IIT DELHI CLIMATE ACTION PLAN

2022

FOREWORD

Dear Friends of IIT Delhi

IIT Delhi is committed to finding sustainable and affordable solutions to the climate change problem. As a leading Centrally Funded Technical Institution, it is our mandate to solve the nations' problems and prepare a workforce that can continue to serve the nation. We use this guiding principle in our multi-pronged approach to tackle the problem of climate change.

First, our green campus leads by example. In 2021, more than 60% of our electricity came from renewable resources that do not emit carbon dioxide. These sources include 2.8 MW of peak solar available from campus rooftop installations and 2 MW from hydropower purchase. In doing so, we have already surpassed the nation's goal of meeting half of our energy needs from renewables by 2030 as promised in the COP26 Glasgow meeting. We have also introduced a range of practises such as bicycle rentals, hybrid rickshaws, CNG buses and electric vehicle charging stations to reduce our carbon emissions. We have developed a robust solid waste management program that includes separation at source, recycling, composting and biogas generation from biodegradable waste. As a result, only 50% of our solid waste reaches the landfills thereby reducing the emission of methane, a potent greenhouse gas.

Second, we have a vibrant research program that tries to understand the causes of climate change, develops cutting-edge, affordable solutions for climate change mitigation and adaptation, and design policies to deploy such solutions. Atmospheric scientists in our institute are studying the patterns of climate change over India and building models to simulate these patterns. These models can even test different mitigation and adaptation strategies to evaluate their efficacy. Our engineers are engaged in research on better and cheaper wind turbines, solar panels, fuel cells, and electric vehicles, as well as software to manage them. All of these are geared towards reducing our carbon footprint. And of course, our work on disruptive technologies in energy storage and carbon sequestration is a giant step into a potentially carbon-free society.

Third, we are training the workforce of the future. Every year we graduate more than a thousand engineers and scientists equipped with skills to solve problems of today and tomorrow. Many of these students come out of programs that are directly relevant for climate change including Atmospheric and Oceanic Sciences, Energy Sciences and Management, Environmental

Engineering, and Water Resource Engineering. Furthermore, most students take courses or do projects on topics that have a direct bearing on sustainability and climate change.

Finally, we have created an enterprise-friendly ecosystem. We encourage our students and faculty to launch their own start-ups and provide them with incubation facilities. Many of these are already working on finding solutions to the climate change problem. We are ramping up our support for knowledge-based entrepreneurship by launching the new Research and Innovation Park managed by the Foundation for Innovation and Technology Transfer. We fully expect to support many more start-ups working on climate and sustainability issues.

We acknowledge that global warming is a formidable problem that will be solved only with sustained effort that must last for a long time to come. The actions taken by us so far are just the beginning. We promise to continue these efforts to ensure a safe future for the coming generations.

Sincerely,
V. Ramgopal Rao
Director, IIT Delhi

PREAMBLE

The Indian Institute of Technology Delhi is a premier engineering education institution of India. We are a 300-acre urban campus located in the heart of New Delhi, the capital of India. Our location within one of the largest metropolitan areas of the world densely packed with more than 30 million people puts us at the intersection of a number of critical environmental hazards of the contemporary world. These include rapid urbanisation, air pollution, and of course climate change. This will be an overwhelming challenge for any institution, especially that from a developing economy. But we here at IIT Delhi have risen to that challenge. We have used appropriate solutions to build a green campus that runs mostly on renewable power, reuses wastewater, and recycles most of its waste. We have also taken this opportunity to build a vibrant research program that looks for affordable technological solutions to mitigate and adapt to climate change not only for our campus but for the country and the entire world. Our researchers also study ways in which to strengthen energy innovation. We note that there are still many challenges ahead of us. In the coming years IIT Delhi will be taking more steps towards becoming climate neutral. This document outlines our multi-pronged approach to face the compounding challenges of climate change and other environmental hazards.

1. CURRENT STATUS

A. Energy Management

In spite of growing power needs for an expanding campus and the addition of a new campus in Sonipat, IIT Delhi has made large strides in reducing our carbon footprint in the electricity sector. IIT Delhi was the first Centrally Funded Technical Institute to reduce its carbon footprint in power consumption by more than 50%. With rooftop solar installations on academic buildings on both the main and Sonipat campuses (~2.8 MWp) as well as 2 MW hydropower from a Jammu & Kashmir based generator, IIT Delhi has more than halved its carbon footprint due to electricity consumption.

	Hauz Khas Campus	Sonipat Campus	Total
Electricity consumption (2021)	2,80,00,000 kWh	10,00,000 kWh	2,90,00,000 kWh
Solar PV generated (2021)	37,00,000 kWh	3,00,000 kWh	40,00,000 kWh
Hydropower purchased			1,40,00,000 kWh
Total carbon-free power consumed			1,80,00,000 kWh (62% of total)
Total carbon emissions saved Assuming 1kWh Coal based generation emits 1 kg of CO2 (BRPL's portfolio is dominated by coal-based generation)			18,000 Tonnes

B. Energy Efficiency Measures

Electrical fixtures (including lighting) and air conditioning units around campus are being systematically replaced with more efficient replacements to take advantage of increases in energy efficiency.

Upcoming buildings in the campus academic area have been designed with air conditioning systems having a Coefficient of Performance (COP) of 3.1 to 4.2 at full load for VRF ACs and 5.4 to 6.3 for the water-cooled chiller.

The IIT Delhi supercomputer *Padum* uses chilled water-cooling technology and other innovative energy-saving measures making it a "green" supercomputer. When it was inaugurated in 2015, it was ranked 28th in the Green500 list of the world's most energy-efficient supercomputers.

C. Solid Waste Management to Protect Environment

IIT Delhi has dramatically improved its solid waste management in recent years. Waste from domestic, hostels and horticultural sources are collected from campus and biodegradable waste and recyclable waste are segregated. Biodegradable waste is used in biogas generation. A pilot-scale biogas production plant having a capacity of 25 m^3/day has been established in the *Mahatma Gandhi Gramodaya Parisar* of IIT Delhi. This plant uses 250 kg of kitchen waste per day, segregated waste collected from various households and hostels inside the campus to produce biogas and compressed biogas (CBG) as demonstration models of proper waste management to produce fuel and biofertilizer for in–campus horticultural application. This activity was taken up under the institute's initiative "Working Group on Waste Management". The biogas produced by this plant is being upgraded to a quality of natural gas using a biogas purification and bottling plant situated in Biogas Production and Upgradation Laboratory. The biogas is being also upgraded by a water scrubbing-based system (20 Nm^3/h of biogas) to upgrade it to natural gas quality fuel. Further, the upgraded CBG is being used as vehicular fuel to substitute CNG.

Segregated kitchen waste in IIT Delhi campus

View of anaerobic digester running on kitchen waste

Horticultural waste is composted and used extensively on campus to conserve soil carbon. After segregating for recycling, only 50% of our solid waste reaches the landfills thereby

minimising methane emissions. We are working with an NGO Chintan in this regard and plan to become a zero-waste campus soon.

Biogas enrichment and bottling facility

CBG filling in car

D. Water Conservation and Management

IITD has set up a 1.5 MLD Sewage Treatment Plant (STP) that reduces untreated water discharge from the main campus. The grey water is extensively used for horticulture on campus.

E. Campus Mobility

The IIT Delhi campus has been rapidly transitioning its preferred mobility and is quickly gearing up for the coming surge of electric vehicles.

In July 2019, cycle rickshaws on campus were converted to battery powered E-rickshaws enabling the operators to transition from human-powered to battery-powered mobility. Currently, about 10 such e-rickshaws operate on campus. Battery powered blue Yulu e-bikes have become a hit on campus with more than 100 e-bikes easily available at designated locations for users to rent for short rides around campus and nearby Metro stations and shopping centres.

Three free charging points for electric vehicles have been installed on campus having both AC and fast-charging DC options. More are planned to provide charging points in the residential areas as well as for use by the transport unit.

Visitors to campus can also avail of battery powered shuttle service from the visitor's parking lot to the academic area. CNG powered buses ply on campus and provide transport once a day to IITD's Sonipat Campus.

2. ACADEMIC SYNERGIES

IIT Delhi's mission includes the generation of new knowledge by engaging in cutting-edge research and to promote academic growth by offering state-of-the-art undergraduate, postgraduate, and doctoral programmes. Based on an informed perception of Indian, regional, and global needs, the institute has identified areas relating to energy, climate, and sustainability to concentrate its efforts both in the area of cutting-edge collaborative research and to develop human potential to its fullest extent so that intellectually capable and imaginatively gifted leaders can emerge.

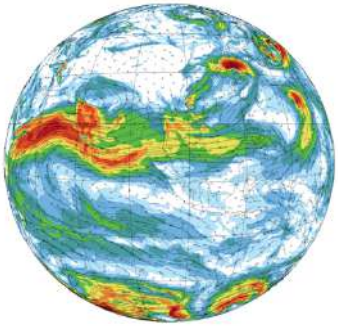
A. Teaching and Learning

Being an academic institution, IIT Delhi makes a broader impact on understanding climate change and finding solutions through teaching and research programs. The Department of Energy Science and Engineering offers a B.Tech., three M. Tech., an M.S.(R) and a Doctoral (Ph.D.) programme focused on training the manpower to meet India's energy transition. IIT Delhi offers more than 30 courses related to various aspects of climate change, ranging from the science of climate change to impacts, adaptation, and mitigation technologies (such as renewable energy and carbon capture & storage) and policy responses to climate change. These courses are offered both at the undergraduate and postgraduate levels. A large fraction of scientific human resources in climate science in India have been educated at IIT Delhi. IIT Delhi faculty actively contribute to the development of policy frameworks to address climate change at local, national, and international levels

B. Research and Innovation

Climate Science

IIT Delhi faculty are doing research on a wide range of problems in climate science, such as physical understanding of regional and global changes in climate, climate modelling, climate change detection and attribution, effects of land use land cover changes on regional climate, renewable energy meteorology, and effects of climate change on health, agriculture, water resources, transportation etc. Currently, IIT Delhi is carrying out eight externally funded projects on physical climate change and another seven projects that investigate the impacts of climate change on the health, energy, water, and food sectors.



Renewable Energy

Renewable energy is a key area of research across various units of IIT Delhi. Ongoing research areas include Renewable Energy Meteorology, Solar Photovoltaic Devices, Solar Thermal Energy Systems, Electrical Power and Renewable Energy Systems, Energy Storage, Wind and Hydro Energy, Alternative Fuels, Bioenergy and Energy System Simulation. Climate scientists are analysing atmospheric data to estimate availability of wind and solar resources. Meteorologists are building new models using numerical and artificial intelligence techniques to forecast wind and solar energy

availability at multiple time scales to help in the grid-integration of renewable energy. Engineers are designing new materials and components for solar panels and wind turbines. One particularly exciting project is taking a second look at vertical axis wind turbines that are cheaper to maintain and operate. The ReNew Power Centre of Excellence for Energy and Environment has been set up in 2017 with industry funding to facilitate real-world application of scientific advances made in our laboratories.

Energy Storage Platform on Batteries (ESPOB)

The DST-IITD ESPOB Centre established in 2018 is a consortium of 6 institutions led by IIT Delhi. The ESPOB Centre is actively working on following energy storage technologies. Flow Batteries, Supercapacitors, Fuel Cells, Electrolyser, Li-ion, Na-ion, Mg-ion and Al-ion batteries as well as Li Recovery

Electric Mobility

The institute has a dedicated unit, the Centre for Automotive Research and Tribology, to work on electric mobility. Researchers at the centre design electronic controllers and health monitoring systems, batteries, and charging systems for electric vehicles. The centre is about to start an MTech degree in Electric Mobility to build the workforce for the future.

Micro-grid Technologies

Major research on Microgrid management, control, protection, and security is carried out by faculty of IIT DELHI. There is a plan to set up a micro-grid at IITD Hauz Khas campus as well as Sonipat campus in the near future. One IUSSTF / DST funded project of around Rupees 7 Crore, with a major component on microgrid is ongoing.

Biogas

The Indian Institute of Technology Delhi has started an initiative for making campus clean and green, by utilising the biodegradable waste generated in the campus (hostel and household areas). The biodegradable waste is being used for energy production and to cut down the greenhouse gases emissions providing sustainable development along with the cleanliness of the campus. The Biogas Development and Training Centre (BDTC), an initiative of the Centre for Rural Development and Technology, is engaged in the research and development of biogas-related technologies.

Waste-to-wealth research and carbon capture and conversion

Circular economy provides vision to minimise the negative environmental impact and maximises resource recycling (energy and materials) from waste streams. Research is being carried out in developing eco-friendly processes to mitigate various waste streams such as electronic waste, plastic waste and agricultural waste. For electronic waste, we have developed a closed-loop process by integrating pyrolysis and low-temperature roasting techniques to recycle valuable metals such as Cu, Ag, & Au. Conversion of RDF (Produce from municipal solid waste processing) and agricultural waste is also going on in the laboratory to produce hydrogen rich syngas and other value-added energy carriers. A pilot scale reactor having capacity of 50 kg/day has been designed and installed at IIT Delhi campus to treat electronic waste and plastic waste streams. Apart from waste mitigation and resource recovery, there is also a focus on capture and conversion of CO_2. For the capture purpose vacuum pressure swing adsorption technique is being utilised and the development of efficient adsorbent for the selective CO_2 capture from flue gases is being investigated. For the conversion aspects thermo-catalytic, photo-catalytic and photo-electro-catalytic processes for its conversion to desired fuels and chemicals are being studied. The aim is to maximise the conversion and production of valuable fuels/chemicals to meet the rising energy demands.

Policy

The School of Public Policy has multiple strands of work relating to climate change. In terms of climate mitigation, faculty members are working on a diverse range of topics, including just transition, renewables integration, and industrial transformations. There also is a research partnership with the Harvard Kennedy School on deep decarbonization. SPP is also exploring similar partnerships with other entities. In climate adaptation, there is some ongoing work on disaster management as well as adaptation in agriculture. We also are working with CAS on examining ways to strengthen the climate science-policy interface. Faculty members also engage with domestic policy makers and other stakeholders within and outside the country.

C. Start-ups incubated at IIT Delhi

IIT Delhi provides an ecosystem for new ideas and technologies to be incubated and numerous start-ups are currently working on aspects related to/climate change, renewable energy, and environment.

Asun Trackers

Asun builds Sun Trackers for Solar Panels. These are 2 axis solar trackers, that can improve solar installation yields by up to 30%.

Aerogram

Aerogram is involved in building a range of portable pollution monitoring devices and creating a network of pollution data with hyperlocal monitoring.

Chakr Innovations

Chakr Innovations has developed the Chakra Shield which is a retrofit emission control device for diesel generators. The technology can capture over 90% of particulate matter emissions from the exhaust of diesel generators without causing any adverse impact on the diesel engine.

Greenleap Robotics

Greenleap Robotics designs and builds autonomous and waterless solar panel cleaning robots. Their product is intelligent, independent, and one of the most advanced ways of cleaning a solar plant.

Tensor Dynamics

Tensor Dynamics works on power forecasting from renewable energy sources like solar and wind. The team has developed hybrid numerical-empirical models to forecast renewable resources at 15 minutes- to year-ahead timescales. Tensor dynamics provides these forecasts and builds forecasting systems for public and private sector entities involved in renewable energy generation and load despatching.

Apart from these, there are multiple start-ups working on Electric vehicles namely: Creatara mobility, Geliose Mobility, HyperX, Quanteon Powertrain, Calvem energy, Intellicon Technologies.

3. FUTURE ACTIONS

Some of the future actions that we are contemplating to further advance our climate goals include:

- Full carbon accounting of the institution.
- A further addition of about 2.5 MWp solar capacity on campus and another 1MW from hydropower to the electricity mix. IITD also plans to get into a Power Purchase Agreement with a waste-to-energy plant for 1MW to augment these.
- Enhance carbon sequestration on campus
- Rainwater harvesting