1. **Electric Vehicles (EV) Agents:**

Attributes:

1. Battery Capacity. Between 50 and 100 kWh.
2. Average kilometer per day, which decreases the battery by X percentage a day. This percentage needs to be charged daily.

States:

1. Current Charge Level: Current energy level in the battery (e.g., 20 kWh).
2. Charging Status: Indicates if the vehicle is currently charging or not.

Actions:

1. Start Charging: Begins the charging process.
2. Stop Charging: Ends the charging process.
3. Adjust Charging Rate: Modifies the rate of charging based on charger availability and load balancing.
4. Get charge level
5. **EV Chargers (Level 2 with Dynamic Load Balancing)**

States:

1. Availability: Indicates if the charger is available or in use.
2. Charging Power: Power output of the charger. Between 6 and 48 amps. Voltage is 240v.
3. Current Output Amperage: The current amperage output, adjusted for load balancing.

Actions:

1. Activate Charger: Turns the charger on when an EV is connected.
2. Deactivate Charger: Turns the charger off when charging is complete or EV is disconnected.
3. Adjust Output Amperage: Changes the amperage output for dynamic load balancing based on the number of active chargers in the circuit.

**C) Electrical Panel**

Attributes:

1. Number of breakers, each breaker having a rating between 20 to 50 amps.

Status:

1. Connected Load: Total current load being drawn of devices connected to the breaker.

**D) Define Charging Time Windows**

- Peak Hours: Identify peak hours when most residents are likely to charge their EVs (e.g., evening hours after work).

- Off-Peak Hours: Determine off-peak hours with lower charging activity (e.g., late night, early morning).

- Variable Hours: Include hours with variable charging activity (e.g., midday for residents who work from home).

**6. Assign Charging Patterns to EVs**

- Random Assignment: Randomly assign EVs to preferred charging time windows based on typical resident behavior.

- Fixed Schedule: For some EVs, assign fixed charging schedules based on known resident routines.

- Probability Distribution: Use a probability distribution to model the likelihood of an EV charging at different times of the day.

**7. Model Daily Charging Cycles**

- Start and End Times: Each EV should have a programmed start and end time for charging within its assigned window.

- Duration: Determine the duration of each charging session based on the EV’s battery capacity and charger output.

**8. Incorporate Dynamic Load Balancing**

- Adjust Charging Rates: Automatically adjust charger output during peak hours to manage the load on the electrical panel and prevent overloading.

**Initial Conditions:**

1. Current number of EV chargers.
2. Capacity of the electrical panel and breakers.
3. Initial number of EVs (agents) in the building.
4. Growth Rate of EV Owners

**Charging Patterns:**

1. Average charging time and frequency for each EV.
2. Peak and off-peak charging hours.

**EV and Charger Specifications:**

1. Battery capacity and charging rate of typical EVs.
2. Charger output and dynamic load balancing capabilities.

**Infrastructure Limits:**

1. Maximum capacity of electrical panel and breakers.
2. Limits on the number of chargers that can be installed.

**Steps to Simulate:**

Year-by-Year Simulation:

1. For each year, increase the number of EVs based on the growth rate.

Simulate daily charging patterns for all EVs:

Load Analysis:

1. Calculate the total power demand from EVs each day.
2. Include dynamic load balancing in the calculation.

Infrastructure Check:

1. Determine if the demand exceeds the capacity of the electrical panel or breakers.
2. Check if the number of chargers is adequate to meet the demand without causing delays or inconvenience.

Outputs:

1. Identify the year when the infrastructure becomes insufficient.
2. Assess whether the limitation is due to panel capacity or the number of chargers.

Recommendations:

1. Suggest the year when an upgrade to the electrical panel is necessary.
2. Propose when additional chargers should be installed.