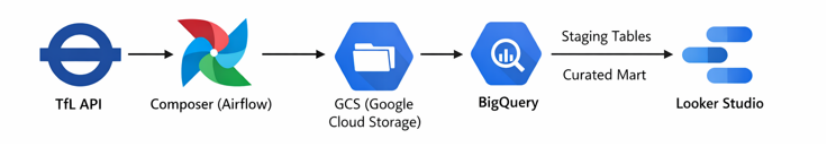
Implementation of EV Charging Points in Central London

Data Source Selection

- Primary Datasource - TfL Unified API (https://api.tfl.gov.uk/)
  - UK's National Chargepoint Registry (NCR) provided open data on EV chargers but was decommissioned on `Nov 28, 2024`.
- **Endpoint:** `/Place/Type/ChargeStation` & `/Place/Type/ChargeConnector`
- **Coverage:** Greater London
- **Format:** JSON (semi-structured)
- **Environment:** GCP (BigQuery + Composer + Looker Studio)
- **GitHub Repository:** GitHub - lakshang/ev-charging-pipeline: Data is sourced from Transport for London(TfL) Unified API via automated ETL pipeline

Architecture

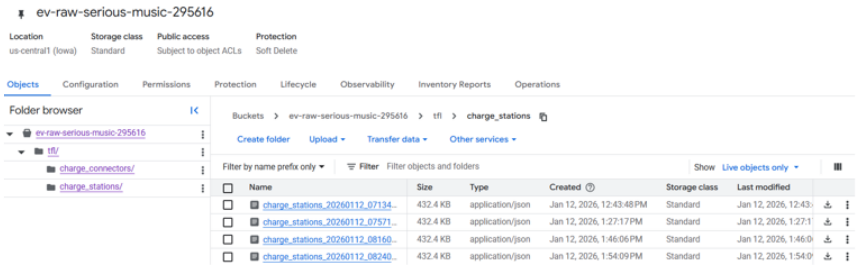


- GCP Components

Component	Role
Cloud Composer (Airflow)	Scheduled Orchestration
GCS	Raw JSON archival & traceability
BigQuery	Staging + Curated Analytical Storage
Looker Studio	Analytics Consumption
IAM/ GCP Service Accounts	Access Control

Pipeline Design

- **Extract**
  - Data pulled from TfL API
  - Stored as timestamped snapshots in GCS for reproducibility
  - Supports audit + historical backfill



- **Load**
  - Big Query Staging Tables:

Table Name	Purpose
stg_ev_stations	Normalized station entities
stg_ev_connectors	Connector-level enrichment

- **Transform**
  - Curated Fact Table: mart_ev_charger → 1 row per connector
  - ID normalization between station + connector
  - Status normalization (charging → in_use, available → operational)
  - Speed classification (slow, fast, rapid)
  - Central London filtering via bounding box
  - Operator standardization

Bounding box used (approximate core London):

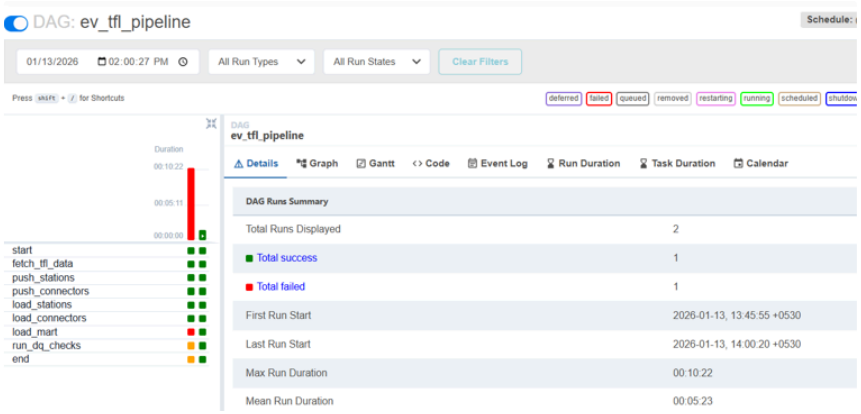
```
lat BETWEEN 51.45 AND 51.60
lon BETWEEN -0.23 AND 0.10
```

Assumption/Limitation:

- *TfL API does not expose borough boundaries; bounding box used for feasibility.*
- Power ratings missing on ~X% of connectors → default classification `unknown`
- Operator naming normalized but not joined to external taxonomy

- **Scheduling**

The DAG is orchestrated in Cloud Composer and is fully repeatable. Scheduled to run weekly.



Composer (Airflow)

Data Modeling

Key Entities

Entity	Description
Station	Physical EV charging site
Connector	Individual charging plug

Entity Relationship

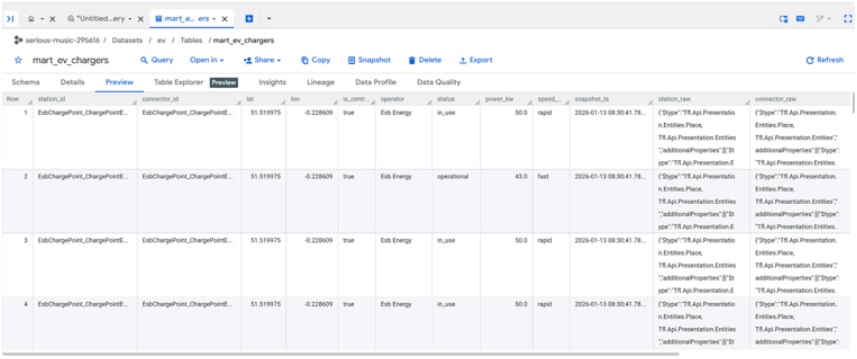
- Station (1)---(N) Connector
- One charging station → serveral charging connectors (plugs)
- ```
  station.id <-> connection.ParentStation
  ```

Charging Speed Classification

Power (kW)	Category
>= 50	Rapid
>=22	Fast
>=7	Slow
else	Unknown

Status Normalization

Tfl Raw Data	Normalized
Avaliable	operational
Occupied/ Charging	in_use
Unavailable	out_of_service
null/ other	unknown
  ```



Snapshot of curated data in BigQuery

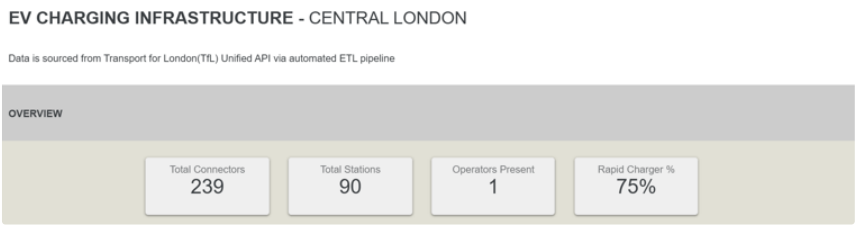
Data Dictionary

```
mart_ev_charger
```

Field	Type	Description
station_id	STRING	Unique station identifier
connector_id	STRING	Unique connector identifier
lat	FLOAT64	Latitude
lon	FLOAT64	Longitude
operator	STRING	Charging network operator
status	STRING	Normalized operational status
power_kw	FLOAT64	Charger power rating
speed_category	STRING	{rapid, fast, slow, unknown}
is_central_london	BOOL	Spatial filter flag
snapshot_ts	TIMESTAMP	Pipeline snapshot time
station_raw	JSON	Raw TfL station payload
connector_raw	JSON	Raw TfL connector payload

Dashboard Summary

EV Charging Infrastructure Central London

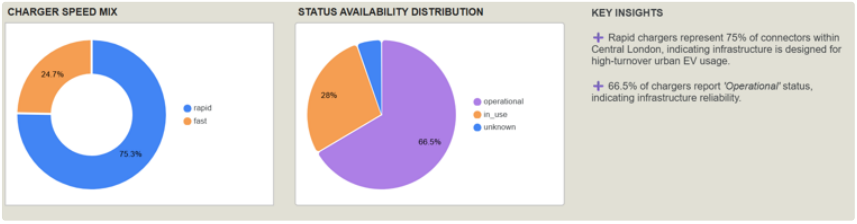


KPIs show:

- **239 connectors**

- **90 stations**
- **Rapid charger: 75%**
- **Operator count: 1 (ESB dominates)**

Interpretation: Central London infrastructure is skewed toward rapid charging, supporting high-throughput usage behaviours (commercial/taxi fleets).



Charger Speed Mix:

- 75% rapid vs 25% fast — no slow chargers captured in this zone.

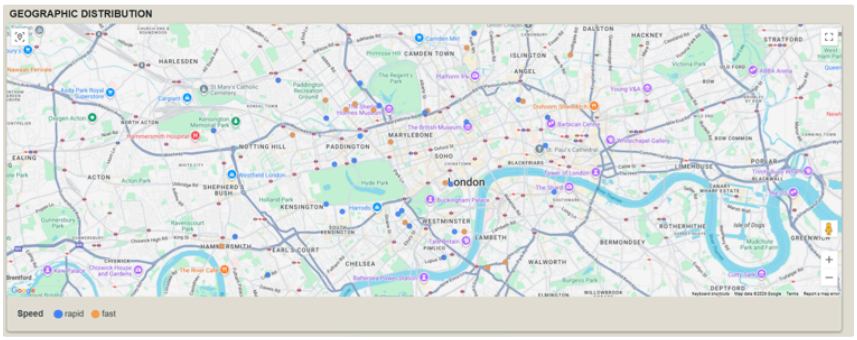
Interpretation: Infrastructure optimized for turnover + short dwell-time urban drivers.

Status Distribution:

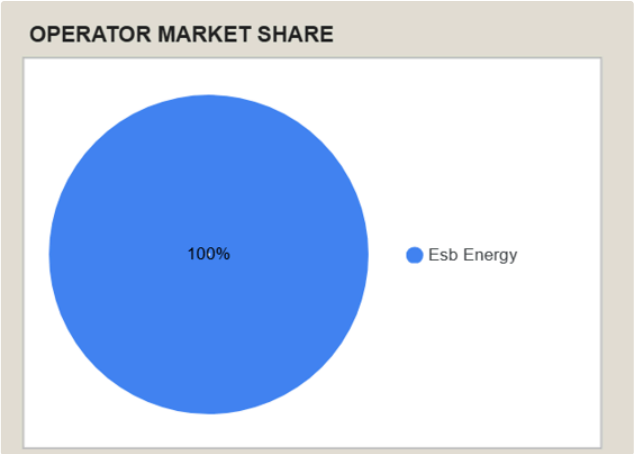
- Operational: 66.5% | In_Use: 28% | Unknown: remainder

Interpretation: High operational uptime suggests network reliability + usage density.

Geographic Distribution (Map):



- Connectors are clustered around
  - Soho
  - Westminster
  - Camden
  - Kensington
- Coverage aligns with commercial activity zones.



Operator Market Share:

- ESB Energy controls 100% of the connectors in the filtered region.