, greenery of the large area in the campus is well maintained

besides keeping remnants of the natural vegetation patches undisturbed. There are block plantation, plantations along roads side, garden space of departmental building premises, and along the residential compounds, while several tree species regenerated naturally and there are seasonal herbaceous plants that cover the whole natural landscapes. Several indigenous trees, shrubs and ornamental plants are carefully selected for the plantation to provide shelter for birds and to deliver a shaded walkway. The objectives of the theme natural eco-system protection and preservation at the campus are following.

- To ensure protection of biodiversity (flora and fauna) by reducing destruction of natural habitats and restoring through plantation.
- To encourage green, healthy and eco-friendly environment and support preservation of natural habitats for safeguarding wildlife.

There are around 100 different tree species consisting of evergreen, semi-evergreen and deciduous trees such as Simolu/Silk Cotton (*Bombax ceiba*), Jagya Dimoru/Cluster Fig (*Ficus glomerata),* Japong/Jamaican nettletree (*Trema micrantha*), Kuhir/Spinous Kino (*Bridelia retusa),* Dimoru/Jongiya Dimoru/Hairy Fig (*Ficus hispida)*, Soalu (*Litsea monopetala*), Udal/Elephant Rope (*Sterculia villosa*) found in natural vegetation patches along the roadsides. Fruits trees like, Jamun (*Syzygium cumini*), Mango (*Mangifera indica*), Olive (*Elaeocarpus floribundus*), Jackfruit (*Artocarpus heterophyllus*), Amla (*Emblica officinalis*), Bel/Wood Apple (*Aegle marmelos*), Black Myrobalan / Silikha (*Terminalia chebula)*, Guava (*Psidium guajava*), Litchi (*Litchi chinensis*), Amora/Indian hog plum (*Spondius pinnata*), Carambola (*Averrhoa carambola*), *Ber* (*Zizyphus mauritiana*), Guljamun (*Syzygium jambos*) Autenga/ Elephant apple (*Dillenia indica*), Leteku / Burmese grape (*Baccaurea sapida*), *Tamarind (Tamarindus indica*)**,** etc. are abundant within the campus. Occurrence of avenue trees like Nahar/Ironwood (*Mesua ferrea*), Bakul/Spanish cherry (*Mimusops elengi*), Kanchan/ Orchid Tree (*Bauhinia purpurea, Bauhinia variegata*) Radhacura/Pink Cassia (*Cassia javanica*), Bilati siris/Rain Tree (*Albizia saman*), Krishnachura/Gulmohar (*Delonix regia)*, Ajar/Queen of Flowers (*Lagerstroemia speciosa*), Copperpod/Rustry Shield Bearer (*Peltophorum pterocarpum*), Weeping Fig (*Ficus benjamina*), Neem (*Azadirachta indica*) and Sonaru/ Golden Shower (*Cassia fistula*) along with the native fruit bearing trees provide food resources and shelter to a number of birds. A few of the gymnosperm like *Juniperus chinensis***,** *Thuja orientalis, Cycas revoluta* and *Araucaria excelsa* also add to the scenic landscape. *The c*ampus also grows timber valued tress like Sisu*/ Indian rosew*ood (*Dalbergia sissoo),* Tita-sopa (*Michelia champaca*), Segun/Teak (*Tectona grandis*), Gomari/Beechwood (*Gmelina areborea*), Hollock/East Indian Almond (*Terminalia myricarpa*), Bonsom (*Phoebe goalparensis*) and Agarwood/Sasi (*Aquilaria malaccensis*). Several ornamental

shrubs like Gandhraj (*Gardenia jasminoides*), Ixora (*Ixora coccinea*), Crape Myrtle (*Lagerstroemia indica*), Croton (*Codiaeum variegatum*) Joba (*Hibiscus rosa-sinensis*), Kathana (*Tabernaemontana divaricata*), Mussaenda (*Mussaenda erythrophylla*), Nerium (*Nerium oleander*), Copperleaf (*Acalypha wilkesiana*), Tecoma/Yellow trumpetbush (*Tecoma stans*), Rose (*Rosa spp*.) Bougainvillea (*Bougainvillea spp*.) and Night blooming jasmine (*Cestrum nocturnum*) are planted in different sites especially in and around the building for campus aesthetic and greenery. More than 55 varieties of birds and 72 varieties of butterflies are recorded from different habitats from within the campus. Presence of large number of butterflies and birds indicates healthy ecological system and sheltered areas for their orientation or basking. All these qualities of green environment and species rich habitats will bring a positive impact on our health and wellbeing. This vast natural setting of green campus indeed bestows a visual treat and gesture of eco-friendly culture unique to Tezpur University.

The main natural vegetation observed at campus are grasses, scrubs and trees comprising of members predominantly belonging to the families *Poaceae, Fabaceae, Rutaceae, Mimosaceae, Leguminoceae, Apocynaceae, Rubiaceae, Thymelaeaceae, Moraceae, Asteraceae, Euphorbiaceae, Verbenaceae, Solanaceae, Convolvulaceae* and *Amaranthaceae*. Sacred Fig/ Peepal tree (*Ficus religiosa*), Banyan tree (*Ficus benghalensis*) and Jagya Dimoru (*Ficus glomerata*) and Simolu/Silk Cotton (*Bombax ceiba*) growing in the campus are the keystone species which attracts numbers of birds and insects. However, the major constituents of the flora of the campus comprises of several herbaceous species that grows naturally in each season and forms the undergrowth vegetation. Therefore, temporal monitoring and documentation of the flora and fauna will help to understand the seasonal changes and any disturbances, and formulating strategies to protect bio-diversity of the campus.

There are water bodies fed by rainfall and artificial recharging which also serve as habitat for number of wild and semi-wild water birds such as egrets, whistling ducks or tree ducks, white-breasted waterhen, snake neck water birds and others. These water bodies along with the associated plants in the surrounding areas are also home to dragonflies, butterflies and semi-aquatic rodent. However, there is an apprehension about the water quality which need to be analyzed seasonally and take necessary measures to taken to make the habitat more hospitable for diverse aquatic life. About 950 house plant pots with indoor plants are managed in interior spaces of academic and

administrative buildings office and other amenity centers for beautification, greenery and purifying air.

Towards the sustainable land use practice, a total of 24,978 numbers of different plants have been planted in various sites within the campus in the last 2 decades. The University has also maintained two 'Citrus gardens' and a botanical garden having an area of 13,125 sq. m. The botanical garden has an orchid house and a fern house beside having number of trees, shrubs, climbers, herbs and bamboos. There are medicinal plants, timber plants, fruit bearing plants, sacred plants and RET (Rare, Endangered and Threatened) plants species. Further plantation of Mosambi, Dragon fruit, Arecanut, Betelvine and Peeper is under progress in possible sites for revenue generation and maintain the landscape.

Work approach

Use of compost, generated in-house serve as a cost-effective and nature-friendly management of plantation, along with regular watering and cleaning help the plants to grow fast and luxuriantly. Maintenance of all existing planted trees along roadside, lawn, hedge and other plantation sites other than botanical garden area was done appropriately. Growing of seasonal flowers on all the flower gardens will be continued regularly in addition to the essential maintenance work. Pruning and trimming of tree branches help the trees in maintaining optimal health. Collection and removal of plant litters like dead leaves, fallen fruits and other parts of the plants are done at regular interval to maintain a healthy habitat. Fallen woods and grasses are also collected by the local people from the nearby villages of the campus for their firewood and fodder. These activities directly or indirectly control the seasonal outgrowth of herbs and remove plants litters while fulfilling their needs. A departmental nursery is also maintained inside the University campus from where seedlings of different avenue/ornamental /fruit trees, shrubs, indoor plants and seedlings of seasonal flowers were produced for plantation within and outside the University campus. Towards the green initiatives, seedlings raised in the nursery are distributed and planted within the campus and the University also promotes plantations in nearby villages and school campuses. The Departmental nursery has raised seedlings of different plant species like Arjun, Agarwood, Champak, Rain tree, Ritha tree, Butterfly tree, Indian Coral Tree, Golden Shower Tree, Pink Shower Tree, Rusty Shield Bearer, Pongam Tree, Litchi, Aonla, Olive, Black Myrobalan, Tamarind, Pomegranate, Rose apple, Guava, Burmese grape, Passion fruit, Agati, Mussaenda, Nerium etc.

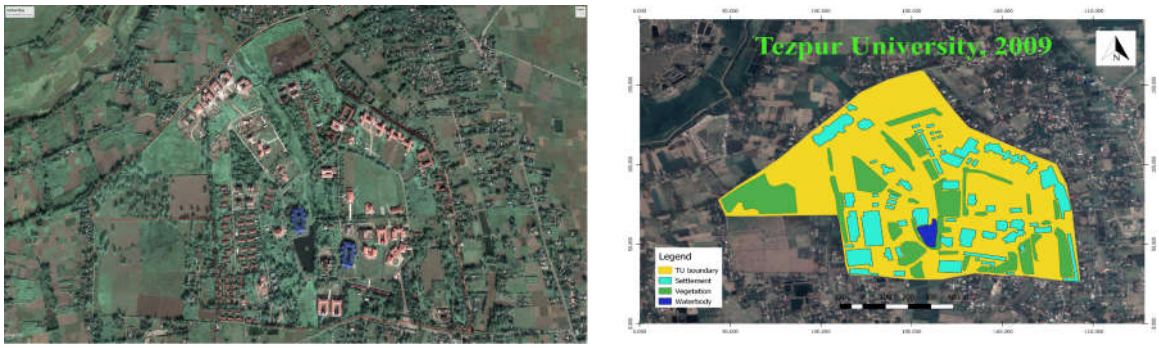
Stakeholder responsibility

Strategic initiatives have always been taken to ensure green coverage, sustain healthy ecosystem and eco-friendly campus without compromising the infrastructure development. The University takes proactive role in shaping the green environment in line with the plantation of several tree species while maintaining the existing natural vegetation patches. Hence, several plantation drive have been undertaken with active participation of students, faculty and staff within the university campus. Every year on 5th June, the Department of Environmental Science in collaboration with 'Horticulture Section' plants trees to celebrate the World Environment Day. Though certain portion of the campus is with concretized but there is still enough land covered by vegetation patches harboring a number of birds and butterflies, fresh air to breathe under the green shade which gives a unique campus environment. The patches of habitat dominated by trees is also showing increasing trend due to concerted efforts of plantation and maintenance enriching the beauty of the campus. Appropriate efforts are in place to make the campus a "green and eco-friendly" space to highlight the ecological significance of green coverage and to ensure quality of life for the campus dwellers and safeguarding the biodiversity. The overall elements of the campus speak about the morale of the University campus aiming at maintaining and protecting natural resources and increasing their resources through greening the various sites with trees. Table 2 and Fig 11 presents the visualization of University Campus Settlement from 2003-2020 through GIS based analysis.

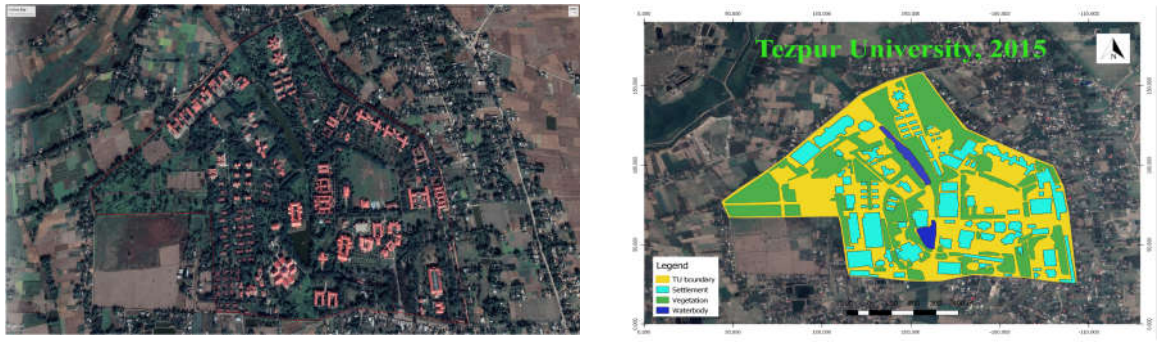
Table 2 Vegetation cover area within the University campus

Vegetation cover area (Sq.m)	**Year**			
	2003	2009	2015	2020
	161664	199837	347816	383721
Vegetation cover of total campus area (%)	15.2	18.8	32.8	36.2
Vegetation cover increase	**Sq. m**	38173 (2003-2009)	147979 (2009-2015)	35905 (2015-2020)
	%	23.6 (2003-2009)	74.0 (2009-2015)	10.3 (2015-2020)

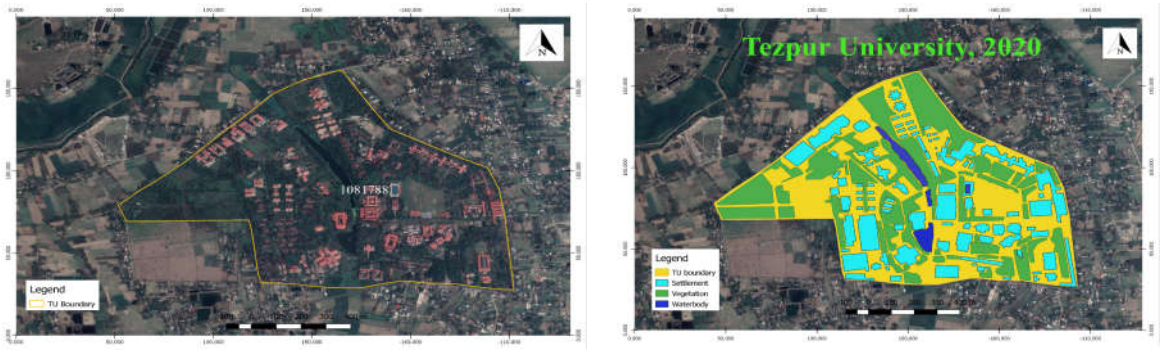
2003



2009



2015



2020

Fig 11 Vegetation cover during 2003-2020 period

Way forward

- At least 40 % green coverage in the University campus by 2030 to improve the environmental quality and reduce carbon footprint within the campus.
- Floristic survey will be done prior to construction work, once an area is earmarked for the new building, and necessary measures will be implemented to protect and conserve the important species.
- Indigenous trees and shrubs suitable for birds (like, Jamun, Bishop Wood, Ivory wood tree, Kadam tree, Bakul tree, Askok tree) will be chosen for plantation to replenish any lost and to provide shelter and food resources for wildlife.
- Documentation of flora and fauna in the campus and formulating measures for protection of biodiversity.
- Biological record of the campus will be hosted at the University Website. This will help students and local community to get involved with the university fraternity in biological recording and become a '***citizen scientist***' and campus shall be developed as a '***living laboratory'*** for education and research.

Theme V - Sustainable Buildings

(Debraj B Sonowal, Lead, Sadhan Mahapatra, Ratul Ranjan Hazarka)

Sustainable buildings or Green buildings are environmentally responsible, resource-efficient throughout the lifecycle of the buildings from design, construction, operation, maintenance, renovation, and demolition. This type of buildings built on principles of ecological sustainability, is one that uses less water, optimizes energy efficiency, conserves natural resources, generates less waste, and provides healthier spaces for occupants, as compared to a conventional building. It focuses on (a) efficient utilization of resources – energy, water, and building materials (b) protection of occupant's health (improved air quality) and enhancement of employee productivity (use of daylight and natural ventilation) and (c) reducing waste and environmental degradation as compared to a conventional building. Emphasis is on in energy efficiency and water conservation techniques, use of recycled waste products (Fly ash based building elements) by adopting an integrated design approach for reducing the operation and maintenance costs over the building life cycle. The design aspects of a green building are looked into in an integrated way from site planning, building envelope design, building systems design like HVAC, lighting etc., integration of renewable energy sources to generate energy on-site, and waste management.

Green buildings consume 40 - 60% (depending on the range of measures adopted) lesser electricity as compared to conventional buildings. This is primarily because they rely on solar passive architectural interventions in the building design and technologies in the engineering design of the building. Green Buildings also attempt to work towards on-site energy generation through renewable energy utilization to cater to its energy needs. For instance, solar thermal systems can help generate hot water and replace the conventional electrical geyser in buildings. Solar PV plants can help generate electricity which can reduce the building's dependence on grid power. Green buildings consume 40% to 80% (depending on the range of measures adopted) lesser water as compared to conventional buildings. By utilizing ultra-low-flow fixtures, dual plumbing systems, waste-water recycling systems and rain-water harvesting, green buildings not only reduce their demand for water use but also look at on-site supply options to cater to its internal and external water demands. Green buildings generate lesser waste by employing waste management strategies on site. All of these can be achieved at a minimal incremental cost with an estimated payback period of about 3-5 years. In recent years, some major buildings constructed in the country have adopted green features. These include the CII- Godrej Green Business Centre, Hyderabad; TERI's Retreat Building, Gul Pahari, Gurgaon; Laboratory Building IIT Kanpur; ITC Green Centre, Gurgaon; Wipro House, Gurgaon; and Transport Corporation of India Ltd, Gurgaon. These may be considered as reference for the University in its future project design.

Building rating systems

Buildings are assessed based on energy efficiency and sustainability by various rating systems. Leadership in Energy and Environmental Design (LEED) and Green Rating for Integrated Habitat Assessment (GRIHA) are the two most popular building rating systems in India. LEED rating system was developed in the USA and LEED-INDIA version based on LEED rating system developed by Indian Green Building Council (IGBC). The rating system is divided into five key areas such as sustainable site development, water savings, energy efficiency, materials selection, and indoor environment quality. The buildings are rated as certified Level to platinum Level depending on the points achieved on those parameters. GRIHA rating system was developed in 2005 by The Energy & Resources Institute (TERI) based at Gurgaon. The rating system is divided into three key areas such as site selection and planning, building design, planning and construction and building operation and maintenance. The building is rated from one star to five stars depending on performance under these parameters. The green buildings involve additional initial costs but over the life cycle these buildings turn out to be more economical. Besides, from the environmental and social consideration, it is desirable to go for green buildings. It is not necessary to incorporate all green features in each

building. Even if some of the green features are incorporated in individual buildings considerable benefit would accrue for the occupant and the environment.

Net Zero Energy Building

A net Zero Energy Building (nZEB) or Zero Energy Building (ZEB) is a building with net-zero energy consumption, meaning the total amount of energy used by the building on an annual basis is equal to the amount of renewable energy base system generated energy on the site. The goal is that these buildings contribute less overall greenhouse gas to the atmosphere during operations than similar non-nZEB buildings. They do at times consume non-renewable energy and produce greenhouse gases, but at other times reduce energy consumption and greenhouse gas production elsewhere by the same amount. The nZEB buildings at the University are (a) Department of Energy (b) Academic Buildings II (c) Department of Chemical Sciences (d) Students Activity Center (e) Library buildings and (f) Department of Environmental Science. In all these buildings' energy consumption is met by the solar power plant generation.

Way forward

- Promotes low energy intensive building materials and introduction of green building design aspects in the new building construction
- Promotes net Zero Energy Buildings (nZEB) and at least one building should be with GRIHA or LEED rating by 2030.

Sustainable Campus Initiatives Policy document clearly identified the thematic areas and way forward to make the University campus a sustainable campus by the year 2030. This policy document provides a holistic approach to make the University campus a sustainable campus. Each thematic area identified the way forwards, which shall be guiding principles for the future course of activities and action.

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