EV CHARGING MANAGEMENT SYSTEM – COMPLETE DOCUMENTATION

1. PROJECT OVERVIEW

The EV Charging Management System is a complete software platform designed to manage electric vehicle charging infrastructure, charger operations, user activities, transactions, payments, tariffs, monitoring, reporting, and OCPP communication.

The system provides a centralized admin panel where Super Admins and operational teams can manage:

- Clients
- Locations
- Charging Stations (Hubs)
- Chargers (Units)
- Connectors (Guns)
- User accounts
- Wallets & payments
- Live charging sessions
- OCPP communication
- Reports & analytics
- Commission management
- Tariff configuration

The platform supports scalable EV charging operations with secure authentication, role-based access control, real-time monitoring, and payment integration.

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2. SYSTEM ARCHITECTURE OVERVIEW

The system follows a hierarchical infrastructure model.

Infrastructure Hierarchy

Client ↓ Location (Site) ↓ Hub (Station) ↓ Unit (Charger) ↓ Gun (Connector)

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3. MODULE-WISE COMPLETE DOCUMENTATION

MODULE 1: SUPER ADMIN LOGIN & AUTHENTICATION

Purpose

This module handles secure login access for administrators and system users.

Features

- Secure authentication
- Role-based access control
- Session management
- Password encryption
- Dashboard access
- User activity tracking
- Login history
- Forgot password
- OTP / Email verification (Optional)

Login Fields

Field Name	Type	Description
Email	String	Registered email address
Password	Password	Encrypted password
Remember Me	Checkbox	Maintain login session
OTP	Number	Optional verification code

User Roles

Role	Access
Super Admin	Full system access
Admin	Operational management
Client Admin	Client-specific access
Support Team	Monitoring & support
Finance Team	Payment & revenue access

Authentication Flow

1. User enters credentials
2. System validates user
3. Password checked using encryption
4. Role permissions loaded
5. Dashboard access granted
6. Login history saved

MODULE 2: INFRASTRUCTURE SETUP (HIERARCHY)

2.1 CLIENT MANAGEMENT

Purpose

Client management handles organizations or businesses that own charging infrastructure.

Features

- Create client
- Edit client
- Delete client
- Client profile management
- Client status control
- Client filtering
- Client search

Client Fields

Field	Type	Description
Client ID	Auto Generated	Unique client identifier
Client Name	Text	Company/business name
Contact Person	Text	Client representative
Email	Email	Client email
Mobile Number	Number	Contact number
Address	Text Area	Full address
City	Text	City name
State	Text	State name
Country	Text	Country

Field	Type	Description
Pincode	Number	Postal code
GST Number	Text	Tax number
Status	Dropdown	Active / Inactive
Logo	Image	Client logo
Created Date	DateTime	Creation timestamp

Operations

Create Client

Adds a new client into the system.

Edit Client

Updates existing client information.

Delete Client

Removes client after validation checks.

Client Listing

Displays all clients with filters and search.

2.2 LOCATION (SITE) MANAGEMENT

Purpose

Locations represent physical charging sites under a client.

Features

- Create location
- Edit location
- Delete location
- Assign client
- Map hubs
- Location listing
- Search & filters

Location Fields

Field	Type	Description
Location ID	Auto Generated	Unique location identifier
Client Name	Dropdown	Parent client
Location Name	Text	Site name
Site Code	Text	Internal site code
Address	Text Area	Full address
Latitude	Decimal	GPS latitude
Longitude	Decimal	GPS longitude
Contact Person	Text	Site contact
Contact Number	Number	Phone number
Opening Time	Time	Operating start
Closing Time	Time	Operating end
Parking Slots	Number	Available parking
Status	Dropdown	Active / Inactive
Created Date	DateTime	Creation date

Functional Flow

Client → Multiple Locations

2.3 HUB (STATION) MANAGEMENT

Purpose

Hubs represent charging stations under a location.

Features

- Create hub
- Edit hub
- Delete hub
- Hub mapping
- Hub listing
- Charger assignment

Hub Fields

Field	Type	Description
Hub ID	Auto Generated	Unique hub identifier
Client	Dropdown	Parent client
Location	Dropdown	Parent location
Hub Name	Text	Station name
Hub Code	Text	Unique station code
Address	Text Area	Station address
Status	Dropdown	Active / Inactive
Total Units	Number	Total chargers
Created Date	DateTime	Created timestamp

Functional Flow

Location → Multiple Hubs

2.4 UNIT (CHARGER) MANAGEMENT

Purpose

Units represent EV charging machines.

Features

- Create charger
- Configure charger
- Edit charger
- Delete charger
- OCPP mapping
- Charger listing
- Status tracking

Unit Fields

Field	Type	Description
Unit ID	Auto Generated	Unique charger ID
Client	Dropdown	Parent client
Location	Dropdown	Parent location

Field	Type	Description
Hub	Dropdown	Parent hub
Charger Name	Text	Charger name
Charger Serial No	Text	Device serial number
Charger Type	Dropdown	AC / DC
Max Power	Decimal	Charger capacity
OCPP Version	Dropdown	OCPP protocol version
IP Address	Text	Network IP
Firmware Version	Text	Firmware information
Status	Dropdown	Active / Inactive
Connectivity Status	Dropdown	Online / Offline
Created Date	DateTime	Creation date

Charger Types

AC Charger

Slow / medium charging

DC Charger

Fast charging

2.5 UNIT CONFIGURATION

Purpose

Stores technical charger configuration details.

Features

- Voltage configuration
- Current configuration
- Power capacity
- Connector mapping
- OCPP configuration
- Firmware configuration

Configuration Fields

Field	Type	Description
Unit Type	Dropdown	AC / DC
Voltage	Decimal	Input voltage
Current	Decimal	Input current
Power Capacity	Decimal	Maximum power
Frequency	Decimal	Electrical frequency
Connector Count	Number	Total connectors
Communication Type	Dropdown	Ethernet / GSM / WiFi
OCPP URL	URL	WebSocket endpoint
Heartbeat Interval	Number	OCPP heartbeat
Meter Value Interval	Number	Meter reading interval

2.6 GUN (CONNECTOR) MANAGEMENT

Purpose

Represents charging connectors attached to chargers.

Features

- Connector configuration
- Gun mapping
- Connector type setup
- Gun status monitoring

Gun Fields

Field	Type	Description
Gun ID	Auto Generated	Unique gun ID
Unit	Dropdown	Parent charger
Gun Number	Number	Connector number
Connector Type	Dropdown	CCS2 / Type2 / CHAdeMO
Power Rating	Decimal	kW output
Status	Dropdown	Available / Charging / Fault

Field	Type	Description
Gun Serial Number	Text	Connector serial number

Connector Types

Type	Description
CCS2	DC fast charging
Type 2	AC charging
CHAdeMO	DC charging standard
GB/T	Chinese EV connector

MODULE 3: CHARGER ONBOARDING

Purpose

Handles registration and provisioning of chargers into the platform.

Features

- Charger onboarding
- Device registration
- OCPP registration
- Mapping infrastructure
- Provisioning

Onboarding Flow

Client → Location → Hub → Unit → Gun

Onboarding Fields

Field	Type	Description
Charger Serial Number	Text	Unique charger serial
OCPP ID	Text	OCPP charger identity
SIM Number	Number	SIM identifier
IMEI Number	Text	Device IMEI
Firmware Version	Text	Firmware information
Configuration Profile	Dropdown	Technical profile

Field	Type	Description
Connectivity Type	Dropdown	GSM / Ethernet / WiFi
Status	Dropdown	Provisioned / Pending

Workflow

1. Register charger
2. Assign charger to location
3. Configure OCPP
4. Map connectors
5. Activate charger
6. Verify communication

MODULE 4: OCPP INTEGRATION

Purpose

Provides real-time communication between chargers and server.

Supported OCPP Functions

- Boot notification
- Heartbeat
- Meter values
- Start transaction
- Stop transaction
- Status notification
- Remote start
- Remote stop
- Firmware update
- Diagnostics

OCPP Communication Flow

Charger ↔ WebSocket ↔ OCPP Server ↔ Management System

OCPP Status Types

Status	Description
Available	Ready for charging
Preparing	User preparing session
Charging	Charging active

Status	Description
SuspendedEV	EV paused
SuspendedEVSE	Charger paused
Finishing	Session ending
Reserved	Reserved charger
Faulted	Technical issue
Unavailable	Offline/unavailable

OCPP Data Fields

Field	Description
Transaction ID	Charging session ID
Meter Start	Initial meter value
Meter Stop	Final meter value
Energy Consumption	Consumed energy
Voltage	Electrical voltage
Current	Electrical current
Power	Real-time power
Temperature	Device temperature
Timestamp	Event timestamp

MODULE 5: DASHBOARD & MONITORING

Purpose

Provides centralized monitoring and analytics.

Dashboard Features

- KPI cards
- Real-time charger status
- Revenue analytics
- Session monitoring
- Fault alerts
- Live maps
- Filtering
- Graphs & charts

Dashboard KPI Metrics

KPI	Description
Total Clients	Total registered clients
Total Locations	Total sites
Total Chargers	Total charging units
Active Sessions	Current charging sessions
Revenue	Total earnings
Energy Delivered	Total energy supplied
Fault Chargers	Faulty chargers
Online Chargers	Active online chargers

Real-Time Monitoring Fields

Field	Description
Charger Status	Online / Offline
Session Status	Active / Completed
Energy Consumption	Live energy usage
Current Power	Live power reading
Cost	Current session amount
Duration	Charging duration

MODULE 6: USER MANAGEMENT

Purpose

Manages EV users and their wallet information.

Features

- User registration
- User search
- Wallet management
- Session history
- Enable/disable users
- Payment history

User Fields

Field	Type	Description
User ID	Auto Generated	Unique user ID
Full Name	Text	User name
Email	Email	User email
Mobile Number	Number	Contact number
Vehicle Number	Text	EV registration number
Vehicle Type	Dropdown	Car / Bike / Bus
Wallet Balance	Decimal	Current wallet amount
Status	Dropdown	Active / Blocked
Registration Date	DateTime	User created date

Wallet Features

- Wallet top-up
- Auto deduction
- Refund management
- Transaction history

MODULE 7: PAYMENT MANAGEMENT

Purpose

Handles financial transactions and wallet operations.

Features

- Payment gateway integration
- Wallet recharge
- Auto deduction
- Refund management
- Transaction tracking
- Payment history

Supported Gateways

- Razorpay
- Stripe
- UPI
- Credit Card

- Debit Card
- Net Banking

Payment Fields

Field	Type	Description
Transaction ID	Text	Unique transaction number
User ID	Reference	Linked user
Amount	Decimal	Payment amount
Payment Method	Dropdown	UPI/Card/Wallet
Gateway Response	Text	Payment response
Status	Dropdown	Success / Failed
Transaction Date	DateTime	Payment time

Payment Flow

1. User adds wallet balance
2. Payment gateway processes payment
3. Wallet updated
4. Charging starts
5. Amount auto deducted
6. Transaction saved

MODULE 8: TARIFF MANAGEMENT

Purpose

Defines charging pricing structures.

Features

- Dynamic pricing
- Time-based tariff
- Location-based tariff
- Charger-based tariff
- Unit-based pricing

Tariff Fields

Field	Type	Description
Tariff ID	Auto Generated	Unique tariff ID

Field	Type	Description
Tariff Name	Text	Pricing plan
Client	Dropdown	Client mapping
Location	Dropdown	Location mapping
Hub	Dropdown	Hub mapping
Unit	Dropdown	Charger mapping
Gun	Dropdown	Connector mapping
Price Per kWh	Decimal	Charging price
Idle Fee	Decimal	Idle penalty
Parking Fee	Decimal	Parking charge
GST Percentage	Decimal	Tax percentage
Effective Date	Date	Tariff activation
Status	Dropdown	Active / Inactive

Pricing Types

Pricing Type	Description
Per kWh	Based on energy
Per Minute	Based on time
Fixed Cost	Fixed amount
Dynamic Pricing	Variable pricing

MODULE 9: CLIENT COMMISSION MANAGEMENT

Purpose

Calculates revenue sharing and commissions.

Features

- Profit calculation
- Commission configuration
- Commission reports
- Client-wise revenue
- Hub-wise commission

Commission Fields

Field	Type	Description
Commission ID	Auto Generated	Unique ID
Client	Dropdown	Client name
Commission Type	Dropdown	Percentage / Fixed
Commission Value	Decimal	Commission amount
Revenue Amount	Decimal	Total revenue
Profit Amount	Decimal	Calculated profit
Settlement Status	Dropdown	Pending / Paid
Settlement Date	Date	Settlement date

Commission Calculation

Revenue - Platform Charges - Taxes = Client Profit

MODULE 10: REPORTS & ANALYTICS

Purpose

Provides detailed business reports and operational analytics.

Available Reports

- Session report
- Energy report
- Revenue report
- Client report
- Location report
- User report
- Fault report
- Payment report
- Commission report

Report Filters

Filter	Description
Date Range	Filter by dates
Client	Filter by client
Location	Filter by location

Filter	Description
Charger	Filter by charger
User	Filter by user
Status	Filter by status

Session Report Fields

Field	Description
Session ID	Charging session ID
User Name	EV user
Charger Name	Charger used
Connector	Connector used
Start Time	Session start
End Time	Session end
Energy Used	kWh consumed
Duration	Charging duration
Cost	Final amount
Status	Completed/Failed

MODULE 11: TESTING & DEPLOYMENT

Purpose

Ensures system quality, security, and production readiness.

Testing Types

Testing	Description
Unit Testing	Individual module testing
Integration Testing	API & module testing
Performance Testing	Load testing
Security Testing	Vulnerability testing
UAT Testing	User acceptance testing
OCPP Testing	Charger communication testing

Deployment Steps

1. Server setup
2. Database configuration
3. Environment setup
4. Build deployment
5. SSL configuration
6. WebSocket deployment
7. Monitoring setup
8. Backup configuration

Production Monitoring

- Error monitoring
- Performance tracking
- Server health
- Database monitoring
- API monitoring
- OCPP connectivity monitoring

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4. SIMPLE USER FLOW

EV User Charging Flow

Step 1: User Registration

User creates account and logs in.

Step 2: Wallet Recharge

User adds money using payment gateway.

Step 3: Charger Discovery

User searches nearby charger.

Step 4: Charger Connection

User selects charger and connector.

Step 5: Charging Starts

Charging session begins.

Step 6: Live Monitoring

System tracks charging in real-time.

Step 7: Charging Stops

Session completed.

Step 8: Amount Deduction

Wallet amount deducted automatically.

Step 9: Session Saved

Complete charging history stored.

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5. DATABASE TABLE OVERVIEW

Core Tables

Table Name	Purpose
users	Stores user accounts
clients	Stores client data
locations	Stores site information
hubs	Stores station details
units	Stores chargers
guns	Stores connectors
tariffs	Pricing configuration
sessions	Charging session history
transactions	Payment records
commissions	Revenue sharing
ocpp_logs	OCPP communication logs
firmware_updates	Firmware management
notifications	Alerts & notifications

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6. TECHNOLOGIES USED

Backend

- Laravel (PHP)
- REST APIs
- WebSocket Server

- Queue Jobs

Frontend

- Blade Templates
- HTML5
- CSS3
- JavaScript
- Bootstrap

Database

- MySQL

Real-Time Communication

- WebSocket
- Pusher
- OCPP

Payment Integration

- Razorpay
- Stripe

Security

- JWT/Auth
- Password Encryption
- SSL
- Role Permissions

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7. API MODULES

Main APIs

API	Purpose
Login API	Authentication
User API	User management
Charger API	Charger operations
OCPP API	Charger communication
Payment API	Transactions
Tariff API	Pricing management

API	Purpose
Report API	Analytics & reports

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8. SECURITY FEATURES

Security Implementations

- Password hashing
- JWT authentication
- Role-based permissions
- Secure APIs
- HTTPS/SSL
- Input validation
- SQL injection prevention
- XSS protection
- API token validation

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9. NOTIFICATION SYSTEM

Notification Types

- Charging started
- Charging stopped
- Payment success
- Payment failure
- Charger offline
- Fault alerts
- Firmware update alerts

Channels

- SMS
- Email
- Push Notification
- In-app notification

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10. FIRMWARE MANAGEMENT

Features

- Firmware version visibility
- Remote firmware update

- Update scheduling
- Firmware history
- Rollback support

Firmware Fields

Field	Description
Firmware Version	Current version
Update Status	Pending/Completed
Release Notes	Update details
Device Compatibility	Supported devices
Updated Date	Update timestamp

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11. SESSION MANAGEMENT

Charging Session Lifecycle

Available → Preparing → Charging → Finishing → Completed

Session Data Captured

- Session ID
- User details
- Charger details
- Energy consumed
- Duration
- Tariff applied
- Cost calculation
- Meter readings
- Payment status

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12. FUTURE ENHANCEMENTS

Planned Features

- Mobile application
- AI-based analytics
- Smart load balancing
- Solar integration
- Vehicle-to-grid support
- Reservation system
- Dynamic energy optimization

- Multi-language support
- Multi-currency support
- GIS map integration

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13. CONCLUSION

The EV Charging Management System is a scalable and enterprise-level platform designed for complete EV charging infrastructure management.

The platform provides:

- Infrastructure hierarchy management
- Secure authentication
- Real-time charger communication
- OCPP integration
- Wallet & payment management
- Live monitoring
- Reports & analytics
- Commission management
- Scalable deployment architecture

This system supports efficient EV charging operations, business management, user engagement, and real-time infrastructure monitoring.