# 📘 PROJECT DOCUMENTATION

\*\*Project Title:\*\* Sustainable Smart City Assistant using IBM Granite LLM

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\*\*Date:\*\* \*June 2025\*

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TEAM DETAILS:

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## 📝 ABSTRACT

The Sustainable Smart City Assistant is an AI-powered solution aimed at assisting urban administrators and citizens in promoting environmentally responsible city management. It leverages IBM Watsonx Granite LLM for natural language understanding and generation, Pinecone for semantic search, and multiple AI modules to analyze urban data, summarize policy documents, generate sustainability tips, detect anomalies, forecast KPIs, and produce reports.

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## 🎯 OBJECTIVES

* - Enable citizens and authorities to interact via an intelligent chatbot.
* - Summarize uploaded city policies using LLM.
* - Predict future sustainability KPIs using historical data.
* - Detect irregularities in city performance metrics.
* - Recommend eco-friendly actions and generate city sustainability reports

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## 🛠️ TECHNOLOGIES USED

| Component | Technology |

|------------------|--------------------------------------------|

| Backend API | FastAPI |

| Frontend UI | Streamlit |

| Language Model | IBM Watsonx Granite-13B-Instruct-v2 |

| Embeddings | Hugging Face Sentence Transformers |

| Vector Database | Pinecone |

| Forecasting | Scikit-learn (Linear Regression, etc.) |

| Visualization | Matplotlib, Pandas |

| Hosting | IBM Cloud, Streamlit Cloud |

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## ⚖️ SYSTEM ARCHITECTURE

\*\*Modules:\*\*

1. \*\*Chat Assistant:\*\* Powered by IBM Granite LLM.

2. \*\*Policy Summarizer:\*\* Uses LLM + semantic vector search.

3. \*\*KPI Forecasting:\*\* Uses regression models to predict future values.

4. \*\*Anomaly Detection:\*\* Detects deviations using statistical thresholds.

5. \*\*Eco Tips Generator:\*\* Suggests helpful eco-friendly advice.

6. \*\*Sustainability Report:\*\* Compiles summaries, graphs, and forecasts.

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## 📁 SYSTEM DESIGN

### 🗂 Project Structure

sustainable-smart-city-assistant/

├── app/

│ ├── main.py

│ └── services/

│ ├── granite\_llm.py

│ ├── policy\_summarizer.py

│ ├── kpi\_forecast.py

│ ├── anomaly\_detection.py

│ ├── eco\_tips.py

│ └── sustainability\_report.py

├── frontend/

│ └── streamlit\_app.py

├── requirements.txt

├── .gitignore

└── README.md

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## ⚙️ MODULE EXPLANATION

### 1. Chat Assistant

* - Interprets user questions using IBM Granite LLM.
* - Replies with intelligent, contextual responses.

### 2. Policy Summarization

* - Upload documents → generate embedding → retrieve context → summarize using LLM.

### 3. KPI Forecasting

* - Trains ML models on existing CSV data.
* - Predicts future values of metrics like air quality, waste, etc.

### 4. Anomaly Detection

* - Flags sudden KPI spikes or drops.
* - Helps authorities take preventive action.

### 5. Eco Tips Generator

* - Recommends daily actionable steps to live sustainably.

### 6. Sustainability Report Generator

* - Combines all modules into a clean PDF report.
* - Includes summaries, forecasts, charts, and recommendations.

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## 🧪 SAMPLE USE CASES

* - \*\*User:\*\* “What are the future predictions of water consumption?”
* - \*\*Admin:\*\* Uploads a document on waste management policies and gets a summary.
* - \*\*City Analyst:\*\* Detects a spike in air pollution and generates a report with visual graphs.

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## 🧾 DEPLOYMENT DETAILS

* - IBM Granite LLM hosted on Watsonx.ai
* - Vector search using Pinecone
* - Backend deployed with FastAPI on Render/IBM Cloud
* - Frontend hosted using Streamlit Cloud

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## 📌 FUTURE SCOPE

* - Integrate real-time IoT sensor data.
* - Enable multilingual interactions.
* - Add voice-based assistant support.
* - Mobile app integration for wider reach.

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## 📚 REFERENCES

* - IBM Watsonx Documentation
* - Pinecone API Docs
* - Streamlit & FastAPI Official Docs
* - Hugging Face Sentence Transformers