

Entities and Their Attributes

1. User

- **Attributes:**
 - `user_id` (Primary key, unique identifier for each user)
 - `name`
 - `email`
 - `phone_number`
 - `address`
 - `account_type` (Residential/Commercial)
- **Participation:** Mandatory in the system as every interaction (e.g., usage tracking, billing) involves a user.
- **Description:** Represents electricity consumers (either residential or commercial).

2. Electric Meter

- **Attributes:**
 - `meter_id` (Primary key, unique identifier for each meter)
 - `user_id` (Foreign key, linking the meter to a user)
 - `installation_date`
 - `Location`
- **Participation:** Mandatory because users need a meter to track their consumption.
- **Description:** Represents the device that tracks electricity usage for each user.

3. Electricity Usage

- **Attributes:**
 - `usage_id` (Primary key)
 - `meter_id` (Foreign key, linking usage to a specific meter)
 - `start_time` (When usage started)
 - `end_time` (When usage ended)
 - `total_usage` (Amount of electricity used, in kWh)

- **Participation:** Optional for new users, but mandatory for tracking active users' consumption.
- **Description:** Tracks the electricity consumed during a specific period.

4. Bill

- **Attributes:**
 - `bill_id` (Primary key)
 - `meter_id` (Foreign key)
 - `amount_due`
 - `due_date`
 - `status` (Paid/Unpaid)
 - `Issue_date`
- **Participation:** Mandatory for all users, as every user is billed for their electricity Usage.
- **Description:** Represents billing information based on usage data.

5. Notification

- **Attributes:**
 - `notification_id` (Primary key)
 - `user_id` (Foreign key, identifying the user receiving the notification)
 - `message`
 - `sent_date`
 - `status` (Read/Unread)
- **Participation:** Optional for users, as notifications are sent based on specific events (e.g., overdue bills, high usage alerts).
- **Description:** Represents notifications sent to users regarding bill payments, usage thresholds, etc.

6. Appliance

- **Attributes:**
 - `appliance_id` (Primary key)
 - `name`
 - `power_rating` (In watts)

- **usage_rate** (Cost per kWh)
- **Participation:** Optional for users who want to estimate the cost of appliance usage.
- **Description:** Represents appliances that users can estimate electricity costs for.

7. Usage Estimation

- **Attributes:**
 - **estimation_id** (Primary key)
 - **user_id** (Foreign key)
 - **appliance_id** (Foreign key)
 - **usage_duration** (Time the appliance was used, in hours)
 - **estimated_cost** (Cost calculated for the given usage)
- **Participation:** Optional, only when a user chooses to estimate the cost of specific appliance usage.
- **Description:** Represents the feature allowing users to estimate electricity costs for individual appliances.

Relationships

1. User–Electric Meter

- **Relationship Name:** "Assigned"
- **Cardinality:** One user can have one or more electric meters, but each meter is assigned to only one user.
- **Type:** 1
(One-to-Many)
- **Participation:** Mandatory for both. Every user must have at least one meter, and every meter must be assigned to a user.

2. Electric Meter–Electricity Usage

- **Relationship Name:** "Records"
- **Cardinality:** One meter can record multiple usage sessions, but each session is recorded by one meter.
- **Type:** 1
(One-to-Many)

- **Participation:** Mandatory for the meter, optional for usage (new users may not have usage records yet).

3. Electric Meter–Bill

- **Relationship Name:** "Generates"
- **Cardinality:** One meter generates many bills over time, but each bill is associated with one meter.
- **Type:** 1
(One-to-Many)
- **Participation:** Mandatory for both. Each user must receive bills based on their meter's readings.

4. User–Notification

- **Relationship Name:** "Receives"
- **Cardinality:** One user can receive multiple notifications, but each notification is sent to only one user.
- **Type:** 1
(One-to-Many)
- **Participation:** Optional for the user (notifications are event-driven).

5. User–Usage Estimation

- **Relationship Name:** "Requests"
- **Cardinality:** One user can request many usage estimations, but each estimation belongs to one user.
- **Type:** 1
(One-to-Many)
- **Participation:** Optional, as not all users will use this feature.

6. Appliance–Usage Estimation

- **Relationship Name:** "Estimates"
 - **Cardinality:** One appliance can be used in many usage estimations, but each estimation involves one appliance.
 - **Type:** 1
(One-to-Many)
 - **Participation:** Optional for both entities (only involved when users estimate appliance costs).
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Entity Relationship	Cardinality	Participation
User–Electric Meter	1	Mandatory for both
Electric Meter–Electricity Usage	1	Mandatory for meter, optional for usage
Electric Meter–Bill	1	Mandatory for both
User–Notification	1	Optional for user
User–Usage Estimation	1	Optional for both
Appliance–Usage Estimation	1	Optional for both

Cardinality and Participation Summary

Diagram Notes

- **Weak Entity:** The **Usage Estimation** entity can be a weak entity, dependent on the **User** and **Appliance**.
- **Primary Keys (PK):** Ensure each entity has a unique identifier (**user_id**, **meter_id**, etc.).
- **Foreign Keys (FK):** Relationships are established using foreign keys (**user_id**, **meter_id**, etc.) to connect related entities.
- **Participation:** Denote mandatory participation with a double line (||) and optional participation with a single line (|) when drawing the relationships.