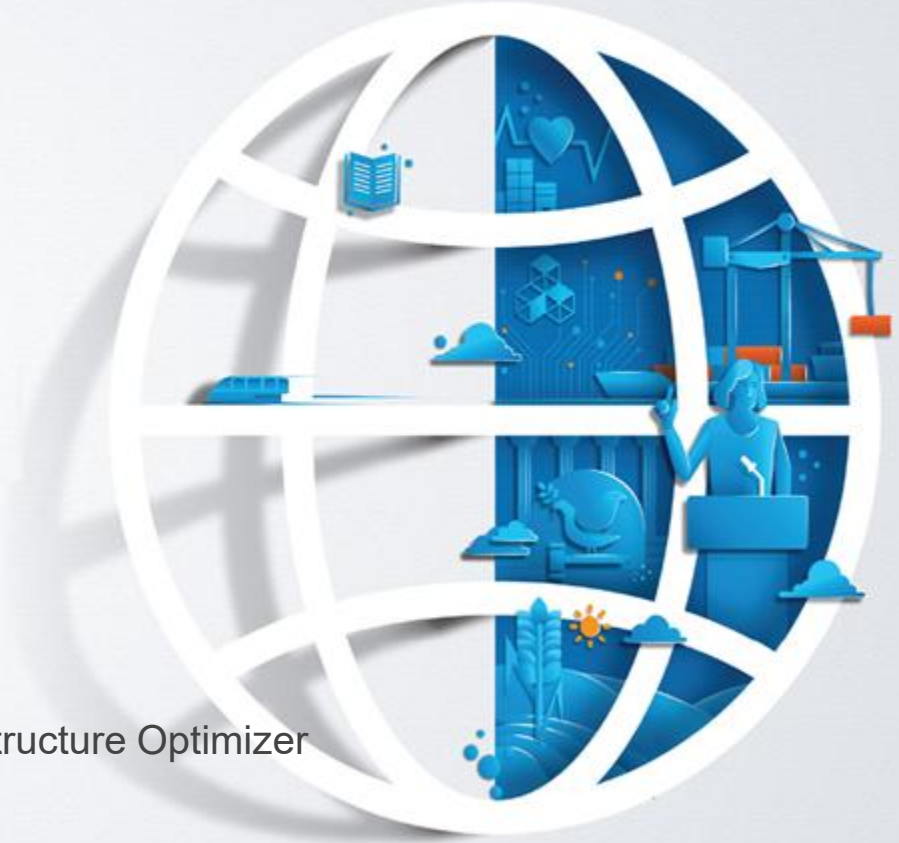
WHEN THE WORLD IS YOUR CLIENT

Infosys Global Hackathon



Team name: E-WE

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Problem Statement: AI- Driven EV Infrastructure Optimizer

Problem

India’s push toward electric vehicle (EV) adoption is hindered by a fragmented and inefficient charging ecosystem. EV users often face:

- Long and uncertain wait times at charging stations.
- Poor visibility of real-time charger availability.
- Sub-optimal routing, leading to range anxiety.
- Lack of integration between fixed charging stations and battery swapping points.
- Lack of consistency in standards, with incompatible plugs and communication protocols causing confusion and charging issues.

The challenge lies in efficiently managing existing infrastructure and providing smart, predictive, and coordinated services for a seamless user experience.

Solution

We propose ChargeSmart, an AI-powered platform designed to:

- Predict demand and usage patterns at charging/swapping points using real-time and historical data.
- Provide intelligent routing for EVs to nearby available stations or swapping centers, minimizing wait times and distance.
- Enable dynamic coordination between fixed chargers and battery swapping networks based on user preference and urgency.
- Optimize infrastructure utilization across the city using AI-based scheduling, reservation, and load-balancing mechanisms.
- Promote standardization by identifying compatibility issues and guiding users to stations that support their EV's charging standards.

The platform will offer:

- A web app for EV users to find, book, and navigate to the best available charging/swapping point.
- A dashboard for operators to monitor usage, forecast demand, and optimize resource deployment.

Technical Outline

A. Data Sources

- Real-time charger/swap point availability (IoT devices, operator APIs).
- Historical charging patterns (time, duration, location).
- Traffic and road data (via Google Maps/OpenStreetMap APIs).
- User preferences and battery status.
- For the hackathon, we will use mock datasets and randomized time-series updates to simulate real-time availability.

B. Core Components

1. Predictive Analytics Engine
- Time-series forecasting (Prophet/ARIMA/LSTM) to predict demand at each station.
- Clustering algorithms to identify usage hotspots.

2. Smart Routing Engine
- Graph-based shortest path algorithms enhanced with wait-time prediction and charger type.
- Dynamic rerouting using A* or Dijkstra with real-time availability.
- Includes a compatibility checker that filters stations based on the user's EV plug type and communication protocol.

3. Charging-Swapping Coordination Module
- Decision engine using rule-based logic to recommend optimal swap/charge based on cost, urgency, and station load.
- Considers compatibility constraints to avoid misrouting users to incompatible stations.

4. Load Balancer & Reservation System
- AI models (e.g., heuristic-based slot allocation systems) to dynamically reserve or defer slots based on predicted demand.
- Incentivization engine to redirect users to less busy stations via gamification or discounts.

Platform Architecture

Frontend: Responsive web application using React.js and Mapbox/Leaflet for map-based UI.
Backend: Node.js (Express) REST API for station data, bookings, and user interactions
Real-Time Updates: WebSocket (Socket.io) or Firebase Realtime DB to simulate live station status.
AI/ML Models: Built using scikit-learn (e.g., XGBoost/Linear Regression) and deployed as a Python Flask API
Database: MongoDB Atlas for storing station metadata, bookings, and usage history
Hosting: Frontend: Vercel or Netlify
Backend: Render / Railway
ML Model API: Render / Replit / PythonAnywhere
MVP Note:
Real-time station load will be simulated using a dummy event generator script
AI will predict expected station congestion using time-series mock data
No mobile app in MVP — fully web-first and desktop/mobile browser compatible

Novelty of the Solution

- AI-First Charging Ecosystem: Unlike existing apps that just show static availability, ChargeSmart predicts, recommends, and reserves based on live city-wide intelligence.
- Dual Optimization: Considers both EV user convenience and station operator ROI.
- Interoperability Layer: First-of-its-kind integration of battery swapping and charging stations with dynamic handoff capability.
- Compatibility-Aware Intelligence: Automatically filters and recommends only those stations compatible with a user's EV plug type and charging protocol—reducing confusion and stranded users.
- Sustainability-Aware Routing: Allows routing based on renewable-powered stations, contributing to SDG 7 and 13.
- Micro-Incentivization Engine: Uses AI to nudge user behavior for optimal load distribution.
- Our MVP also showcases how predictive AI can be embedded into web-based tools for smart infrastructure, providing a proof-of-concept for scalable deployment.