EV vs ICE Decision Support System

1. System Objective

The objective of this system is to support informed decision-making for Electric Vehicle (EV) adoption by comparing EVs and Internal Combustion Engine (ICE) vehicles across economic cost, environmental impact, and infrastructure readiness.
The system is designed as a Decision Support System (DSS) rather than a predictive forecasting model.

2. **Data Foundation**

The system integrates multiple authoritative, policy-backed datasets into a single master dataset:
-Electricity tariffs (₹/kWh) for EV charging
-Fuel prices (₹/litre) for ICE vehicles

-Grid CO_2 emission factors (kg CO_2/kWh)
-Maintenance and replacement cost assumptions (vehicle-class level)
-Public EV charging infrastructure availability
These heterogeneous datasets are cleaned, normalized, and merged into a unified scenario-based master dataset at the level of:
(State, City, Vehicle Class, Powertrain)
This master dataset forms the single source of truth for all downstream analysis

3. Core System Architecture
The system follows a layered architecture, ensuring clarity, transparency, and extensibility.
Layer 1: Deterministic Core (Truth Layer)
This is the core of the system.
Computes cost per km, CO_2 per km, Total Cost of Ownership (TCO), and break-even

metrics
Uses explicit formulas based on physical and economic relationships
Scales results using user inputs such as distance traveled and ownership period
Does not use machine learning
Example logic:
#Running Cost = Cost_per_km × Distance
#CO_2 Emissions = CO_2_per_km × Distance
#TCO = Running Cost + Maintenance Cost + Replacement Cost
This layer is:
Fully explainable
Reproducible
Policy-aligned

Layer 2: ML Intelligence Layer (Pattern Discovery)

Machine learning is applied only after deterministic computation, where it adds analytical value.

This layer uses unsupervised learning, not prediction.

-PCA (Principal Component Analysis)

Reduces multiple correlated metrics into interpretable indices

Produces composite Economic Index and Environmental Index

-Clustering (e.g., K-Means / Hierarchical)

Groups cities into patterns such as:

EV-ready cities

Cost-advantage cities

Infrastructure-lag cities

ML is used for insight discovery, not for replacing known formulas.

Layer 3: AI Explanation Layer (Human Interface)

This layer translates numeric outputs into human-understandable explanations.

Explains why EV or ICE is better in a given scenario

Handles what-if questions, such as:
“What if fuel prices increase?”
“What if the grid becomes cleaner?”
Does not compute values
Acts purely as an interpretation and explanation layer
This improves accessibility and decision clarity.

4. **<u>Role of User Input</u>**

User input is introduced at inference time, not during data collection.
Examples:
Daily or annual travel distance
Vehicle class selection
Ownership duration
This design:
Avoids hard-coded assumptions
Keeps the dataset generic
Allows personalized scenario analysis

5. Why This Design Is Correct
Cost and emission relationships are known and deterministic → computation is correct
ML is used only where learning adds value → pattern discovery
AI is used only for explanation → transparency
The system is explainable, policy-safe, and academically defensible
6. Final System Summary (One-Line)
<u>Core → calculates truth</u>

<u>ML → finds structure in truth</u>

<u>AI → explains truth</u>