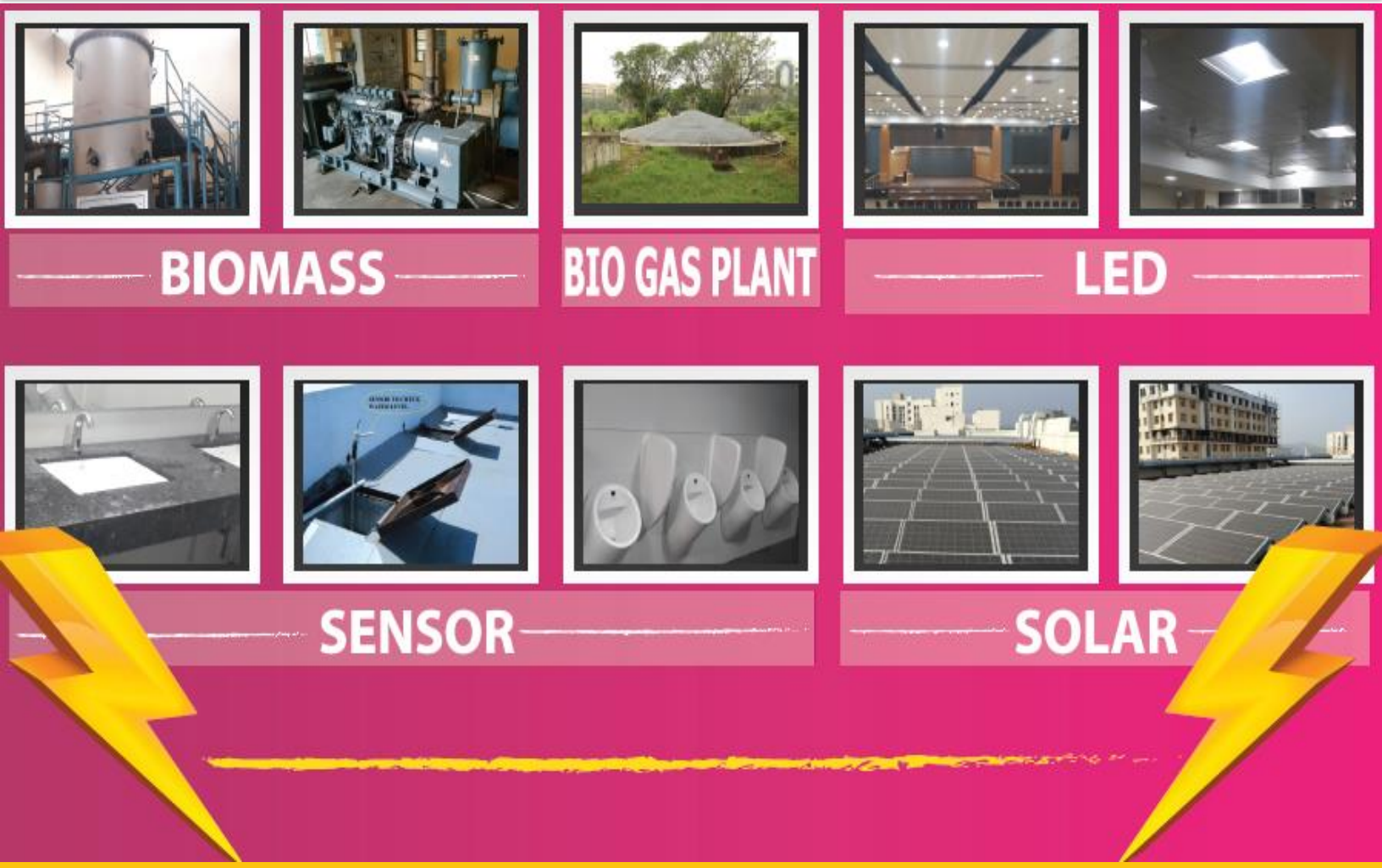
VIT®
Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

SDG-07 Annual Report 2019-20

7 AFFORDABLE AND CLEAN ENERGY

Ensure access to affordable, reliable, sustainable and modern energy for all



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Report of VIT-Vellore Campus

Preamble

Renewable energy solutions are becoming cheaper, more reliable and more efficient every day. Our current reliance on fossil fuels is unsustainable and harmful to the planet, which is why we have to change the way we produce and consume energy. Implementing these new energy solutions as fast as possible is essential to counter climate change, one of the biggest threats to our own survival.

Vellore Institute of Technology (VIT) has facilities for alternate sources of energy and energy conservation measures like

- Solar energy
- Biogas plant
- Wheeling to the Grid
- Sensor-based energy conservation
- Use of LED bulbs
- Energy efficient ceiling fan used in all new and renovated buildings
- 5 star rated energy efficient pumps
- Radiant surface cooling system to reduce HVAC load
- Energy efficient data center
- Centralized chiller plant

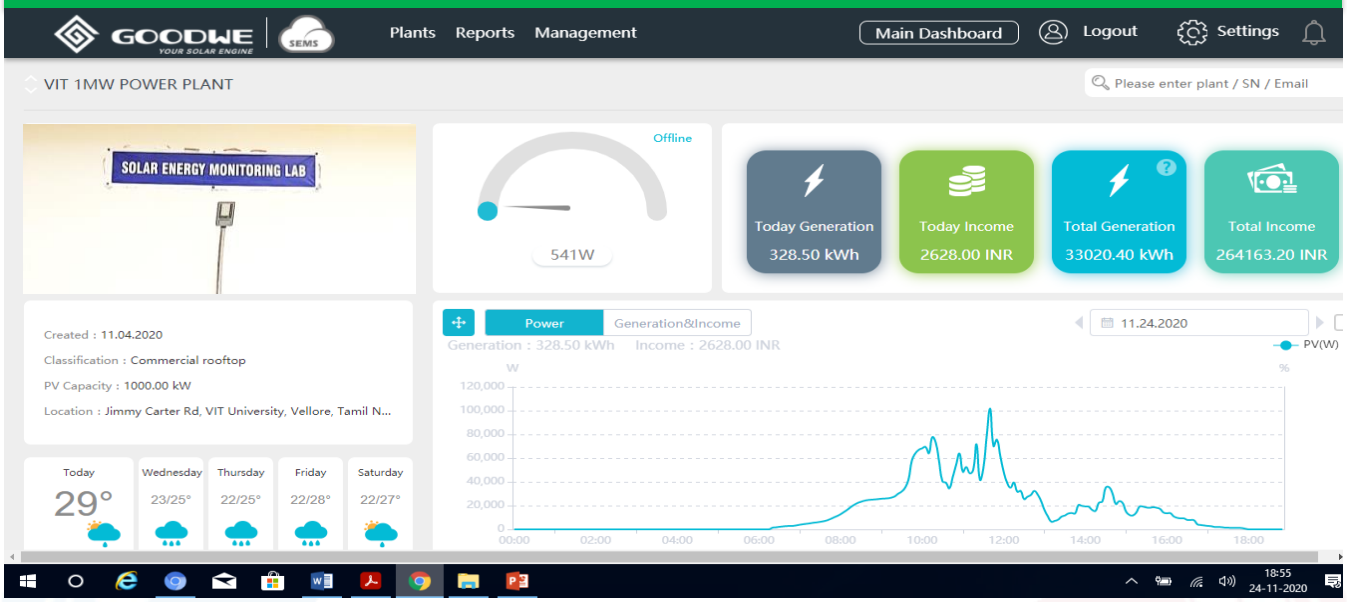
I. Installation of solar projects

In the year of 2003, 8.25 kW Solar panels were installed at a cost of INR 5 million, fully funded by VIT. In 2015, a 500 kW which can produce approximately 2500 units daily was set up. Another 625 kW of rooftop solar PV was installed in 2018 September. Recently, November

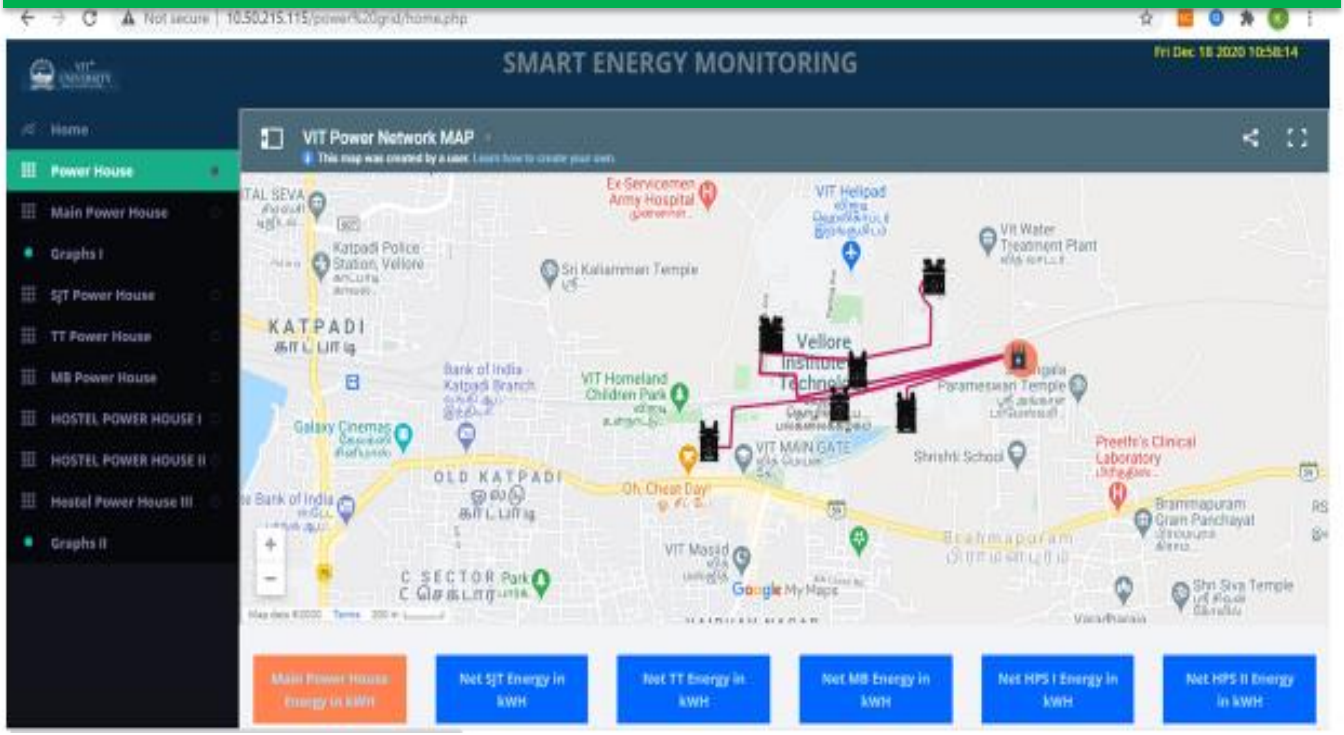
2020, VIT also established 1000 kW of rooftop solar PV system with remote energy monitoring facility ie. solar energy monitoring lab. 90 Lakhs units of wind power is purchased per annum through third party power purchase agreement. A fully operational 10 kW solar dish Stirling engine power plant (INR 8 million), which is recognized as the most efficient technology, was imported from Germany. The working gas is either Helium or Hydrogen. A 80000 litre solar water heater installed in the academic and Hostel campus meets the pre-heated water demand on campus. Most of the hostel buildings are equipped with solar water heaters. Heat pump based water heating system is used in the recently built hostels with 80000 liters capacity per day. The undergraduate students of VIT, in association with the University of Strathclyde, United Kingdom, have installed an off-grid photovoltaic (PV) solar system in a community college near VIT.

Roof top Solar panels

Solar PV Generation Online Monitoring



Online Energy Monitoring



II. Centralized Chiller Plant of 5500 Tons of refrigeration

In hostels and academic blocks 85 % of split and windows ACs are replaced by centralized chiller water based cooling for the rooms, meeting halls, laboratories and auditoriums from 2019. This unit consumes only 55 % electrical energy when compared to conventional ACs. This is another milestone at VIT in terms of energy saving measures.

Chiller system

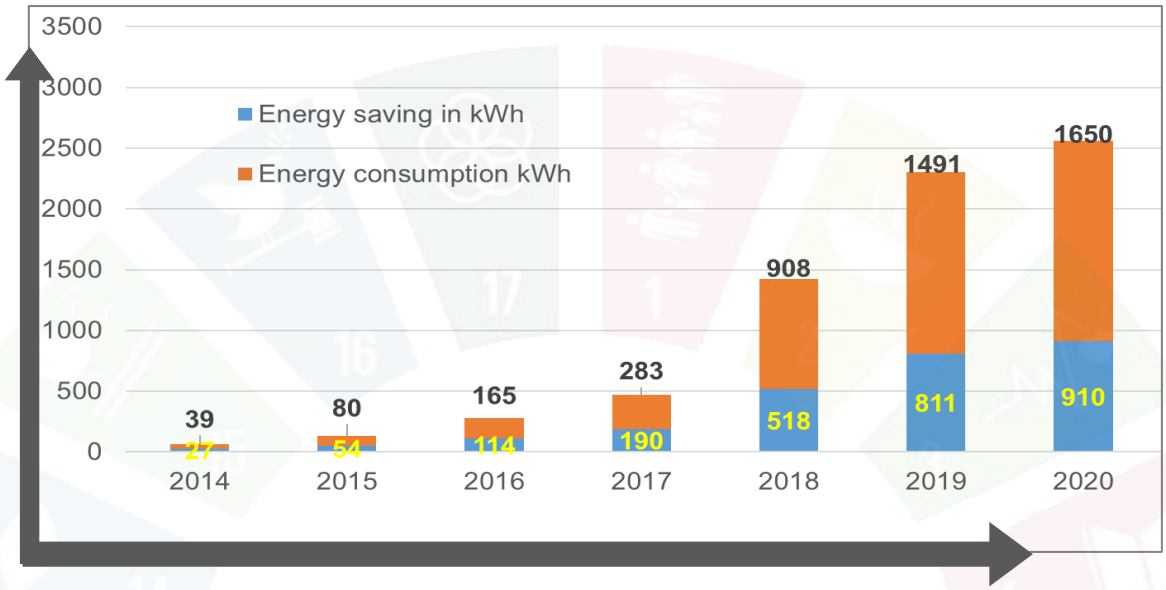
Energy, emission and social cost of carbon savings

Savings (in one-year)	
Energy (kWh)	43,95,349
Emission (kg of CO_2)	63,03,778
Operating cost (Rs.)	3,53,82,558
Social cost of carbon (Rs.)	4,02,79,880

III. Replacement of conventional lightings with LEDs

All the newly constructed hostel blocks are installed with 10 W LED lamps and the hostel toilets and corridors are installed with 20 W and 15 W LED lamps respectively. A few of the washrooms/ restrooms in the academic buildings are equipped with occupancy sensor based

LED lights. All the streetlights and pathways lights are replaced with 80 W LED of lesser wattage (1/5 of conventional) when compared to conventional light sources like metal halide and sodium vapour lamps of 400 W.



Biodiesel heavy vehicles and solar powered cars in campus since 2012, buses operating within the campus are powered with 30% biodiesel. These vehicles have covered more than 60,000 km without any breakdown. A Laboratory model glass unit produces the biodiesel. At present, Pongamia and Jatropha oil are used for biodiesel production. Works are in progress to use Sterculia and Vilosa seeds too. Apart from the seeds, even the use of kitchen waste for biodiesel production has become a thrust area of research.

A solar powered (255W x 4 solar panels) 12 seater car equipped with a pair of 3.7 kW DC motor, christened as the 'Green Energy Vehicle', is fully operational (nearly 8 hours a day) during the working hours.

As a part of the energy awareness and conservation programme, VIT hosts numerous workshops and training sessions on a regular basis. Energy Conservation week is a regular practice in line with Energy conservation day- December 14. During this week 3rd and 4th days were observed as 'No Air Conditioner' and 'No Automobile' days of the VIT campus respectively.

ASME's International Human Powered Vehicle Challenge with more than 400 participants provided an opportunity for the students to develop practical and sustainable modes of transportation.

Link: https://vit.ac.in/about/Sustainability/EnergyConservationProgramme

IV. Radiant surface cooling system

VIT developed innovative cooling system, energy efficient solution for the educational building. Also, to promote advancement in building thermal comfort, district energy system in accordance with India cooling action plan (ICAP).

1. Radiant cooling with indirect Evaporative Cooling for open classrooms and the corridors.
2. Radiant cooling with chiller system for seminar halls, laboratory and closed classrooms.

Innovative cooling system

V. Promoting sustainable practices

VIT has established the CO2 Research and Green Technologies Centre, which is a unique and advanced research laboratory, to carry out research on Carbon Capturing (better)-and Utilization – CCU, whereas many other leading research institutions are concentrating on Carbon Capturing and Storage – CCS. The centre was inaugurated on 15th Feb 2010 by Dr. Farooq Abdullah, Hon'ble Minister for New and Renewable Energy (MNRE) Govt. of India.

The green facade drape subway walls are yet another unique feature in VIT. They absorb the entire atmospheric pollutants spewed by the vehicular emissions.

The on-going research activities on these green drapes have proved their atmospheric cleansing capability. A physical green drape on high-rise buildings can save considerable amount of building's annual energy consumption. The green drapes can serve as excellent acoustic dampers too.

The School of Electrical Engineering (SELECT), in association with the School of Electronics Engineering (SENSE), has developed low cost energy efficient systems, in particular, energy efficient light automation devices, which are fully functional in some of the new laboratories and hostels.

a. Biomass Power plant

VIT has installed a biomass based power plant of 96 kW capacity using the biomass available in and around Vellore District. The power plant produces about 1500 kWh of power a day utilizing nearly 1.8 metric tons of Juliflora wood. This power is supplied to four hostels in the VIT campus.

The producer gas generated in the gasifier can be used as dual fuel in the conventional DG set for power generation or for thermal application directly. Since its inception, the biomass power plant has produced 11.8 lakh units of electricity

Biomass Power Plant

b. Biogas power plant

VIT has installed a 300 m3 capacity biogas plant which uses the sludge from the wastewater treatment plant. The plant funded by MNRE is under operation since December 2012. A 40 kVA biogas engine is operated utilizing the gas generated from the biogas plant and the evacuated power is supplied to run the wastewater treatment plant. This has resulted in conservation of about 20,000 kWh of power since 2013.

Biogas power plant with generator

Quality audits on environment and energy

The objective is to make Vellore Institute of Technology, Vellore, as energy efficient campus by means of using renewable energy, energy efficient technologies and appliances by proper Energy Audit. An energy audit is an inspection survey and an analysis of energy flows for energy conservation in a building. This will involve the analysis of energy consumption of Vellore Institute of Technology by knowing the different loads that are in use, their ratings, their consumption, the consumption pattern and providing alternatives to reduce the energy consumption and thereby reducing the cost spent on electricity bills and also reduce the harmful effects on the environment due to conventional way of power generation. It may include a process or system to reduce the amount of energy input into the system without negatively affecting the output. Thus by the help of this audit the institution is made both energy and cost efficient.

1. Energy audit report:
   http://naac.vit.ac.in/naac_old_21/c7/716/Proofs/Energy_audit_report.pdf
2. Policy document on environment and energy usage:
   http://naac.vit.ac.in/naac_old_21/c7/716/Proofs/Policy_document.pdf
3. Beyond the campus environmental promotion activities:
   http://naac.vit.ac.in/naac_old_21/c7/716/Proofs/Beyond_the_campus_environmental_activities.pdf

Green campus initiatives include:

- *Restricted entry of automobiles*
- *Use of Bicycles/ Battery powered vehicles*
- *Pedestrian Friendly pathways*
- *Ban on use of Plastic*
- *landscaping with trees and plants*

1. Energy conservation week -2019:
   http://naac.vit.ac.in/naac_old_21/c7/715/Proofs/Energy_Conservation_Week.pdf
2. Value Added Program on Energy audit:
   https://vit.ac.in/school-electrical-engineering-select/value-added-program-energy-audit
3. Circular on restricted entry of automobiles:
   http://naac.vit.ac.in/naac_old_21/c7/715/Proofs/Circular.pdf
4. Use of Bicycles/ Battery powered vehicles:
   https://vit.ac.in/about/Sustainability/TransportationPolicy
5. Circular on Ban on :
   http://naac.vit.ac.in/naac_old_21/c7/715/Proofs/Plastic_free_campus.pdf

Research Publications: Affordable and Clean Energy (from 2017 to 2020)

1046	11449	10.95
Publication	Citation	Citation (Mean)

Report of VIT-Chennai Campus

Preamble

The main targets under this SDG are:

a) To ensure access to affordable, reliable and modern energy services

b) To increase substantially the share of renewable energy in the global context

c) To facilitate clean energy research and technology, including renewable energy, energy efficiency, and advanced and cleaner fossil-fuel technology

Policies / Major decisions taken regarding the SDG

The sprawling VIT Chennai campus is an energy efficient campus. The institute has won the accolade of green rated infrastructure. Solar panels are installed in abundance for efficient energy storage and conversion. Various energy conservation measures that are carefully considered and implemented in the campus are listed below:

1. All the elevators in the campus are provided with AC variable voltage, variable frequency drives (ACVVF). Recently the elevators are grouped and configured to stop at specific floors instead of stopping at all the floors to save considerable energy.
2. Power factor maintained is at 0.95 or higher. This will reduce electrical power distribution losses during installation.
3. Compact fluorescent lamps (CFL) with high frequency ballast are used in hostel rooms. Also all corridors are fitted with 16/18 W LED lamps. This reduces the power consumption greatly.
4. Energy efficient fluorescent tube lights (T-5) are used in place of conventional fluorescent tubes (FTL). The replacement is done with 16 W LED tube light whenever the FTL is not working.
5. All fluorescent light fixtures are incorporate electronic chokes which have lower power loss compared to electro-magnetic chokes and result in superior operating power factor. This indirectly saves energy. Electronic chokes also improves life of the fluorescent lamps. All fluorescent light fixtures uses high frequency ballast and thereby consumes less energy.
6. Energy efficient fluorescent lamps & CFL lamps give approximately 30% more light output for the same amount of power consumed and therefore require less number of fixtures and lower wiring costs. The sodium vapour lights installed in the streets are

replaced with LED lights which consumes only ¼ of the energy as that of sodium vapour lamps.

7. An APFC relay based on thyristor switching is used for power factor correction/ improvement within a few cycles of deviation from the set value and reduces inrush currents as well.
8. Transformers have minimum no load losses as compared to conventional transformers. All cables are separated well to avoid heating during use. This also indirectly reduces losses and improves reliability.
9. Solar water heater system is used in hostels blocks. Thus the renewable energy is used appropriately for energy conservation.
10. Instead of spit or window type air-conditioners, three of our hostel blocks are connected with centralized chiller plant based air-conditioners which save 40% of energy as compared to that of split air-conditioners. Roof top solar panels of 550 kW are installed at our building roof tops in hostel and academic blocks for the same.

Power water saving through sensor based water taps

550 kW rated solar panels installed at roof top

VIT Chennai - A Green Campus

Solar and wind powered LED street lights

Academic details pertaining to the SDG (Launch of program, inclusion of course, modifications in syllabus etc.)

The School of Electrical and Electronics Engineering (SELECT) offers B. Tech and Ph.D in Electrical Engineering. A wide range of research specializations such as Power systems, Power Electronics, Control Engineering, Electric Vehicles, Power Converters for Renewable power generation system, Controllers for grid integration, Special machines and drives for Industrial applications, Microgrid, Internet of Things, Robotics, Wireless power transfer system, Industrial Automation and deregulated power system are carried out by a diverse and versatile team of faculty members and students in the school. In addition to this, School of Advanced Sciences (SAS) and VIT School of Law (VISOL) offer courses on Environmental Sciences, with course code CHY1002 and LAW1102 respectively which impart sound knowledge on sustainable energy conservation and management to the students.

Major events organised Conferences / Workshops / Symposium

With the infrastructure instituted at VIT Chennai, the following programs were conducted during the last academic year for the teaching and non-teaching staff members in order to emphasize the significance of affordable and clean energy in the campus with reference to the global context.

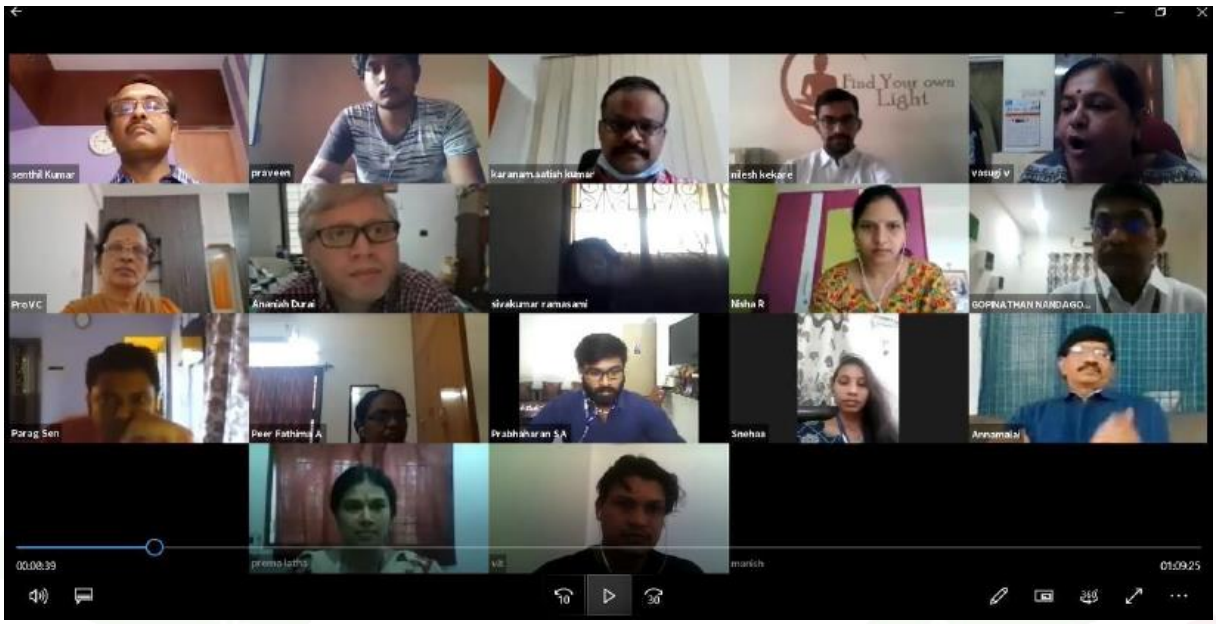
S. No	Title of the Programme	Date		No of days	No of participants attended
		From	To		
1.	Workshop on Design and Benchmark of Power Converters for Power forge	08.02.2019	08.02.2019	1	18
2.	Workshop on Clean Water and Clean Energy	10.02.2019	10.02.2019	1	41
3.	Workshop on Hands on Training on Renewable Energy Generation Systems	19.07.2019	19.07.2019	1	10
4.	Seminar on Grid Integration of Renewable Energy Sources-Challenges and Possible Solutions	27.07.2019	27.07.2019	1	20
5.	Workshop on Introduction to dsPIC microcontrollers for PWM generation in Power Electronics	07.09.2019	07.09.2019	1	29
6.	International Conference on Power Engineering, Computing, and Control PECCON 2019	12.12.2019	14.12.2019	3	130
7.	Workshop on PCB design and circuit design for Power Converters	21.02.2020	22.02.2020	2	12
8.	Online National Workshop on Towards Achieving C Neutrality TACN 2020	29.05.2020	29.05.2020	1	40

These events had a focus on the access and availability of reliable, renewable and clean energy for the campus in the global context. Few glimpses of the programs is given below:

Workshop on Design and Benchmark of Power Converters for Power forge

International Conference on Power Engineering, Computing, and Control PECCON 2019

Workshop on PCB design and circuit design for Power Converters



Online National Workshop on Towards Achieving C Neutrality TACN 2020

List of publications:

Faculty members and research scholars are always working on various research problems pertaining to energy conservation and produce significant results. Their findings are peer reviewed and published in various reputed journals too. Some of their publications are listed below:

1) M EEdwin, M Saranya Nair, S Joseph Sekhar, "Review for Power Production and Economic Feasibility on Hybrid Energy Systems for remote communities", International Journal of Ambient Energy,2020, pp1-13.
2) Sharma A et al, “A secure, energy-and SLA-efficient (SESE) E-healthcare framework for quickest data transmission using cyber-physical system”, Sensors (Switzerland), 2019, pp 1424-8220
3) Ramya K.C et al, “Fuzzy based hybrid incorporating wind solar energy source by reduced harmonics”, Journal of Intelligent and Fuzzy Systems, 2019, 1064-1246
4) Arul Rajagopalan et al “A Socio Cultural Study on Solar Photovoltaic Energy System in India: Startification and Policy Implication”, Journal of Cleaner Production, 2019, 2277-3878
5) Arul Rajagopalan et al “A Review of Optimal Operation of Microgrids”, Indonesian Journal of Electrical Engineering and Computer Science, 2019, 2502-4752
6) Febin Daya J.L et al “Design and Construction of an Automatic Solar Tracking System”, International Journal of Pure and Applied Mathematics, 2019, 1311-8080
7) Febin Daya J.L, Sooraj V, “A High Gain LCL Architecture Based IPT System For Wireless Charging of EV”, IET Power Electronics, 2019, 1755-4535
8) Lenin N.C, Hemantha Kumar R, “Overview on Direct Torque Control Schemes for Permanent Magnet Motor Drives and its Application to Hybrid/ Electric Vehicles”, IET Power Electronics, 2019, 1755-4535
9) Lenin N.C, Ramesh P, “High Power Density Electrical Machines for Electric Vehicles-Comprehensive Review Based on Material Technology”, IET Transaction in Magnetics, 2019, 0018-9464
10) Karthikeyan, Annapoorani I, “Co-Simulation and Hardware Implementation of Multi-Port Rectifier for Power System and Renewable Energy Applications”, Wind Engineering, 2019, 0309-524X

11) Sri Revathi B, Prabhakar M, “A Novel Compact Converter for DC Distribution”, Electric Power Components and Systems, 2019, 1532-5008
12) Febin Daya J.L, Sooraj V, “Estimation of Optimal Operating Frequency for Wireless EV Charging System under Misalignment”, Electronics, 2019, 2079-9292
13) Sitharthan R et al “Automated Power management Strategy for Wind Power Generation System Using Pitch Angle Controller”, Measurement and Control, 2019, 0020-2940
14) Amirtharaj S et al “Optimal Utilization of Renewable Energy Sources in MG Connected System with Integrated Converters: An Agonn Approach”, Analog Integrated Circuits and Signal Processing, 2019, 0925-1030
15) Gnana Swathika OV et al “IOT Based Energy Management System for standalone PV Systems”, Journal of Electrical Engineering Technology, 2019, 1975-0102
16) Bhagyasri S and Kanimozhi G, “EV Charging through three Port Wireless Power Transfer”, International Journal of Recent Technology and Engineering, 2019, 2277-3878
17) Arindam Mukherjee et al, “Investigation of a PV FED Improved Smart Home EV Battery Charging System Using Multi Output Hybrid Converters”, International Journal of Renewable Energy Research, 2019, 1309-0127
18) Priyanka M et al, “Feasibility Study of Replacement of Hybrid Renewable Energy-A Case Study”, International Journal of Innovative Technology and Exploring Engineering, 2019, 2278-3075
19) Paratha Sarathi Subudhi S and Krithiga S, “PV and Grid Interfaced Plug in EV battery Charger Operating in P-VG and P-V and V-G mode”, International Journal of Recent Technology and Engineering, 2019, 2277-3878
20) Jayaveronica A et al, “Robust PI Controller Design for frequency stabilisation in a Hybrid Microgrid System”, IET Generation Transmission and Distribution, 2019, 1751-8695
21) Senthil Nagayam V, Premlatha L, “Wireless Power Transmission for Dynamic Charging of Battery Application in Multipurpose Smart Solar Bag”, International Journal of Engineering and Technology, 2019, 2248-8958
22) Paratha Sarathi Subudhi S et al “Wireless Electric Vehicle Battery Charging System for Solar Powered Residential Application”, International Journal of Power and Energy System, 2019, 1078-3466
23) Sujitha N and Krithiga S, “Grid tied PV Electric Vehicle Battery Charger using Bidirectional Converter”, International Journal of Renewable Energy Research, 2019, 1309-0127
24) Venugopal P and Vigneswaran T, “State of Charge Estimation Models for Li-ion Batteries in Electric Vehicles”, International Journal of Innovation Technology and Exploring Engineering, 2019, 2278-3075
25) Vijaykumar P et al, “IoT Based Wireless Smart Shoe and Energy Harvesting System”, International Journal of Innovative Technology and Exploring Engineering, 2019, 2278-3075
26) Karunamurthy K et al “Prediction of solar pond performance parameter using artificial neural network”, International Journal of Computer aided Engineering and Technology, 2019, 1757-2665
27) Pradeep R and Venugopal T, “Experimental study of Li-ion battery cooling using mixture of phase change materials”, International Journal of Electric and Hybrid Vehicles, 2020
28) Tamilselvan P et al, “Experimental Analysis of VCR Engine Operated with Prosopis Julifera Biodiesel B”, International Journal of Renewable Energy Research, June 2020
29) Prema E and Rajavenkatesan PRL, “Solar Power Transforming the Face of Rural India: Climate Justice for All”, IOP Conference Series: Earth and Environmental Sciences, June 2020

Thus VIT Chennai campus is striving towards efficient use of affordable and clean energy with reference to the global context.

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