**Project Design Phase**

**Solution Architecture**

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| Date | 26 june 2025 |
| Team ID | LTVIP2025TMID32104 |
| Project Name | sustainable smart city assistant using ibm granite llm |
| Maximum Marks | 4 Marks |

**Solution Architecture:**

Solution architecture is a complex process – with many sub-processes – that bridges the gap between business problems and technology solutions. Its goals are to:

* Find the best tech solution to solve existing business problems
* Describe the structure, characteristics, behavior, and other aspects of the software to project stakeholders
* Define features, development phases, and solution requirements
* Provide specifications according to which the solution is defined, managed, and delivered

**Sustainable Smart City Assistant Solution Architecture Overview**

The Sustainable Smart City Assistant follows a modular AI-based architecture that supports real-time urban governance, sustainability tracking, and citizen engagement. It leverages IBM Watsonx Granite LLM and Pinecone for natural language understanding, semantic search, and intelligent forecasting.

**Key Components:**

* Frontend:  
  Streamlit-based interactive dashboard for city administrators and citizens, supporting navigation across multiple modules (KPI dashboard, chat assistant, eco tips, feedback).
* Backend:  
  FastAPI handles routing and connects user actions to ML and LLM services, supporting modular routers (chat, feedback, summarizer, etc.).
* AI Models:  
  IBM Watsonx Granite LLM (13B Instruct) powers summarization, eco tips, anomaly analysis, and chat interactions.
* Machine Learning Modules:  
  Linear Regression for KPI forecasting and statistical anomaly detection on uploaded .csv files.
* Semantic Search:  
  Pinecone vector database indexes policy documents using Sentence Transformers (MiniLM), enabling fast semantic lookups.
* Data Integration:  
  JSON/CSV/text input support for KPI metrics, policies, and feedback.
* Configuration & Security:  
  Python-dotenv and Pydantic for managing API keys and environment variables.

**Development Phases:**

* Phase 1: Frontend layout and module routing via Streamlit sidebar
* Phase 2: Integration of policy summarization and semantic search
* Phase 3: Development of eco tips generator and anomaly detection modules
* Phase 4: Addition of KPI forecasting and AI-powered city sustainability report generation
* Phase 5: Implementation of chat assistant using IBM Granite LLM
* Phase 6: Pinecone document embedding and semantic retrieval logic
* Phase 7: Final UI/UX enhancements (theming, components, input cards, toast messages)
* Phase 8: End-to-end integration testing and deployment

This architecture ensures a scalable, modular, and real-time assistant that empowers smart cities to operate more efficiently, transparently, and sustainably using state-of-the-art AI tools.