TCS Academic Alliances Group welcomes you to

APEX Faculty Development Programme

CAPSTONE PROJECT 1

Title: Generative AI Agent for Environmental CO_2 Reduction Awareness and Action Planning

Problem Statement

Climate change and global warming are driven largely by excessive CO_2 emissions from industries, transportation, and daily human activities. Engineering professors who have completed their AI learning will build a Generative AI Agent that helps communities and individuals identify high CO_2 emission activities, generate actionable recommendations to reduce carbon footprint, and provide awareness insights. The agent should process structured and unstructured data (like activity logs, energy consumption records, or simple text queries) and return user-friendly sustainability suggestions.

This project should be completed in 15 hours and focuses on building with open-source, no fine-tuning or model training. Instead, Retrieval-Augmented Generation (RAG) and pre-trained open LLMs will be used.

Benefits

- Practical Impact: Helps users adopt eco-friendly practices to reduce carbon emissions.

- Learning Outcome: Professors gain hands-on experience with AI agents, RAG, embeddings, and structured workflows.

- Open-Source & No-Code Tools: Encourages sustainable, replicable solutions without dependency on closed APIs.

- Scalable Concept: Can be extended to educational campaigns, smart cities, or enterprises.

Technical Stack (All Open Source)

- LLM: OpenAI-compatible open-source models via Ollama or Hugging Face Inference (e.g., LLaMA 3, Mistral).

- Agent Framework: LangChain or LlamaIndex.

- Vector Database: ChromaDB (open-source).

- Embeddings: SentenceTransformers (e.g., all-MiniLM-L6-v2).

- Interface: Streamlit (simple web-based UI).

- Dataset: CSV/Excel-based structured activity data + text-based sustainability tips.

Detailed Steps

Step 1: Define Scope - Agent should answer queries like: 'How can I reduce CO_2 from commuting?' or 'What are top eco-friendly practices for households?'

Step 2: Prepare Dataset - Create a CSV with activities and approximate CO_2 emissions.

Step 3: Build Vector Store - Convert sustainability tips into embeddings using SentenceTransformers and store in ChromaDB.

Step 4: Create Agent Workflow - User enters activity or uploads small dataset. Agent retrieves relevant suggestions and generates recommendations.

Step 5: Build Simple Streamlit UI - Input box for queries, upload option for dataset, output sustainability recommendations.

Step 6: Test & Validate - Use sample dataset provided below.

Sample Input Dataset (10 rows)

Activity	Avg_CO2_Emission(kg/day)	Category
Car (Petrol, 20 km)	4.6	Transport
Bus (20 km)	1.2	Transport
Bicycle (20 km)	0.0	Transport
AC usage (8 hrs/day)	6.0	Household
LED Bulb (5 hrs/day)	0.05	Household
Old Bulb (5 hrs/day)	0.2	Household
Meat-based diet	7.0	Food
Vegetarian diet	2.0	Food

Online shopping (1)	1.0	Lifestyle
Local shopping (1)	0.3	Lifestyle

Sample User Query & Output

Input Query: “I drive 20 km daily using a petrol car. How can I reduce my CO_2 emissions?”

Agent Output:

- Current activity emits ~4.6 kg CO_2/day.
- Suggested Actions:
  - Use public bus → reduces to ~1.2 kg CO_2/day (74% reduction).
  - Consider cycling for short distances → 0 CO_2.
  - Carpooling with 3 colleagues → ~1.5 kg CO_2/day per person.
- Long-term: Consider EV adoption or hybrid models.