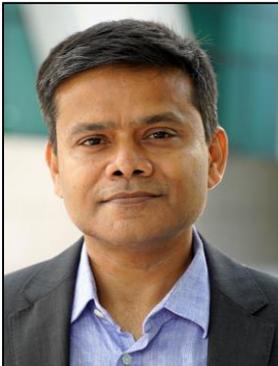


# IIT DELHI CLIMATE ACTION PLAN



2024

## FOREWORD



Dear Friends of IIT Delhi,

As a good global citizen, IIT Delhi is committed to finding sustainable and affordable solutions to the climate change problem. This also aligns with our mandate as a leading Centrally Funded Technical Institution 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.

The mainstay of our efforts is a robust Climate Action Plan that identifies a baseline and establishes a roadmap to reduce emissions from that baseline to achieve NetZero by 2070 or earlier. We have already started taking concrete steps to achieve our ambitious goals. First, our green campus is leading by example. We have reduced our carbon footprint in the power sector by 12% compared to last year by using the 3.5 MW of peak solar available from campus rooftop installations. 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 designs 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. Our plans for the future include full accounting of our carbon emissions and developing a pathway to achieve Net Zero. We promise to continue these efforts to ensure a safe future for the coming generations



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## 1. CLIMATE ACTION PLAN

Climate change is perhaps the greatest environmental challenge faced by the world today. Science shows that climate change is primarily caused by increase in GreenHouse Gas (GHG) concentrations in the atmosphere. Hence, the primary tool in our arsenal to combat climate change is reduction of GHG emissions. The IIT Delhi Climate Action Plan is a step-by-step roadmap to combat climate change. The four cornerstones of this plan are given below:

- A. identify a emissions baseline, reduce emission with respect to the baseline and achieve NetZero earlier than the national deadline of 2070. The progress in emission reduction will be evaluated every two years and the plan will be updated every five years.
- B. Develop a complete emission inventory of all campuses of IIT Delhi. This will allow us to identify the sectors that contribute the most to our total emissions.
- C. Identify pathways to achieve the emission reduction goals using state of the art modelling tools that can optimize various available strategies. Apart from emission reduction, these strategies will also include carbon sequestration. Actively engage in developing new technology to enhance the strategies at our disposal.
- D. Establish synergies of our climate policy with our plans for future growth, in particular for the new campuses.

Our Climate Action Plan sends a strong signal to the global community that IIT Delhi is playing an active role as a good global citizen to solve a global problem. is an ambitious effort that will require the support of the entire IIT Delhi community. We are confident in our ability to execute this plan to achieve our climate goals and be a role model for academic institutions worldwide.

## 2. CURRENT STATUS

### A. Energy Management

Despite growing power needs for an expanding campus and the recent addition of two new campuses, IIT Delhi has made large strides in reducing our carbon footprint in the electricity sector. In 2023, IIT Delhi was the first Centrally Funded Technical Institute to reduce its carbon footprint in power consumption by almost 50% with rooftop solar installations on academic buildings on the main campus (~2.8 MWp) and Sonipat campus (~0.7 MWp) as well as 2 MW hydropower from a Jammu & Kashmir based generator. The power purchase agreement is currently in abeyance to resolve contractual issues. We expect it to be back in operation soon.

Table 1 provides more details on our power consumption for 2023. Our campus solar power generation has led to a saving of 3321 Tonnes of CO<sub>2</sub> equivalent that is a 12% improvement over last year.

<b>TABLE 1: IIT Delhi power data for 2023</b>	
<b>Total electricity consumption</b>	3,75,57,177 kWh
<b>Solar PV generated on campus</b>	41,00,000 kWh
<b>Total carbon emissions saved</b> Assuming 1kWh Coal based generation emits 0.81 kg of CO <sub>2</sub>	3321 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. Our new Lecture Hall Complex that covers 15% of our academic area has received 5-star Griha rating. Upcoming buildings in the 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. Most of the fenestration, HVAC, and electrical installations are Griha compliant.

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 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<sup>3</sup>/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 biomethane 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 natural gas quality fuel in a biogas purification and bottling plant situated in Biogas Production and Upgradation Laboratory. It uses a water scrubbing-based system (20 Nm<sup>3</sup>/h of biogas) that has been patented by IIT Delhi. 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 three Sewage Treatment Plants (STP) with 1.55 MLD capacity that reduces untreated water discharge from the main campus. Currently, the STP treats about 1.24 MLD of wastewater. The

grey water from the STP is extensively used for horticulture on campus. We have also initiated a comprehensive rainwater harvesting program.

### 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.



Twelve charging points for electric vehicles have been installed on academic and residential campus having both AC and fast-charging DC options. Fourteen more are planned to provide charging points throughout the campus as well as for use by the transport unit.

Visitors to campus can also avail of battery powered shuttle service provided by two vehicles 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.

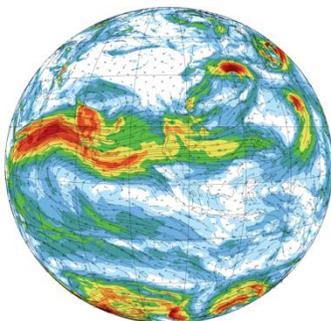
### A. Teaching and Learning

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., M.S.(R) and Doctoral (Ph.D.) programmes 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, Internal Combustion Engines and 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 Institutes 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. The Sustainable Environenergy Research Lab (SERL) in the Department of Chemical Engineering is working on Vanadium Redox Flow Battery (VRFB). The team has installed a charging kiosk in powered by a VRFB prototype for charging personal gadgets with plan to scale up to a e-vehicle charging facility.

## 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 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) is an initiative of the Centre for Rural Development and Technology, IIT Delhi 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 agro 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 agro-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<sub>2</sub>. For the capture purpose vacuum pressure swing adsorption technique is being utilised and the development of efficient adsorbent for the selective CO<sub>2</sub> 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.

## Public 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. Internationally, they have been involved in the IPCC AR6, in a US National Academies study on solar geoengineering and the UN Global Sustainable Development Report 2023.

### C. Start-ups incubated at IIT Delhi

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

Ahods Technology India Pvt Ltd	AHODS (Advanced Hydrogen On Demand System) Technologies is an ESG startup. Their proprietary technology is used in Gensets and IC engines to reduce its running cost, carbon emission and increase profitability.
Aquasense Equipments Pvt Ltd	Aquasense Equipments provide pragmatic solutions for water measuring devices. They automate farm water systems and build groundwater level measurement sensors
Asun trackers	Asun Solar Power Private Limited provides best in class Rooftop EPC solutions and O&M and solar asset management solutions for solar energy plants across India
Baud Resources	Gravity Storage, an scalable alternative to Pumped Hydro Storage (PHS) to generate sustainable green electricity
Brownbag Corporate & Social Sustainability	Brownbag intends to provide climate solutions to industries and Government agencies for sustainable development
Calvem Energy Private Limited	Calvem Energy Private Limited is developing high-performance electric powertrains (Motor + controller) for Light Electric Vehicles.
Capattery	Capattery™ is a pioneer in ultra-fast charging battery technology. They have developed the patent-pending, graphene-based, hybrid battery technology that can fully charge the battery in seconds.
Cluix Pvt Ltd	Solar Inverters and Solar-EV Chargers for daytime applications.
Createra Mobility Pvt Ltd	Createra has developed the world's 1st adaptive modular platform in the electric 2-wheeler (E2W) segment.
Dash Dynamics	Dash Dynamic is developing wireless charging technology for EVs.

Geliose	Geliose Mobility is engaged in designing energy-efficient, passenger-convenient and cost-effective EVs for public transport.
Green Aero Propulsion	Develops Hydrogen based Gas Turbine
Hexense Labs Pvt Ltd	Hexense Labs Private Limited is working in the segment of connected cars and modular smart car devices.
HyperX Energy Pvt Ltd	HyperX Energy is working on Smart Lithium-ion battery packs along with in-house developed Smart BMS (modular & stackable).
Ingo Electric Pvt Ltd	inGO's effective micro-mobility solution (e-scooter) helps travel anywhere faster, safer & seamlessly
Intellicon Technologies Pvt Ltd	Intellicon Technologies working on Made In India indigenous technology development in the world of E-mobility
M/s. Gokalp H2CNT Pvt. Ltd.	The company plans to develop a reactor for decomposing Methane into Hydrogen and Carbon Nano Tubes (CNT) It will use domestic waste for generating Methane and produce high quality CNT at low cost and high running time of the reactor.
M/s. Komitsudo Enrgitek Pvt. Ltd.	Komitsudo intends to design, manufacture an efficient energy storage system using Vanadium Redox Flow Battery system.
Motorama EV Pvt Ltd	MOTORAMA is developing a 2-Wheeler Low-Speed Electric Vehicle Motor for Bicycle application.
Octarange Technologies	Octarange develops stackable battery modules with inbuilt protection circuits, thermal management system, battery cloud analytics and cloud based Li ion battery simulation platforms for automotive, defense, energy storage and aerospace industry.
P3C Technology and Solutions Pvt Ltd	P3C develops new generation PVs and the associated components, to make electricity affordable.
Quanteon Powertrain Pvt Ltd	Quanteon Powertrain Private Limited offers powertrain solution to the EV OEMs.
Shavaas Sustainable Solutions Pvt Ltd	Shavaas Sustainable Solutions is creating a sustainable ecosystem for Indian organic farmers.
Solarse Power Technologies Pvt. Ltd.	Design and manufacturing of high-quality Renewable energy products like "off-grid/on-grid Battery-Less
Surface Moto Pvt Ltd	Surface Moto is a consumer EV startup that designs and manufactures micro-electric vehicles for the urban commute.

TadPole Project pvt Ltd	Tadpole aims to provide affordable and clean energy conveyance solutions to the masses focusing on waste management and power efficiency at the same time.
TerraNxt Pvt. Ltd.	Digitises Solar PV Adoption to Accelerate Net Zero
Vecmocon Technologies Pvt Ltd	Vecmocon Technology is engaged in the design and development of Electric Smart Vehicles.

### 3. FUTURE ACTIONS

We will build on the first steps detailed above to further advance our climate goals. Some of the future actions that we have planned for the immediate future include:

- A. Next 2 years: Identify a baseline for emission reduction and develop an emission inventory of all IIT Delhi campuses.
- B. Next 3 years: Preliminary SCOPE 1 emissions indicate that the power sector is responsible for most of our emissions. To accelerate our intervention in this sector. For this purpose, we plan to add about 2.5 MWp solar capacity on campus and 1MW from hydropower to the electricity mix. Additionally, we will also enter into a Power Purchase Agreement with a waste-to-energy plant for 1MW to augment these.
- C. Next 5 years: Identify pathways to achieve our emission reduction goals using advanced computer models.

