EV CHARING SLOT RESERVATION & LOAD MANAGEMENT

Use Case Diagram

1. Actors

1. **EV User**
   The end-user who searches stations, books slots, starts charging, and receives alerts.

2. **Station Operator**
   Manages charger status, views dashboard, handles faults and on-ground issues.

3. **System Admin**
   Responsible for managing stations, chargers, pricing rules, and configurations.

4. **Load Management Engine**
   Backend service that calculates load and distributes power.

5. **Pricing Engine**
   Calculates dynamic pricing based on demand, time of day, and membership.

6. **Notification Service**
   Sends booking confirmations, reminders, queue updates, charging alerts.

7. **Charger IoT / Telemetry System**
   Sends real-time charger status: Available, In Use, Faulty, Offline, Temperature, Load.

2. Use Cases

2.1 Slot Reservation

1. **Search Stations** – User searches nearby stations by GPS or location.

2. **View Charger Status** – User checks real-time charger availability at a station.

3. **View Time Slots** – User sees all available/reserved/blocked time slots.

4. **Reserve Slot** – User books a time slot.

5. **Modify / Cancel Booking** – User updates or cancels an existing booking.

6. **Auto-Expire Booking** – System auto-expires if user doesn't arrive within 10 min.

2.2 Queue Management

7. **Join Virtual Queue** – User automatically added when all slots full.

8. **View Queue Position** – User sees real-time queue position.

9. **Confirm Queue Slot** – User confirms reserved slot when notified.

2.3 Charging Session

10. **Start Charging Session** – Session starts when vehicle connects.

11. **Monitor Charging Session** – System tracks energy consumed, duration, temperature.

12. **Stop Charging Session** – Automatic/manual session stop when completed.

2.4 Load Management

13. **Calculate Station Load** – Load engine calculates power load every few seconds.

14. **Enforce Load Threshold** – Delay/deny charging if station overloads.

15. **Dynamic Load Balancing** – Intelligent power distribution across chargers.

16. **Emergency Priority** – Emergency vehicles bypass queue/load rules.

2.5 Dynamic Pricing

17. **Compute Pricing** – Pricing engine calculates base and dynamic rates.

18. **Membership Discount** – Discounts applied for premium users.

19. **Refresh Pricing** – Recalculate pricing every 15 minutes.

2.6 Notifications

20. **Send Booking Confirmation**

21. **Send 30-Min Reminder**

22. **Send Queue Alerts**

23. **Send Charging Complete Notification**

24. **Send Fault Alerts to Operator**

2.7 Operator/Admin

25. **View Operator Dashboard** – Status, load, faults, bookings.

26. **Mark Charger Faulty / Active**

27. **Manage Stations & Chargers**

28. **Manage Pricing Rules**

29. **View Demand Forecast**

3. Use Case Relationships

Relationship	Description
EV User → Search Stations	Primary interaction
EV User → Reserve Slot	Main booking flow
Reserve Slot → «include» → Compute Pricing	Pricing must be calculated before confirmation
Reserve Slot → «include» → Send Booking Confirmation	Notification after booking
Auto-Expire → «extend» → Reserve Slot	Happens when user does not show
Join Queue → «include» → Send Queue Alerts	User receives queue updates
Start Charging → «include» → Monitor Charging	Real-time tracking
Monitor Charging → Load Management Engine	Telemetry triggers load adjustments
Price Engine → Refresh Pricing	Updates every 15 minutes
Operator → Dashboard	Operational monitoring
IoT → View Status	Sends telemetry

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4. Summary

This Use Case diagram represents all the key interactions between the system and users. It shows how EV users, operators, admins, and automated backend engines work together to deliver real-time slot booking, charging, load management, and notifications.