CAIC TROPHY

TECH GC 2025

Decarbonizing IIT Delhi

Sustainability / Consulting

Introduction & Motivation

IIT Delhi aims to lead climate action by achieving carbon neutrality by 2030, with an annual consumption of 25 MW of electricity and emissions of 15,000 metric tons of CO_2. The campus seeks innovative solutions to reduce its carbon footprint through renewable energy, waste management, and smart systems. The "Decarbonizing IIT Delhi" competition challenges participants to create technically innovative, economically viable, and scalable solutions to achieve a carbon-neutral campus by 2030. The competition focuses on energy integration, waste circularity, and AI-powered monitoring.

Problem Statement

Participants must develop a decarbonization roadmap tackling energy transitions, waste reuse, and carbon management using AI, IoT, and machine learning for optimization. They should focus on renewable energy, waste circularity, water-energy nexus, low-carbon transportation, and real-time monitoring. Teams must address at least three focus areas, including energy transitions, waste circularity, AI monitoring, low-carbon transportation, and carbon capture. Solutions should include a cost-benefit analysis.

Detailed Description

Your task is to develop a comprehensive decarbonization roadmap for IIT Delhi that focuses on technological innovations, optimized resource utilization, and carbon emission mitigation.
This roadmap should tackle energy transitions, resource reusability, waste circularity, and carbon management systems while integrating advanced tools like AI, IoT, and machine learning for monitoring and optimization.
Participants are encouraged to combine prototypes, data-driven simulations, and policy-level strategies to achieve actionable results.

The problem statement requires addressing the following technical challenges:

1. Renewable Energy Integration

- Replace the campus's existing grid dependence with renewable sources (e.g., solar, wind) and ensure at least 80% energy independence by 2030.
- Design Battery Energy Storage Systems (BESS) to stabilize the variability of renewable energy sources.
- Propose smart grid systems for efficient energy distribution and integration with decentralized systems like microgrids.

2. Waste Reusability and Circular Economy

Propose solutions for reusing campus-generated waste, such as:

- Organic Waste: Use anaerobic digesters to generate biogas, which can power 5–10% of the campus's energy needs.
- Plastic and Paper Waste: Develop thermal or chemical recycling techniques for material recovery.
- E-Waste: Implement advanced sorting and recycling systems to recover precious metals like gold, silver, and copper.
- Quantify the potential reductions in landfill contributions and emissions through these strategies.

3. Water-Energy Nexus

- Develop solar-powered desalination systems or energy-efficient water treatment plants for optimizing water usage and recovery.
- Integrate water recycling systems to meet at least 50% of campus irrigation and utility water demand.

4. Low-Carbon Transportation

- Design a fleet of electric or hydrogen-powered campus vehicles, supported by on-site EV charging or hydrogen refuelling stations.
- Quantify the reduction in emissions from the current campus transportation system and propose smart scheduling systems to optimize fleet usage.

5. Real-Time Monitoring and Optimization

- Use IoT sensors and AI-powered platforms to monitor energy use, waste generation, and emissions in real-time.
- Propose a digital twin model of the campus to simulate energy, waste, and water scenarios, enabling predictive analysis and optimized decision-making.

6. Geospatial and Demand Analysis

- Conduct geospatial mapping of rooftop areas, open fields, and building layouts to identify the potential for renewable energy installations.
- Assess and quantify the seasonal energy demand of the campus, proposing strategies to match supply and demand dynamically.

Quantified Example

To contextualize the scope of the problem:

- The campus generates an estimated 2,000 metric tons of organic waste annually, which could produce up to 200,000 cubic meters of biogas through anaerobic digestion, contributing to 5% of the campus's energy demand.
- A 10 MW rooftop solar system covering 100,000 square meters can offset 50% of electricity consumption, reducing 7,500 metric tons of CO_2 annually.
- Incorporating a 500 kWh BESS would stabilize renewable energy supply during peak loads.

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Solution Deliverables

Deliver a detailed roadmap supported by simulations and calculations, quantify the impact of solutions, and include a functional prototype (e.g., a smart grid or monitoring tool). Proposals should be scalable and transferable. Submit a 10–15-page report with calculations, schematics, datasets, and a technical roadmap. Finalists will present their solutions to a panel, showcasing feasibility and technical rigor.

Evaluation Parameters

- Innovation & Technical Rigor (30%): Novelty and feasibility of solutions.
- Environmental Impact (25%): Quantified reductions in emissions, waste, and energy consumption.
- Economic Viability (20%): Cost-benefit analysis and ROI.
- Scalability (15%): Replicability for other campuses.
- Presentation (10%): Clarity and use of data.

Team Size

A team can have a maximum of 5 members

Resources

- Technical data: Energy usage (25 MW/year), emissions (15,000 metric tons of CO_2/year).
- Examples: Biogas production from organic waste, rooftop solar systems, and BESS stabilization.
- Tools: AI, IoT, machine learning, and geospatial mapping.
- Quantified impacts: Biogas for 5-10% energy needs, solar systems offsetting 50% electricity consumption, reducing 7,500 metric tons of CO_2 annually.