



SDG 7: Affordable and Clean Energy

ENSURE ACCESS TO AFFORDABLE, RELIABLE, SUSTAINABLE AND MODERN ENERGY FOR ALL

The Indian Institute of Technology, Gandhinagar (IITGN), has embedded sustainability at the core of its master plan. As a testament to its commitment, IITGN achieved a remarkable milestone in 2016 by becoming the first campus in India to be awarded a prestigious 5-star rating by Green Rating for Integrated Habitat Assessment for Large Developments (GRIHALD).

RESEARCH

Our institute is at the forefront of extensive research activities covering a broad spectrum of energy-related areas. This research is not conducted in isolation; the institute actively cooperates and collaborates with local, regional, and national governments to advance energy conservation and management.

To support these research initiatives, the institute provides a wealth of resources, including a well-equipped library, state-of-the-art laboratories, and a conducive learning environment. This ensures that researchers have the tools and infrastructure needed to conduct groundbreaking studies in energy.

About 100 researchers at the institute have their research focus on water. Nearly 60 articles were published in reputed journals covering topics related to energy consumption, economic modelling, energy efficiency, cyber-physical power distribution networks, energy management, smart distribution grid, electric vehicle, electricity market, energy assessment, solar energy storage, photovoltaic batteries, etc. in the years 2021 and 2022.

Wide Array of Energy Research

Our research activities span a diverse range of energy-related subjects, including but not limited to:

- Integrated Smart Grid: Investigating innovative approaches to develop intelligent and efficient energy distribution systems.
- Water and Energy Technologies for Smart Sustainable Cities: Contributing to developing sustainable urban environments with a focus on water and energy efficiency.

- Sustainable and Energy-Efficient Buildings: Exploring architectural and technological solutions to create eco-friendly and energy-efficient structures.
- Intelligent Power Management Systems: Developing systems for the intelligent control and optimization of power usage.
- Efficient Storage of Clean Energy: Researching advanced storage solutions for clean and renewable energy sources.
- Scalable Energy Disaggregation: Exploring methods to distribute and manage energy consumption efficiently.
- Solar Energy and Brine Treatment: Innovating in the field of solar power and the treatment of brine by-products.
- Electric Vehicle and Solar Cell Applications: Pioneering technologies for electric vehicles and the utilization of solar cells.

Collaboration with Governments

In addition to our research endeavours, the institute actively cooperates and coordinates with local, state, and national governments in advancing renewable energy and low-carbon technologies. This collaboration is crucial in addressing the global imperative of transitioning to more sustainable and environmentally responsible energy sources.

Through our research, facilities, and collaborations, we are dedicated to being at the forefront of the energy revolution, driving innovative solutions, and contributing to a more sustainable and energy-conscious future.

PATENTS FILED

Anode Material for Ultra High-rate Li-ion Batteries: Inventors include Varma Akash Kiran, Matsumi Noriyoshi, Badam Rajashekar, James Asha Liza, and Prof Jasuja Kabeer.

The research projects along with the names of the funding agencies are as follows:

- Intelligent Power Management System for Monitoring, Diagnosis & Prognostics of Electric Loads in Armoured Fighting Vehicles-DRDO.
- Foundation consultancy for Development of Proposed 10 GW RE (Wind and/or Solar) Projects in Great Rann of Kutch, Gujarat-NTPC.
- Understanding the impact of air pollution on solar photovoltaics and developing surface-engineered panel materials for improved performance of solar plants-MHRD.
- Developing a new plasmonic antenna-reactor platform for efficient solar energy storage as clean fuels. - GUJCOST.
- High-yield exfoliation of layered metal diborides to synthesise boron analogs of graphene for developing a new class of energy storage nanocomposites.GUJCOST.
- Investigating Air Quality and its Dynamics in Built Environments in Urban India. SERB
- Climate change impacts on hydropower in India- UNDP

- IITGN-KISEM Industry Energy Assessment- IITMS
- In Silico Studies to understand the effect of polymer binders on the electrical, mechanical, and transport properties in Li ion batteries -OLA Electric Technologies

The focus of research laboratories related to energy at IIT Gandhinagar includes Smart Grids, Power Systems, and Energy Management among others.

Power Systems and Smart Grid Lab Power Systems and Smart Grid Laboratory focus on the research in innovative distribution grids/microgrids and integration of distributed generations and energy management. The lab is equipped with a fully digital real-time power engineering simulation platform consisting of Opal-RT (OP4508 F11-3+1) real-time digital simulator - OP5600 and customized modular hardware and firmware for hardware-in-the-loop (HIL) and rapid control prototype (RCP) studies in power systems and smart grid-related research activities. The lab also has power systems simulation packages – PSCAD, CYMDIST and GAMS Optimisation tools. National/international collaborative projects majorly support research activities.

At Smart Manufacturing and Robotics (SMART) Lab, human intuition and intelligence are implemented to design and automate processes and systems. Examples of research areas of this lab include Laser Micropolishing of Metals, Multi-Agent Robotics, and Flexible Manipulators.

Electrical Machines and Power Electronics lab is equipped to research the design, control, and diagnosis of various electric machines. These include transformers, rotating electric devices, and power converters. Design and analysis of novel and existing topologies using 2D and 3D electromagnetic finite element analysis in Ansys Maxwell. Test setups for experimentation on various rotating electric machine topologies are available in the lab.

Energy Systems Lab: The motivation behind the Renewable Energy laboratory facility is to provide a broad range of experimental experience to undergraduate and graduate students in renewable energy. This facility comprises high-quality experimental setups in wind, thermal, and solar power. This testing facility includes a thermal energy storage training system, solar concentrator training system, wind energy training system, and solar PV training and research system. A fuel-cell test system and a heat transfer experimental module have been procured.

The **Central Instrumentation Facility (CIF)** has been established to provide sophisticated characterization services to researchers within and outside IITGN. It houses several high-end analytical instruments such as **SEM, XRD, AFM, NMR, LC-MS, MALDI-TOF, ICP- MS & ICP-OES, Confocal Microscope, and Single Crystal XRD**. We have recently added new instruments such as **Transmission Electron Microscope (TEM)** and Multipurpose XRD with modules like Powder Analysis, Thin Film, SAXS, and in-plane scattering for Material Science and Research. The CIF aims to provide a central facility consisting of the latest and advanced analytical Instruments to facilitate multidisciplinary research and to cater to the needs of academic research institutes, universities, and industries for high-end material characterization. IITGN regularly conducts the Technical Education Quality Improvement Programme (TEQIP) training program, where CIF facility staff and students are involved in giving short lectures on the technical and application aspects of CIF Instrumentation.

IITGN CIF is on the National I-STEM Portal to avail the usage of the facility by users nationwide and internationally. CIF has been catering to the needs of industries at various levels. Many pharmaceutical industries like Sun Pharma, Piramal Pharma, Zydus Research Centre, Cadila Healthcare, Torrent Pharma, and Sud-Chemie are regular users of our facility. Nearly 30 major industries are users of the CIF IITGN. CIF has also constantly provided services to universities, institutes, and R&D departments. The primary goal has been to build an environment leading to significant collaborations between academic institutes.

OPERATIONS

In alignment with Sustainable Development Goal 7, the institute actively undertakes various initiatives and awareness campaigns. These efforts not only emphasise the importance of energy conservation but also extend into the campus and the surrounding community, fostering a culture of responsible energy use and environmental stewardship. IITGN stands as a model for sustainable campus development, showcasing how dedication to green practices can significantly contribute to a more sustainable future.

Embracing Sustainability in Building Management

To operate and maintain its buildings, the institute adheres to a sustainable management policy and employs green building rating systems. These practices are in line with its dedication to environmental responsibility.

Salient features of sustainability relating to energy

The IITGN campus stands as a beacon of sustainability in terms of energy management. Notable features include:

- Solar Energy Generation: The campus harnesses solar energy, a clean and renewable source, to reduce its carbon footprint and promote clean power generation.
- Passive Cooling and Energy Conservation: The campus infrastructure is thoughtfully designed to support passive cooling techniques and energy conservation in construction, operations, and management.
- Low-Energy Sewage Treatment: The campus has implemented low-energy sewage treatment solutions to efficiently manage wastewater.
- Solar Photovoltaic Plants: Rooftop solar photovoltaic plants harness the sun's power, reducing the institution's reliance on conventional energy sources.
- Solar Water Heaters: Solar water heaters contribute to eco-friendly hot water solutions, reducing energy consumption.
- Biogas Plant: The biogas plant provides a sustainable and renewable energy source.
- Energy-Efficient Lighting and Equipment: Energy-efficient lighting, motors, and pumps are used throughout the campus to minimise energy consumption.
- Natural Sunlight Utilisation: Natural sunlight is harnessed in corridors, reducing the need for artificial lighting during the day.

- Passive Cooling Systems: The campus is designed with passive cooling systems that optimise thermal comfort while conserving energy.
- Pedestrian-Friendly Campus: A pedestrian-friendly layout encourages environmentally friendly modes of transportation and reduces the reliance on motorised vehicles.
- Energy-Efficient Building Design: As a relatively new institution, all IITGN buildings are constructed with energy efficiency in mind. The design optimises energy consumption and demands without compromising the comfort of occupants. Furthermore, all facilities adhere to the mandatory clauses of the Energy Conservation Building Code (ECBC) of 2007.
- Promoting Clean and Renewable Energy: IITGN actively reduces its reliance on carbon-intensive energy sources like coal and oil by investing in clean and renewable energy alternatives, notably solar and biomass. This initiative aligns with national missions aimed at reducing carbon emissions and expanding solar energy capacity.
- Innovative Construction and Eco-Friendly Materials: Innovative construction technologies and materials are employed to enhance sustainability. Unfired fly ash-gypsum bricks and cavity wall systems reduce embodied energy and heat gain. Cross ventilation is incorporated in housing apartments, reducing glare. Using environmentally friendly materials extends to furniture, fixtures, and finishes, minimising environmental impact.
- Pedestrian and Cycling-Friendly Campus: IITGN is designed to be pedestrian and cycling-friendly. Public transportation modes are integrated for both on-campus and off-campus transportation, promoting a modal shift from motorised to non-motorized transportation methods. The entire campus is designed to be barrier-free with universal access.
- Promoting Sustainable Transportation Practices: To discourage personal motor vehicle usage, the possession and use of private motor vehicles by students are not permitted. Instead, the campus actively encourages cycling and walking, providing segregated cycle tracks, shaded cycle parking, and promoting a modal shift from motorised to non-motorized transportation.
- Behavioral Changes and Increased Awareness: In our efforts to teach positive behavioural changes and raise awareness among our community members and nearby villages, we continually advocate for energy-efficient practices. Our appeals resonate with the importance of switching to energy-efficient CFLs and LED bulbs while emphasising the significance of turning off electrical appliances when not in use. We promote using stairs over elevators, offering a dual advantage of enhancing human health through physical activity and conserving energy. These simple yet impactful actions contribute to energy savings and a healthier lifestyle for our community.

These initiatives underscore our commitment to creating a culture of energy efficiency and environmental responsibility, ensuring that our institute is not only a centre of academic excellence but also a model for sustainable and responsible living.

The Energy Performance Index (EPI) for all the built areas on the campus is calculated on an annual basis, which contributes to assessing energy utilisation. Regularly monitoring the site's energy

consumption is ensured by installing digital metres at the utility grid and each building level point source. Sub-meters for water pumping, outdoor lighting, and common areas are established. Performance monitoring and validation are conducted by implementing operation and maintenance protocols. Air Handling Units (AHUs) have been integrated into the Building Monitoring System (BMS) for efficient energy management, operations, and maintenance. The vital statistics for the year 2021-2022 are as follows: Total energy used: 34740 gigajoules

Total energy used from low-carbon sources: 2222 gigajoules

Percentage of energy used from low-carbon sources: 8.4%

In summary, IITGN stands as a model of sustainability, exemplifying how meticulous campus planning, energy-efficient building design, and eco-friendly practices can harmoniously coexist with academic excellence, contributing to a more sustainable and environmentally responsible future.

EDUCATION

Our institute offers a diverse array of both graduate and undergraduate courses that focus on sustainability, with a specific emphasis on energy-related subjects. These courses are designed to provide students with the knowledge and skills required to actively contribute to realising Sustainable Development Goal 7 (SDG 7), which ensures access to affordable, reliable, sustainable, and modern energy for all.

Comprehensive Sustainability Education

As part of our commitment to sustainability, the institute is actively engaged in curriculum development. This involves integrating modules on sustainability into existing courses, expanding our educational approach to encompass vital environmental themes. Our aim is not only to enrich the educational experience of our students but also to advance sustainability education on a national and global scale.

Fostering Academic and Research Exchanges

The institute actively promotes student, academic, and research exchanges with institutions across the country and around the world, all with a shared focus on sustainability. These exchanges facilitate the cross-pollination of ideas, knowledge-sharing, and collaborative research initiatives.

Energy-Focused Workshops and Short Courses

In 2021-2022, the institute conducted numerous workshops and short courses primarily focusing on energy-related topics. These initiatives served as knowledge-sharing platforms, fostering networking and exploring potential joint research projects. The goal was to equip participants with the skills and insights to address contemporary energy challenges with sustainable solutions.

Offered Graduate and Undergraduate Courses in 2021-2022

During the academic year 2019-20, our institute proudly offered several graduate and undergraduate energy-related courses. These courses represent our dedication to educating the next generation of sustainability leaders.

The following courses were offered:

CE 202: Sustainability and Environment

EE 331: Electrical machines

EE 332: Power Systems

EE 333: Power Electronics

EE 425: HVDC Transmission and FACTS

EE 426: Electric Vehicle Technology

EE 611: Restructured Power Systems: Operation and Management

EE 629: Power Electronic Converters

EE 643: Solar Photovoltaics: Physics, Technologies and Applications

EE 650: Power System Dynamics and Control

EH 302: Elements of Earth System Science

ES 103: Introduction to Electrical Systems

ES 632: Energy Systems

ME 636: Fuel Cell and Battery Systems

ME 642: Energy-efficient design of separation processes

MSE 626: Light Metal Alloys for Automotive Industry

Details of workshops, invited lectures and short courses conducted at the institute that linked to energy are as follows:

Short Courses

Management of Domestic Wastewater - Conveyance, Treatment and Reuse by Prof Sudhir K Arora, Professor of Practice, Civil Engineering, IITGN, January 31-February 04, 07- 11, 2022.

Renewable Energy Future beyond 2030 by Prof Anand Kumar, Professor of Practice, Electrical Engineering, IITGN, every Tuesday & Friday from March 22 to April 22, 2022

COMMUNITY OUTREACH

Faculty members of IITGN and IIT Kanpur came together for a Joint Symposium on Energy Technologies on April 15 and 16, 2022, to discuss research areas of mutual interest in the domain of

energy technologies. The event provided a platform to identify potential joint research proposals and projects. Prof Atul Bhargav coordinated the event.

IITGN, in collaboration with Gujarat Urja Vikas Nigam Limited (GUVNL) and Gujarat Energy Training & Research Institute (GETRI), conducted a two-week advanced training programme on "System Operation and Commercial Aspects of Power Purchase, Open Access, & Energy Accounting" for senior officers/engineers of the state electricity companies from June 27 to July 8, 2022. The valedictory session of this residential workshop was held in the presence of Shri Jai Prakash Shivahare (IAS), Managing Director, GUVNL. The workshop was coordinated by Profs Anand Kumar and Naran Pindoriya.

A workshop on Electricity Regulations in India was conducted by Prof Anand Kumar, Professor of Practice, Electrical Engineering, IITGN, every Tuesday and Friday from October 15 to November 16, 2021.

Our institute is dedicated to fostering awareness and promoting energy efficiency among our community members. Several activities are organised with this goal in mind. These initiatives include safe driving drives conducted within the campus and neighbouring areas. Additionally, we closely monitor the implementation of road traffic safety measures within our campus, ensuring the safety of all.

We actively encourage green commuting on campus, inspiring community members to embrace walking and cycling as eco-friendly modes of transportation. Our guidelines define the structure and rules to maintain a noise-free campus, fostering a tranquil and environmentally friendly environment.